The Variability and Optimization of Mental Toughness

Submitted by Ken Bradford Cooper to the University of Exeter

as a thesis for the degree of

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……  ……

The Variability and Optimization of Mental Toughness

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Dedication

To Suzanna Lynn, the calm in the storm, the cool whisper of encouragement on a hot summer day, the hope for a better tomorrow and, Lord willing, the hand to hold through it all for the rest of our days.

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The PhD journey is like no other – and it does not come to fruition without the insights, sacrifices, encouragement and guidance of a virtual assembly of key contributors…

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Abstract

This thesis examined within-person variability and potential optimizers of mental toughness through a literature review and four central studies, three of which have been published and a fourth currently under review. Study I focused on within-person mental toughness and potential optimizers in a single elite Masters athlete across a series of endurance events (3,000 mile Race Across America, Hawaii Ironman Triathlon World Championship qualifier and a sub-3 hour marathon) over a five month period and beginning six weeks after a bike wreck resulted in eight fractures and an increased emphasis on the mental aspects of the events. Notable variability and potential optimizers were both identified via an autoethnographic approach. The second study expanded upon the first by investigating the presence of within-person variability and potential optimizers in a group of 13 elite Masters athletes. In addition to the larger group of participants, Study II also identified within-person mental toughness variability, utilizing the Mental Toughness Index (Gucciardi, 2015) to specifically track the potential variability over a 30-day period. The exploratory case study design also included collection of qualitative data regarding the potential optimizers and lead to the development of three primary higher order themes of mental toughness optimizers: Thrive, Prepare and Activate. Study III examined the influence of sleep on mental toughness, a potential optimizer identified previously within the Thrive and Prepare higher order themes. Within-person variability in mental toughness was again demonstrated and while sleep was not shown to be related to mental toughness in all participants as hypothesized, it was an influencer of mental toughness in the majority of participants. In addition, Study III provided insights into additional buoys of mental toughness utilized by participants when sleep was limited. Study IV then investigated whether self-talk

(identified previously as a potential optimizer under the Prepare and Activate themes) influenced mental toughness and performance. The influence of self-talk on mental toughness and performance was demonstrated. The thesis concludes with a discussion about the findings, their implications for additional settings and applications, and future research opportunities.

Publications and Presentations Resulting from Thesis Development

Publications

- Cooper, K. B., Wilson, M. R., & Jones, M. I. (2018). A 3000-mile tour of mental toughness: An autoethnographic exploration of mental toughness intra-individual variability in endurance sport, *International Journal of Sport and Exercise Psychology*, doi.org/10.1080/1612197X.2018.1549583
- Cooper, K. B., Wilson, M. R., & Jones, M. I. (2019). The impact of sleep on mental toughness: Evidence from observational and N-of-1 manipulation studies in athletes. *Sport, Exercise, and Performance Psychology*. Advance online publication. doi.org/10.1037/spy0000174
- Cooper, K. B., Wilson, M. R., & Jones, M. I. (2019). An Exploratory Case Study of Mental Toughness Variability and Potential Influencers over 30 Days. *Sports, 7, 156*. doi.org/10.3390/sports7070156
- Cooper, K. B., Wilson, M. R., & Jones, M. I. (Under review). Fast talkers? Investigating the influence of self-talk on mental toughness and finish times in 800-meter runners. Submitted for publication August 13, 2019.

Presentations

Academic Conferences

- December 2018 – Oral presentation: Optimizing Mental Toughness. BPS Division of Sport and Exercise Psychology Annual Conference; Belfast, Northern Ireland.
- July 2019 – Oral presentation: Sleep Quality and Quantity Related to Mental Toughness. European Congress of Sport & Exercise Psychology; Munster, Germany.
- July 2019 – Symposium: Self-regulation of Endurance Performance: Novel Research Findings (Symposium with Dr Carla Meijen, Dr Samuel Marcora, Dr Martin Jones). European Congress of Sport & Exercise Psychology; Munster, Germany.

Professional Conferences/Event Oral Presentations

- November 2017 – Guest Lecturer – Health & Wellness Coaching Methods. Department of Health & Human Performance. Metropolitan State University; Denver, CO.
- November 2017 – Guest Lecturer – Health Promotion Capstone Course. Department of Health & Exercise Science. Colorado State University; Ft. Collins, CO.
- May 2018 - Mental Toughness: How it Works in the Real World and Why You Should Care. Association of Legal Administrators National Conference; National Harbor, MD.

- May 2018 – University of Colorado (UCCS) Business School graduation event keynote speaker. Colorado Springs, CO.
- May 2018 – IRONMAN Pre-race Swimlabs Endurance Performance Panel. Centennial, CO.
- July 2018 – Applying Mental Toughness to Clinical and Wellbeing Settings. Panorama Orthopedics and Sports Medicine team event; Golden, CO.
- October 2018 – The Strength to Endure. Avail Partners Corporate Special Event; Denver, CO.
- January 2019 – Optimizing Reality! (lunchtime keynote presentation). GCHRA Conference - Kenwood Country Club; Cincinnati, OH.
- April 2019 – How Mental Toughness Insights Can Impact Your Wellbeing Outcomes. The Art & Science of Health Promotion; Hilton Head, SC.
- April 2019 - The Role of Mental Toughness in Nutrition and Wellness. Academy of Nutrition and Dietetics Annual Symposium; Phoenix, AZ.
- August 2019 - Real World Wellness: 5 Keys to Engagement, Application and Outcomes. HR Florida SHRM Conference; Kissimmee, FL.
- September 2019 – Thrive: Putting Our (Exclamation) Mark on the World. Rocky Mountain Health & Wellness Coaching Retreat; Estes Park, CO.
- October 2019 – Beyond Grit: Optimizing Performance & Coaching Outcomes through the Integration of Functional Mental Toughness. National Wellness Conference; Kissimmee, FL.

Chapter One: Introduction

Introduction

I wasn't a very tough kid.

Growing up in a middle-class, suburban Colorado neighborhood in the 1970's, we spent every free moment playing basketball or football. However, fights were so unusual that I still remember the day in 6th grade when a classmate, angry about something occurring in a basketball game, started punching me as I was heading home and I had no response. I could swish a 3-pointer, throw a perfect spiral and fake out a defender. But fight? That just wasn't me…

That was 42 years ago. Over the four plus decades since that day, I've had the opportunity to work with some incredible athletes as a certified athletic trainer, treated patients recovering from orthopedic and neurological injuries as a licensed physical therapist, come alongside employees looking to improve their personal health and wellness and coaches looking to help others do the same as the CEO of a national wellness company, and personally competed as an elite Masters runner and triathlete in over 200 events, including the 3,000 mile Race Across America and 11 Ironman Triathlons, with four of those occurring at the Ironman World Championship in Kona, Hawaii. Along the way, I've also watched those close to me struggle through unexpected disease, divorce, and career debacles. In the process, I had come to the personal conclusion that mental toughness plays a critical role in every aspect of life – not simply for those who make their living within the confines of a boxing ring. I had also surmised that mental toughness varied across different situations and circumstances and might just be malleable.

As an athlete, I craved the discovery of new "secrets" to optimal performance. As a father, husband, and friend, I wanted to learn how to best support those close to me in their own pursuits. As the CEO of an organization focused on

helping individuals from all walks of life move toward “better than yesterday” in their own health and wellbeing, I was looking for how we could help the broader community. The answers to these questions were beginning to be examined (Clough, Earle, & Sewell, 2002; Gucciardi, 2017; Jones, Hanton, & Connaughton, 2002). However, the opportunity to contribute to the scientific community as well as expand potential application beyond traditional military, student and elite athlete settings led to the pursuit of this PhD.

Purpose and Structure of this Thesis

The purpose of this thesis is to report a program of research on the variability of within-person mental toughness and identification of potential optimizers of that within-person mental toughness. An interpretive, post-positivist qualitative approach to MT was emphasized in the early MT research and I will be building on that established foundation as my primary research methodology. This thesis is underpinned by pragmatic research, by which pluralistic methods are utilized during multiphase research studies (Giacobbi, Poczwardowski, & Hager, 2005). One core emphasis of my research is an effort to shift the mental toughness discussion away from comparing the mental toughness of one person to that of another (between-person) and instead focus in on the within-person variability and opportunities each individual may have to enhance their own mental toughness, regardless of starting point or comparison to peers, teammates or competitors. This is not done with the intent to ignore the trait-like aspects of mental toughness previously noted in the literature (Beattie, Alqallaf, Hardy, Ntoumanis, 2019). For example, sub-dimensions of mental toughness such as optimism are considered to be trait-like. These and other sub-dimensional traits helped set the stage for the reference to capacity (cMT) and functional (fMT) mental toughness. The cMT brings in the influence of the trait

elements of mental toughness while the fMT places the emphasis on how to optimize the available mental toughness. The focus of this thesis is to address the existence and utilization of potential optimizers for each individual, regardless of current baseline. As such, our initial study can be construed as an analytic autoethnography (Andersen, 2006) with a flavour of evocation (Ellis, 1995). This was followed by a qualitative exploratory case study (Study II), a study utilizing a longitudinal N-of-1 methodology (Study III), and a single subject, multiple baselines research methodology (Study IV). The decision to focus on qualitative studies emphasizing the individual was made to explore personal changes that can get lost in group-based designs (Vieira et al., 2017).

The core of this thesis is comprised of six primary sections, including an extensive literature review, four peer-reviewed studies and a broader discussion. Three of the studies have been published in international journals and the fourth is currently under review for publication. Following the Literature Review, our initial study (A 3000-mile tour of mental toughness: An autoethnographic exploration of mental toughness intra-individual variability in endurance sport, *International Journal of Sport and Exercise Psychology)* investigated the presence of within-person mental toughness variability in a single Masters athlete across three high-level endurance events over a five month period (3,000 mile Race Across America cycling event, qualifying for the Hawaii Ironman World Championship, and running a sub-3 hour marathon), six weeks after a bike wreck resulted in eight fractures to the ribs, clavicle and pelvis.

The individual variability in, and potential optimizers of, mental toughness resulted in curiosity regarding whether the within-person variability and optimizers were only true for me based on my own unique background? Or would similar

findings be noted more broadly across a larger group of individuals. To investigate this further and determine whether similar effects were prevalent in other athletes, Study II then examined the within-person mental toughness variability across multiple elite Masters athletes (An Exploratory Case Study of Mental Toughness Variability and Potential Influencers over 30 Days, *Sports*). The findings in Study II lead to the development of the functional mental toughness (fMT) model, which included Thrive, Prepare and Activate as three higher level themes providing strategies through which individuals could influence their personal availability and accessibility of mental toughness. The expanded results about within-person variability as well as the initial fMT model design were intriguing, but a closer look at the elements identified as potential optimizers was necessary and this was addressed in our two final studies.

Sleep was one of the aspects identified to have overlapping influence under the Thrive and Prepare sections of mental toughness optimizers in Study II. It had also been studied previously with adolescents (Brand, et al., 2014) in relation to mental toughness but not in Masters athletes and not in the same direction (e.g., previous research examined how mental toughness influenced sleep rather than how sleep influenced mental toughness as a potential optimizer). Consequently, Study III (The impact of sleep on mental toughness: Evidence from observational and N-of-1 manipulation studies in athletes, *Sport, Exercise, and Performance Psychology)* then took a closer look at the influence of sleep on mental toughness. Self-talk was also a potential optimizer identified in Study II within the Prepare and Activate categories. Self-talk is a key element within sports psychology (Van Raalte, et al., 2016) but has not been studied in relation to the potential influence on mental toughness. Thus, the concluding study included in this thesis then investigated the influence of self-talk

(Fast talkers? Investigating the influence of self-talk on mental toughness and finish times in 800-meter runners, *under review)* on within-person mental toughness.

Chapter Two: Literature Review

Literature Review

> A lot of people run a race to see who is fastest. I run to see who has the most guts, who can punish himself into an exhausting pace, and then at the end who can punish himself even more.

Those words (Putnam, 1972) were spoken by Steve "Pre" Prefontaine, who, at the time of his fatal car crash at age 24 and still years from his prime as a distance runner, held every single American running record from 2,000 up to 10,000 meters. While Prefontaine had the physical gifts allowing him to compete at the highest levels, he consistently pointed to his willingness to mentally push himself further, to access an elevated level of mental toughness than his competitors as the ultimate key to his success. The construct of mental toughness has been defined as a "psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal-directed pursuits" (Gucciardi, 2017, p. 18). This purposeful, psychological (rather than merely physical) resource was Prefontaine's "more" that allowed the race to go beyond "who is fastest." However, was this mental "more" something Pre was born with that did not change, or was it a variable he developed over time? A brief description from his biographer provides some initial insight:

> Scott (teammate) might have blown by him at one part of the workout. Three days later, Pre just obliterated him, and you realized what had happened: Pre had gone home, and for the next 48 hours had mentally prepared (Jordan, 1997, p. 97).

Is this "more" available to anyone? Is it identifiable, measurable, and potentially even malleable? The purpose of this PhD is to attempt to provide an answer to this question. In contributing to the overall thesis, the aim of this literature

review is to identify initial answers available within the scientific community to this point of variability and malleability and the opportunities to build upon the shoulders of these researchers.

Interest within the scientific community about the concept of mental toughness has expanded significantly over the past decade. A search within Web of Science on July 27, 2019, using “Mental Toughness” as the topic search criteria revealed just 25 total articles in publication on the subject before 2006. From 2006-2015, the number of articles increased to 189. Since 2016, an additional 246 articles have been published. Almost 50% of all research studies ever performed on mental toughness has been published in the past three years (see Figure 1*:* Published studies with mental toughness in the topic).

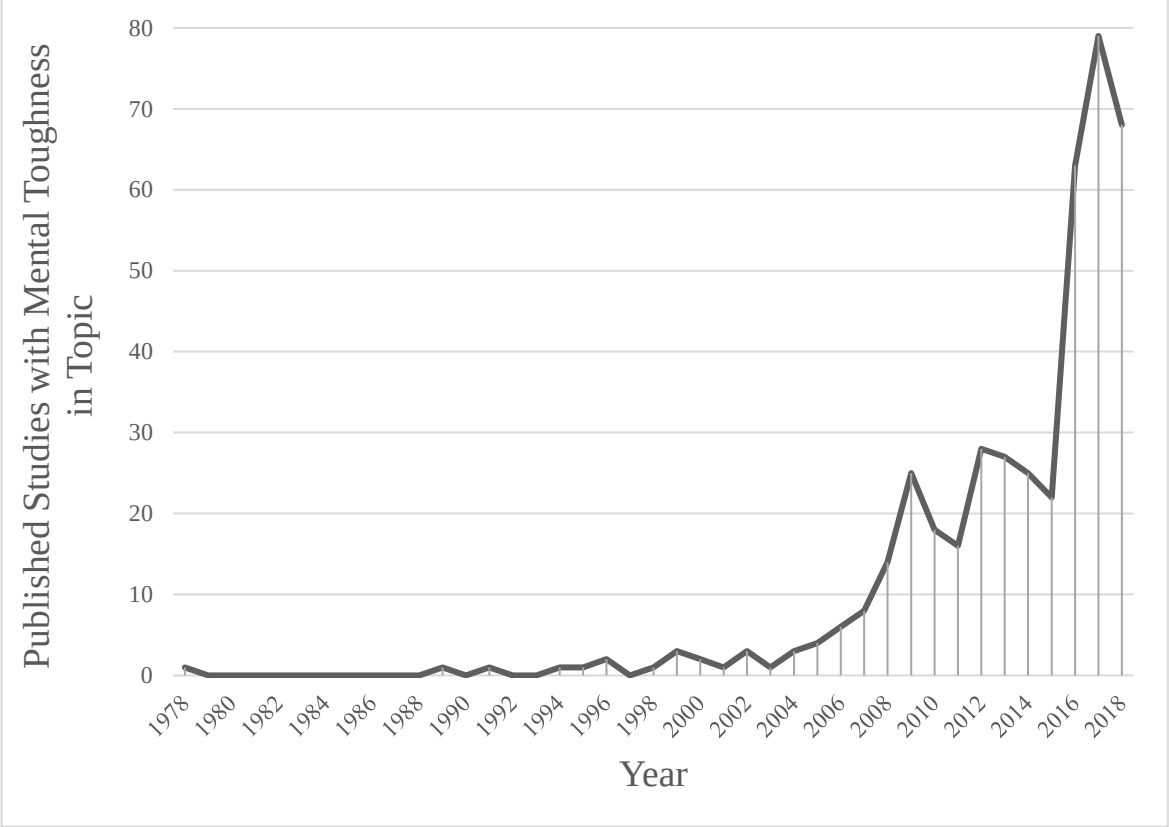


Figure 1*:* Published studies with mental toughness in the topic

The interest in the study of mental toughness in the research community is increasing significantly. However, it is unclear whether these trends indicate a similar interest and application among individuals, coaches, and others who are looking for ways in which to improve performance across a range of settings and situations. For those where an application of mental toughness is of critical importance, it is crucial to determine whether mental toughness is a malleable construct that can be optimized and activated when needed most or a generally stable trait that may be interesting to analyze and track but of little value to those desiring to improve outcomes in the real world. Investigating what the currently available research indicates in terms of whether mental toughness can be optimized is the purpose of this literature review. I will provide an overview of the mental toughness literature and existing data on within-person variability, consider the theoretical underpinnings of mental toughness and the variables and condition that might influence within-person variability, and examine prior interventions used to optimize mental toughness in athletes.

What Do We Know About Mental Toughness?

Recent literature reviews (Cowden, 2017), meta-studies (Anthony, Gucciardi, & Gordon, 2016) and systematic reviews (Liew, Kuan, Chin, & Hashim, 2019) have provided summary insights about mental toughness. These reviews have noted improved outcomes in performance and achievement, but point to limitations based on inconsistent definitions, measurement, and cross-sectional research methodologies. Among these is a continued discussion about whether the construct is multi or unidimensional. It was also noted that the interdependence between the individual and the context in which the mental toughness is utilized is an essential factor (Anthony et al., 2016). My purpose in this section of the literature review is

not to re-create the depth provided in these studies but rather to provide an overview of the construct of mental toughness and set up the viewpoint I will be taking forward and testing in my thesis.

References before 2000

Before 2000, athletes and coaches commonly used the term mental toughness, but there was little empirical research to flesh out what it meant or how to optimize it (Jones, Hanton, & Connaughton, 2002). Mental toughness was generally used by pundits and commentators to describe successful athletes, but psychologists had not studied the construct in-depth. The literature on the construct was generally relegated to the popular press (Loehr, 1986) and a handful of scientific studies such as investigating the interaction between motivation and mental toughness (Dennis, 1978). However, references to the notion of mental toughness date back thousands of years; promptings to be mentally "strong and courageous" (Joshua 1:9, New International Version) appear throughout the books of Deuteronomy and Joshua written in the 7th century BC, and Marcus Aurelius, in the second century CE, was credited with "You have power over your mind — not outside events. Realize this and you will find strength" (Aurelius, 2013, book IV, passage 3). Rocky Balboa, from the 1976 film that won Best Picture was identified (Caddick & Ryall, 2012a) as representing the "Hollywood hero" characteristics of mental toughness that allows him to achieve ultimate success. The opposite of this "ability to push oneself to one's physical, mental, and emotional limits in pursuit of victory" (Caddick & Ryall, 2012, p. 140) is the natural inclination for human beings to select the alternative that requires the least amount of energy. The natural desire to minimize the need for an internal push to the limit was noted by a linguist in reference to our choice of words (Zipf, 1949). Similarly, an economic interpretation connecting the natural resistance

to a mental and physical effort was noted 50 years later: “Economists instinctively assume [that] thinking is a costly activity… mental effort is like physical effort – people dislike both” (Camerer & Hogarth, 1999, p. 9). These early references offered little in terms of scientific analysis or understanding but did set the stage for the mental toughness research that would follow.

2000-2015

With the turn of the century, mental toughness appeared to garner increasing interest from the academic world. 2000-2015 marked a period during which the number of published studies demonstrated an initial increase before the escalated spike occurred in 2016. In a qualitative study of English Channel swimmers, mental toughness was identified as “tenacity for success” (Hollander & Acevedo, 2000, p. 5) and was also associated with lower mood disturbance. A qualitative study titled “What is this thing called mental toughness?” (Jones, Hanton, & Connaughton, 2002) defined the term and identified 12 specific attributes associated with mental toughness. The definition, specific to athletics, was “Mental toughness is having the natural or developed psychological edge that enables you to: Generally, cope better than your opponents with the many demands (competition, training, and lifestyle) that sport places on a performer. Specifically, be more consistent and better than your opponents in remaining determined, focused, confident, and in control under pressure” (Jones, Hanton, & Connaughton, 2002, p. 209). This definition was followed with the statement, “therefore, mental toughness provided the performer a psychological advantage over opponents” (p. 209).

The top-ranked attribute of mental toughness was self-efficacy, identified as “Having an unshakable self-belief in your ability to achieve your competition goals” (Jones, et al. 2002, p. 211). The remaining items in the top five included bouncing

back via increased determination, a self-belief in what makes you better than opponents, a full focus, and a strong desire to succeed. A related study that identified a list of 30 attributes of mental toughness (Jones, 2007) clustered them into four dimensions as attitude/mindset, training, competition, and post-competition. These included both internal (belief, focus, handling pressure) and external (controlling the environment, using long-term goals) elements and made note of the ability of these super-elite athletes (those who would likely be in settings where mental toughness would more often be valued and practiced) to more effectively articulate mental toughness with greater awareness than others.

In the same year, the 4C's (control, commitment, challenge, and confidence) model of mental toughness was introduced along with the Mental Toughness Questionnaire 48 or MTQ48 (Clough, Earle, & Sewell, 2002) by adding confidence to the previously established hardiness construct (Kobasa, 1979). Validity and reliability of the MTQ48 have been questioned (Gucciardi, Hanton, & Mallett, 2013) but it remains one of the most widely utilized assessments of mental toughness (Vaughan, Hanna, & Breslin, 2018). It has been utilized to examine mental toughness related to attendance, pain tolerance, coping, and the use of psychological strategies (Perry, Clough, Crust, Earle, & Nicholls, 2013).

Bull, Shambrook, James, and Brooks (2005) developed the mental toughness pyramid. Bull et al. compared mental toughness to a vehicle, in which Environmental Influence – Tough Character – Tough Attitudes - Tough Thinking were analogous to The Production Line – The Engine – The Fuel - The Performance, respectively (Bull, Shambrook, James, & Brooks, 2005). Bull et al. also identified different types of mental toughness, ranging from that required by endurance athletes continually pushing the body to the mental toughness of a golfer making a final putt

to a cricket player willingly entering a high-intensity setting. In terms of the eventual outcome or performance, the aspect of tough thinking shifted the emphasis to what happens in the context of the moment when mental toughness is needed most – the heat of the competition. Within this "tough thinking" construct, components including robust self-confidence and clear thinking are highlighted. There was also mention of the influence of personal physical conditioning on mental toughness as previously suggested in the popular press (Loehr, 1995). The mind cannot draw from an empty well if the body is not prepared to support the request. The mental toughness pyramid (Bull et al., 2005) provided a framework around which malleable mental toughness could be positively influenced through environment and training strategies.

In a 2007 review of the topic, Crust (2007) set the stage for the coming expansion of mental toughness research, noting that while those making their home in sport (athletes, coaches, and sports psychologists) consistently reference the term as being of critical importance, actual study of the construct has been a very recent occurrence. He noted that previous researchers have fallen short in forming adequate definitions of mental toughness and proceeds to identify the shortcomings. These deficiencies ranged from a focus on what MT allows one to do (rather than how it is defined) to a lack of uniformity in perceptions across the study participants (Crust, 2007). Tibbert (2013) identified a set of nine core characteristics as being self-belief, coping/handling pressure, attentional control (focus and concentration), motivation, control, sporting intelligence/knowledge, tough/resilient attitude, personal values, and physical toughness. These nine characteristics compare positively with the seven indicators of mental toughness from Gucciardi et al. (2015), which encompassed

generalized self-efficacy, buoyancy, success mindset, optimistic style, context knowledge, emotion, and attention regulation.

Mental toughness is not restricted to the achievement of high-level goals, as noted in sport-specific studies (termed "thriving"). Instead, (Gucciardi, Hanton, Gordon, Mallett, and Temby, 2015) also proposed to extend it to "striving" (the process of working toward goals) and "surviving" (the daily grind of life). Gucciardi et al. suggested that mental toughness is fundamental for all three of these (thrive, strive, and survive) across various aspects of life.

Previous descriptions of mental toughness as a multi-dimensional concept (Clough et al., 2002; Coulter, Mallett, & Gucciardi, 2010; Jones et al., 2002) were challenged by a new unidimensional mental toughness assessment (Gucciardi, Hanton, Gordon, Mallett, & Temby, 2015c). The assessment was developed as part of a series of related studies. The first focused on generating items that would reflect mental toughness followed by a second study to refine the first items into a shorter version, which was termed the Mental Toughness Index (MTI). The third and fourth studies in this series utilized the MTI to examine mental toughness (and the effectiveness of the assessment) in work, education, and military settings. In the process, a clarified definition of the construct also developed as "A personal capacity to achieve consistently high levels of subjective (e.g., personal goals or strivings) or objective (e.g., sales, race time, GPA) performance despite everyday challenges and stressors as well as significant adversities" (Gucciardi et al., 2015, p. 28).

The period between 2000 and 2015 effectively expanded upon the understanding and general framework of mental toughness. It provided insight regarding what it looks like (Jones et al., 2002), ways to measure it (Gucciardi, Hanton, Gordon, Mallett, & Temby, 2015a), what it allows you to do, and

characteristics of a mentally tough individual (Tibbert, 2013). However, the construct often continued to be viewed in the broader context (you have it – consistently - or you do not) in comparing one individual to another and tying it more closely to "super athletes" than others. The key contention of this thesis is that a comparison to others may not be the most valuable aspect of mental toughness. Focusing on between-person comparisons may be simply giving the construct credit for any outcome variable the observer cannot attribute to a measured physical attribute. Instead, turning the focus toward within-person mental toughness and the opportunity to improve one's own performance (which then may contribute to exceeding that of an opponent) may be more meaningful for real world integration. Additionally, many studies utilized a cross-sectional research design and the retrospective recall of events and responses or the perspectives of others (e.g., coaches) to interpret the levels of mental toughness rather than a longitudinal research design. Qualitative studies identified variability in mental toughness and related antecedents but rarely combined within-person variability with those antecedents. Specific guidance for individuals to improve their mental toughness for a specific pursuit at a specific time remained limited.

2016 to present

The most recent period represented a threefold increase in published mental toughness literature and included an examination of mental toughness across a broader spectrum of settings and outcomes, including education, careers, psychological well-being and personality (Lin, Mutz, Clough, & Papageorgiou, 2017). The interaction between self-compassion, mindfulness and mental toughness (and the impact of self-compassion and mindfulness on the development and maintenance of mental toughness) was identified as part of the "zipper effect" in a

study of elite Canadian women athletes (Wilson, Bennett, Mosewich, Faulkner, & Crocker, 2019). Psychological skills training was reported to increase mentally tough behaviors in military personnel (Fitzwater, Arthur, & Hardy, 2018) but the study did not measure mental toughness aside from instructor ratings. A study involving Paralympians identified two themes (formative experiences and support/coping resources) and multiple subthemes in the development of mental toughness (Powell & Myers, 2017). However, neither actual variation nor malleability in mental toughness was measured as part of the study, and the gaps addressing the positive optimization of mental toughness continued during this period.

Mental toughness was shown to have a positive impact on psychological well-being in the elderly (Sohrabi, Abedanzade, Boushehri, Parsaei, & Jahanbakhsh, 2017) and examined as an antecedent of Olympic distance triathlon performance (Jones & Parker, 2017; Meggs, Chen, & Koehn, 2018). A positive correlation was noted between self-awareness and mental toughness and extrapolated as a potential opportunity for the development of additional mental toughness (Cowden, Clough, & Asante, 2017). The interaction between mental toughness and stress in athletes demonstrated a benefit in that those individuals with higher mental toughness reported less mental health issues when in high-stress situations and mental toughness was shown to offset some of the adverse effects of the stress in these young elite athletes (Walter et al., 2018). While this study did not point to the optimization of mental toughness, it did highlight a key area that would benefit from such optimization beyond actual sports performance.

A summary of key definitions and related comments related to each is provided in the following table (see Table 1):

Table 1: *Mental Toughness Definitions and My Comments/Critiques*

Mental Toughness Definitions	***My Comments/Critiques***
Loehr (1994, p. 5) - "Toughness is the ability to consistently perform toward the upper range of your talent and skill regardless of competitive circumstances."	*Emphasis on the individual is a valuable component.* *Wording indicates competition setting (or lack thereof) is not influencer of MT.* *Not all situations require use of MT as physiological capacity may be adequate at lower levels.*
Jones et al. (2002, p. 209) - "Having the natural or developed psychological edge that enables you to, generally, cope better than your opponents with the many demands (competition, training, lifestyle) that sport places on a performer and, specifically, be more consistent and better than your opponents in remaining determined, focused, confident, and in control under pressure."	*Identified as an "edge" or something that does make a difference when needed is important element.* *Definition centers on outcome of MT rather than what MT actually is.* *Inclusion of "more" and "better" (than opponent) wording puts emphasis on between-person comparison and ignores the opportunity for each individual to positively impact within-person MT.*

Clough et al. (2002, p. 38) - "Mentally tough individuals tend to be sociable and outgoing; as they are able to remain calm and relaxed, they are competitive in many situations and have lower anxiety levels than others. With a high sense of self-belief and an unshakeable faith that they control their own destiny, these individuals can remain relatively unaffected by competition or adversity."	*The indication that MT holds value across a multitude of situations brings additional value to construct.* *"…sociable and outgoing" implies extrovert MT exceed introvert MT. This is inconsistent with introverted endurance athlete general reputation.* *In addition, the emphasis on remaining "calm and relaxed" discounts potential benefit an emotional response may provide as MT catalyst.*
Fletcher (2005, p. 158) – "An individual's propensity to manage the demands of environmental stressors, ranging from an absolute resilience to extreme vulnerability."	*Focus on the individual without necessarily comparing to others is a positive.* *"Managing the demands" points toward resilience and survival rather than strive and/or thrive pursuits.*
Thelwell et al. (2005, pp. 328-329) – "Mental toughness is having the natural or developed	*Generally a remix of Jones 2002 definition. Use of the word "always" is red flag (not possible to "always cope better.")*

psychological edge that enables you to always cope better than your opponents with the many demands (competition, training, and lifestyle) that soccer places on the performer. Specifically, be more consistent and better than your opponents in remaining determined, focused, confident, and in control under pressure."	
Gucciardi et al. (2008, p. 278) - "Mental toughness in Australian Football is a collection of values, attitudes, behaviours, and emotions that enable you to persevere and overcome any obstacle, adversity, or pressure experienced, but also to maintain concentration and motivation when things are going well to consistently achieve your goals."	*Use of word "persevere" and "maintain" may lead to possibility that MT extends an already present capacity at least a little bit longer than could be done in absence of adequate MT.* *Specific to Australian Football. Use of word "any" is unrealistic red flag.* *Outcome of "consistently achieve your goals" not a given as outcomes benefit from MT but are also dependent upon a multitude of other factors such as physical training that influence eventual outcome.*

Gucciardi et al. (2009a, p. 67) - "Mental toughness is a collection of experientially developed and inherent sport-specific and sport-general values, attitudes, emotions, and cognitions that influence the way in which an individual approaches, responds to, and appraises both negatively and positively construed pressures, challenges, and adversities to consistently achieve his or her goals."	*The integration of influence of MT to positive pursuits (rather than only stressors) is important addition to the discussion.* *MT does not need to be limited to sport-specific settings.* *Use of "consistently achieve" a concern based on above note (other elements involved in achieving outcome).*
Coulter et al. (2010, p. 715) - "Mental toughness is the presence of some or the entire collection of experientially developed and inherent values, attitudes, emotions, cognitions and behaviours that influence the way in which an individual	*Similar to Gucciardi 2009 definition but moves beyond the sport-specific context.* *"…the entire collection of…" is an extremely broad brush.* *It also appears to focus on elements that are involved in optimizing MT rather than identifying actual MT itself.*

approaches, responds to, and appraises both negatively and positively construed pressures, challenges and adversities to consistently achieve his or her goals."	
Mallett and Coulter (2011, p. 191) - "Mental toughness is associated with the pursuit of goals in achievement contexts, and in that quest, particular values, attitudes, emotions, cognitions, and behaviours seem to influence the way in which an individual approaches, responds to, and appraises both negatively and positively construed pressures, challenges and adversities."	*Appears to continue the move from sport-specific to potential impact beyond the athletic setting.* *MT is "associated with…"? Many things are associated with pursuit of goals. Definition should indicate what MT is rather than items with which it's associated. Breathing is associated with pursuit of goals too, but that doesn't make breathing MT.*
Clough and Strycharczyk (2012, p. 1) - "The quality which determines in large part how	*Emphasis (albeit potentially too much emphasis) on the value of MT across a number of settings.*

people deal effectively with challenge, stressors and pressure… irrespective of prevailing circumstances."	*Aren't there a multitude of qualities that determine how people deal with these, such as background, training, peer group, etc? MT does influence this but it's accompanied by a multitude of other aspects.*
Mahoney, Gucciardi, Mallett, and Ntoumanis (2014, p. 234) - "A collection of personal characteristics (i.e., forces, resources, and demands, discussed later) that allow individuals to regularly perform to or around the best of their abilities regardless of circumstances faced."	*Further extension of definitions moving beyond exclusively athletics. Emphasis on the individual noted and shifts outcome from "consistently achieve" to be "to or around" (their best).* *The phrase "regardless of circumstances faced" appears to be too extreme. MT makes a difference, but even in its strongest form, there are circumstances it cannot overcome.*
Hardy et al. (2014, p. 70) - "The ability to achieve personal goals in the face of pressure from a wide range of different stressors."	*This definition seems to move focus to include all personal goals, inside or outside of sport.* *The ability to achieve personal goals is dependent upon a wide range of factors and not exclusively MT.*

Gucciardi et al. (2015, p. 28) - "A personal capacity to produce consistently high levels of subjective (e.g., personal goal achievement) or objective (e.g., race times) performance despite everyday challenges and stressors as well as significant adversities."	*Very positive shift to ways in which outcomes are measured (both subjective/objective elements) and furthers the inclusion of "everyday" aspects of life.* *The production of "consistently high levels" discounts possibility of variability of MT over time.*
Jones & Parker (2018) "Encompasses a positive mindset brought to bear in the presence of, or anticipation of, stress.	*Emphasis on mindset separates MT from the wide range of other components overlapping MT* *If a positive mindset in the face of stress is the core of MT, do we need a separate definition of MT?*

Measuring Mental Toughness

As the research tied to mental toughness continued to develop, so did attempts to measure the construct. The result has been the development of a wide range of assessments measuring different possible aspects of mental toughness. While it is not the focus of this literature review to examine all mental toughness measurement tools, there has been a proliferation. A sampling from among those developed to this point include the Psychological Performance Inventory (Loehr, 1986), Swimming Mental Toughness Inventory (Beattie, Alqallaf, & Hardy, 2017), Military Training Mental Toughness Inventory (Arthur, Fitzwater, Hardy, Beattie, &

Bell, 2015), Mental Toughness Behavior Scale (Anthony, Gordon, Gucciardi, & Dawson, 2017), Mental Toughness Inventory (Middleton, Marsh, Martin, Richards, & Perry, 2004), a second (unrelated) Mental Toughness Inventory (Hardy, Bell, & Beattie, 2014), the Mental Toughness Questionnaire 48 (Clough et al., 2002), Sports Mental Toughness Quotient (Sheard, Golby, & Van Wersch, 2009) and the Mental Toughness Index (Gucciardi et al., 2015c). I chose to critically examine three leading (i.e., widely used) measures to inform the research design of my studies by noting their structure, benefits, and limitations.

The Mental Toughness Questionnaire 48 (MTQ48: Clough et al., 2002) was one of the first and has since become one of the most widely used mental toughness assessments. The MTQ48 identified mental toughness as a multi-dimensional construct and was developed through interviews with elite athletes, coaches, and sport psychologists. The final format was built on the shoulders of the concept of hardiness (Kobasa, 1979), which incorporated the sub-dimensions of control, commitment, and challenge. The MTQ48 added confidence to these three to form the 4Cs of control, commitment, challenge, and confidence. It has been widely utilized both inside and outside of sport and is also marketed to organizations on various websites (e.g., mental toughness partners). The MTQ48 has received a significant critique since its creation as it "appears that the MTQ 48 has been uncritically adopted as a preferred tool for mental toughness measurement before a thorough examination of its dimensionality has been undertaken" (Gucciardi, Hanton, & Mallett, 2012, p. 202). Limited details on participants, data collection and rationale for the conceptualization of combining hardiness with confidence (Connaughton, Hanton, Jones, & Wadey, 2008) were noted as initial critiques and "empirical evidence detailed here (analysis) raises questions about the viability of the correlated

four-factor model hypothesized to underpin the MTQ 48 (Gucciardi et al., 2012, p. 209). Published follow-up discussions regarding the MTQ48 (Clough, Earle, Perry, & Crust, 2012; Gucciardi et al., 2012, 2013) questioned the MTQ48's conceptual underpinnings and cautioned scholars using this tool to assess mental toughness to report on the validity and reliability for the specific sample (Gucciardi et al., 2013). A 2018 study on the MTQ48 (Vaughan et al., 2018) came to similar conclusions, noting their results indicated caution when utilized with elite athletes as well as a need for further refining of the subscale level. Additionally, the statement "mentally tough individuals tend to be sociable and outgoing" (Clough et al., 2002, p. 38) appears at the surface to be unrelated to a construct commonly associated with solo activities such as ultra-marathons (Jaeschke, Sachs, & Dieffenbach, 2016) and mountaineering (Crust, Swann, & Allen-Collinson, 2016).

The Sports Mental Toughness Quotient or SMTQ (Sheard et al., 2009) is a three-factor 14-item model that centers on three factors: Confidence, Constancy, and Control for application, as the name indicates, specifically among athletes. Similar to the MTQ48, it identifies mental toughness as a multi-dimensional construct. At the time of its development, the SMTQ was noted as being "the only psychometrically acceptable mental toughness instrument that includes a measure of emotional and negative energy control, a characteristic routinely identified in the mental toughness literature" (p. 191). Initial reporting on the SMTQ noted the profile of someone with "high levels of mental toughness appeared to distinguish older, male, performers operating at the highest competitive standard" (Sheard et al., 2009, p. 192). As was noted with the MTQ48 referencing sociability as a central aspect of mental toughness, this reference to age, sex, and experience appears to be unrelated to the construct. Due to the multidimensionality and the questionable leaning toward

elevated scores related to age, sex, and experience (which would not be beneficial when measuring within-person variability or optimization of mental toughness), I determined this assessment was not our optimal choice.

The Mental Toughness Index (MTI: Gucciardi et al., 2015) utilized an eight-question, seven-point Likert scales. The eight questions were selected through a series of studies (Gucciardi et al., 2015) that began with a list of 70 items. The MTI incorporated seven facets (self-belief, attention regulation, emotion regulation, success mindset, context knowledge, buoyancy, and optimism) along with the ability to deal with adversity as the foundation of the assessment. The MTI created a unidimensional model and demonstrated an excellent fit and good-to-excellent factor loadings and validity when tested across athletes, students, military personnel, and employees, moving beyond the historical emphasis on athletes. This unidimensional model differed significantly from the multidimensional models provided previously by others (Coulter et al., 2010; Jones, 2002), including the MTQ48 and SMTQ. The relative brevity (8 questions, 7-point Likert scales) and availability to the public (unlike the MTQ48) provides a validated and reliable assessment for studying the variability and potential optimizers of mental toughness. It is for these reasons and the ability to serve as a direct assessment of mental toughness that the Mental Toughness Index was selected as the assessment of choice in our studies.

The Malleability Tension: State or Trait

One of the tensions in the mental toughness literature is whether mental toughness functions as a state or trait. For example, Clough (2002) and Hardy et al. (2014) reference mental toughness as a generally stable trait while others identify it as being more state-like and a combination of genetics, environment and social learning (Gucciardi et al., 2015c; Harmison, 2011). The wide range and often

questionable reliability and validity of assessments, questionnaires, indexes and inventories to determine levels of mental toughness across a spectrum of individuals, settings, time frames and circumstances also influences the state-trait tension. Such variety creates a lack of consistency in what is being measured and difficulty comparing results across settings.

Trait

Traits are identified as being "relatively enduring psychological characteristics that influence people's thoughts, feelings, and behaviours" (Nezlek, 2007, p. 791). These enduring, automatic patterns guide how individuals generally respond in various situations (Roberts, 2009). However, this distinction does not infer the characteristic will never change throughout a lifetime, but rather it remains stable over a set period such as a week or month.

Many of the early mental toughness studies and assessments treat mental toughness as a (generally) constant trait. For example, in a study with mono and dizygotic twins from North America and the MTQ48 as the tool of reference, mental toughness was defined as a trait (Horsburgh, Schermer, Veselka, & Vernon, 2009). It was noted that individual differences in mental toughness could be attributed to genetic and (nonshared) environmental factors. Horsburgh et al. went on to state, "this trait then, is behaving in the same manner as virtually every personality trait that has ever been investigated in a behavioral genetic study" (p. 104). Further, mental toughness (as assessed through the MTQ48 using the 4C's model of control, commitment, challenge, and confidence) is stated clearly to be a narrow personality trait (Clough et al., 2002). In a later study using the Mental Toughness Inventory, researchers noted no significant difference in a test-retest (three weeks later) and reliability of 0.96 (Bell, Hardy, & Beattie, 2013). This lack of variability over time

has been referenced as being an indicator that mental toughness is a trait-like construct. Further, mental toughness is often referred to in the same context as other personality styles where there is an approximate 50/50 split in variability tied to genetics or environment. Such a 50/50 split suggests a certain level of stability but also indicates a potential for the development of mental toughness (Cowden, 2016; Crust & Clough, 2011).

State

In contrast with the concept of a trait, a state may change both over time and across various situations. They can include psychological states, behaviors, and situational variables but are not defined by a specific period during which the state must exist (Nezlek, 2007). In addition to the trait-based references noted above, mental toughness has also been "defined as a state-like psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal-directed pursuits" (Gucciardi, 2017, p. 18). Rather than being generally consistent, a state-like construct may demonstrate variability based on setting, situation, and scenario. Conceptualizing mental toughness as a resource caravan (Gucciardi et al., 2015c) provided a manner in which variability was demonstrated across such settings, situations, and scenarios based on whether those exceeded the personal resources available within the individual.

Over time, additional state-like indicators were highlighted in the research, including a recent study involving 12 elite tennis players between age 14 and 20 years who reported a fluctuation in mental across various situations. The players identified various components ranging from emotion to specific behaviors when perceiving a sense of mental toughness (vs. mental weakness) and indicated they experienced both mentally tough and mentally weak responses in their training and

competition (Weinberg, Butt, Mellano, & Harmsion, 2017). Regarding characteristics of mental toughness, Gordon (2012) noted that the evidence to date suggested that while a portion of mental toughness is inherited, a varying amount is also a result of socialization and coaching.

In educational settings, within-person (state-dependent) variance in mental toughness was noted to represent 56% of the differences, which left just 44% due to between-person differential (Gucciardi et al., 2015c). Harmison (2011) echoed the reference to variance, stating mental toughness is a mindset that varies across situations and over time. Similarly, a study which utilized the Mental Toughness Inventory showed test-retest stability of the subscales to be relatively stable after 24 hours but then decreasing after three days (Tibbert, 2013), indicating a general lack of traitness. Tibbert clarified this further, saying "the test-retest correlations tell a different story (that is to) suggest is that most of the subscales have poor test-retest reliability, and whatever they are measuring is not trait-like" (p. 105). There was also a potential overlap between self-control and mental toughness that is tied to a state-like concept as self-control is shown to be an ever-changing combination of priorities, motives, and values (Inzlicht, Legault, & Teper, 2014; Kool, McGuire, Rosen, & Botvinick, 2010).

'Optimizers' of Mental Toughness

To "optimize" is to make something as effective as possible (Merriam-Webster's online dictionary, 2019). A central theme to my PhD research has been to identify potential optimizers of mental toughness – tools, resources and strategies that would allow individuals to positively impact the construct or make it as effective as possible. A variety of mental toughness optimizers have been identified in the literature. These are identified here as either an antecedent (affecting mental

toughness but not part of a purposeful intervention), or actual interventions performed to develop mental toughness. A book in the popular press (Sheard, 2010) refers to mental toughness as a mindset in the title, implying it is open to malleability and molding through specific mental skills training. Others (Bull, Albinson, & Shambrook, 1996; Gibson, 1998; Goldberg, 1998; Loehr, 1995) present a similar outlook on mental toughness, suggesting that the construct is at least partially subject to change. The scientific literature on specific interventions influencing mental toughness is limited but developing.

Antecedents

In a study involving swimmers, self-regulated training behaviors appeared to be a precursor to the assessment of self-reported mental toughness and the mental training behaviors rated by informants. Researchers noted, "at its worst, self-regulated training behaviors and self- assessed levels of MT explained 26% of the variance in informant ratings of athlete mental toughness behaviours" (Beattie et al., 2018, p. 189). The authors noted the importance of future research, exploring precisely which training behaviors help develop mental toughness. A separate study with ultramarathoners identified five themes of mental toughness development. These included camaraderie within the ultra-running community, experiences garnered from racing and training, perspective/life experience, heredity/upbringing, and finally a broader perspective on life (Jaeschke et al., 2016). While these themes provided beneficial insights from this unique population, an actual measurement of mental toughness was not included, nor were specific interventions identified. A study involving youth cricketers (Gucciardi, 2011) noted while a desire to achieve and attentional control did have a relationship with mental toughness, experience and number of training hours per week did not, while peer interaction demonstrated both

positive and negative influence. A study with a similar population (Gucciardi & Jones, 2012) pointed to the possibility that exposure to core elements of positive human development may provide the setting for developing mental toughness. A later study that included both females and males across various sports found initiative experiences to provide the most relevant predictor of mental toughness (Jones & Parker, 2013).

Self-awareness and self-insight were examined in tennis players using the SMTQ and revealed these attributes were predictive of elevated mental toughness. However, as with related studies, authors noted these findings may be beneficial in the development of mental toughness but stopped short of identifying specific ways of doing so (Cowden, 2017). A series of four interconnected studies on the neuropsychological model of mental toughness (Hardy, Bell, Beattie, 2014) found that severe punishment and low reward sensitivity were associated with mentally tough behavior. The proposed explanation was that high punishment/low reward sensitivity individuals were able to identify threats earlier, providing the opportunity for a more effective response. While intriguing and of benefit to the broader mental toughness understanding including the development of the Mental Toughness Inventory, the study did not provide specific interventions. A study involving youth Australian footballers found two different psychological skills training programs to be equally effective in developing mental toughness (Gucciardi, Gordon, & Dimmock, 2009b).

Interventions

A review covering the development of mental toughness notes “scant literature” on the topic (Harmison, 2011, p. 65). While there have been some additional contributions to the topic since, studies providing specific and effective

interventions continues to be limited. One example includes the use of the Mental Toughness Education and Training Program (MTETP) with elite football officials (Slack, Maynard, Butt, & Olusoga, 2015). The MTETP was integrated into the referee season over an eight-month period via a series of workshops. Themes covered by the workshops included personal mental toughness attributes, awareness of mentally tough behaviors and situations requiring mental toughness, including media and peer or coach interaction. The trainings included the sharing of information, role playing, video analysis and exposure exercises. Interestingly, Slack et al. note the MTQ48 has a trait conceptualization and for that reason was only administered a single time during the baseline phase (August) as variability within this period was not expected. The MTQ48 was then administered three times during the intervention phase (October, January and April). Slack et al. did show improvements in mental toughness measurements during the study. However, they utilized the multi-dimensional MTQ48 as the assessment tool, and the training itself was specific to such a unique subset of the population (elite football referees) that application to other settings was finite.

In a study focusing on soccer players, coaches, and parents (Coulter et al., 2010), the authors used semi-structured interviews to highlight a variety of mental toughness elements, including its development. Peer pressures, time away from home, moving up levels, and making sacrifices were some of the items noted. A similar study looked at mental toughness in elite performers and identified key factors to mental toughness development and maintenance as skill mastery, competitiveness, experiencing success and international participation, education, psychological skills, social support networks and reflective practice (Connaughton, Hanton, & Jones, 2010). Neither study incorporated a mental toughness assessment

nor provided guidance beyond generic concepts about potential optimizers of the construct.

In a two-year longitudinal study of elite youth cricketers, a notable change in mental toughness was demonstrated as the result of a specific intervention involving repeated exposure to punishment-conditioned stimuli (Bell et al., 2013). Integrating exposure to punishment-conditioned stimuli during practice was hypothesized to allow the athletes to more effectively cope with threats experienced in the midst of actual competition. The intervention, which provided participants the opportunity to deal with pressure in a practice setting, was performed over 46 contact days during training camps and a competitive tour. Participants were also instructed in coping strategies to help deal with the environment, and mental toughness markers were compared over time, providing the first theoretically derived intervention showing an effect on mental toughness beyond psychological skills training. However, the measure of mental toughness utilized an informant-rated inventory rather than integrating an individual self-assessment of mental toughness. A separate study looked at an intervention to develop mental toughness administered through training coaches to utilize more autonomy-supportive approaches in their coaching was not supported due to a lack of perceived changes in coaching behavior by the athletes (Mahoney, Ntoumanis, Gucciardi, Mallett, & Stebbings, 2015).

An intervention program for swimmers involving five mental skills: goal-setting, visualization, relaxation, concentration and thought-stopping skills (Sheard & Golby, 2006) looked at the influence of this mental skills intervention on mental toughness and performance. Results included improvement in mental toughness in 28 of 36 participants and 23 of 36 showed improvement in overall swim performance. However, the assessment tool utilized for the study was the non-validated

Psychological Performance Inventory (Loehr, 1986) for the measurement of mental toughness changes over time, which was later shown not to actually measure mental toughness (Gucciardi, 2011). In hindsight, it is likely that rather than influencing mental toughness, the set of five mental skills was more likely positively influencing an antecedent of mental toughness. For example, visualization and thought-stopping skill enhancement may have improved self-efficacy. Similarly, relaxation training may have influenced sleep quality. A review was also provided regarding the development of mental toughness that looked at the influence of genetics, environment, and psychological skills to that point (Crust & Clough, 2011) but did not provide any additional specific interventions to improving the construct.

Gaps in the literature

The vast majority of research on the concept of mental toughness has been completed in the past two decades. While expanding in scope and specificity, there remain several gaps in the literature. One of these is taking a closer look at within-person variability across real-world settings. Rather than comparing mental toughness between individuals to demonstrate who is mentally tougher (Andersen, 2011), there is value in turning the focus inward with an emphasis on identifying what any individual can do to improve their mental toughness from the current baseline. Further, due to the connection between mental toughness and effort and motivation (Haugen, Reinboth, Hetlelid, Peters, & Høigaard, 2016), the outcome difference in measuring levels of mental toughness in a self-selected activity (e.g., a cycling event) compared with an artificially conceived lab activity (e.g., holding a weight for an extended time period) could be significant.

It has been noted that prior investigations of mental toughness optimization were limited by cross-sectional designs requiring retrospective recall by athletes and

inadequate measures. A call for future studies to correct this shortcoming through longitudinal designs and the use of "conceptually and psychometrically sound instruments and tracked over time" (Harmison, 2011, p. 65). Studies that investigate unidimensional mental toughness over multiple periods within individuals are needed to identify valid and reliable measurements of within-person variability over time. Further, the investigation of specific potential optimizers of mental toughness (e.g., sleep, self-talk) within individuals over time would provide valuable insights for athletes, coaches and others looking for ways in which to positively influence their outcomes and could be integrated into broader psychological skills training programs and more expansive interventions (Bell et al., 2013).

An additional opportunity to fill gaps in the literature is to study high level Masters athletes. Youth, college students and professional athletes, who make up the majority of the participants studied in the mental toughness literature, often live their day-to-day lives in somewhat of an artificially protected (or at least modified) setting. By comparison, elite Masters athletes are training to perform at the highest levels while simultaneously working (usually full time), often raising children, and facing the day to day pressures of financial, professional and family stresses which may play a central role in how mental toughness and mental toughness optimizers function in the real world.

Interest by the scientific community on the construct of mental toughness has grown exponentially over the past two decades, with the number of published journal articles expanding from a single article in 2001 to 68 in 2018. Along with this growth, a number of often conflicting definitions, assessments and perspectives on the construct have also come to the forefront. The purpose of this literature review was to provide an overview of these developments and to specifically identify both

current perspectives and future opportunities for enhanced research developments. Our focus throughout this literature review and across the broader PhD thesis was and is to identify current perspectives on within-person variability of mental toughness and potential optimizers of the construct.

Chapter Three: Study I

Cooper, K. B., Wilson, M. R., & Jones, M. I. (2018). A 3000-mile tour of mental toughness: An autoethnographic exploration of mental toughness intra-individual variability in endurance sport, *International Journal of Sport and Exercise Psychology*, doi.org/10.1080/1612197X.2018.1549583

A 3,000-Mile Tour of Mental Toughness: An autoethnographic exploration of mental toughness intra-individual variability in endurance sport

Abstract

Mental toughness has garnered considerable attention over the past two decades because of the perception that this psychological construct influences an athlete's ability to strive, thrive, and survive in sport. However, few researchers have explored the lived experiences of mental toughness within endurance sport. Analysis of lived experiences could help reveal how athletes demonstrate (or do not demonstrate) mental toughness in real-world settings. The current autoethnographic approach provides an alternative perspective to supplement existing mental toughness literature and offers a valuable alternative to existing mental toughness research paradigms. This study recounts and analyses the personal experience of mental toughness across a trilogy of cycling, triathlon, and running endurance events over a 5-month period. The main findings focus on the variability of perceived mental toughness at different stages of competition and training and identify potential factors driving the notable fluctuation in levels of mental toughness.

Keywords: Narrative of self, Emotion, Endurance athlete, Variability

A 3,000-Mile Tour of Mental Toughness: An autoethnographic exploration of intra-individual mental toughness variability in endurance sport

"A cyclist is coming up behind you pretty quickly… it looks like it is the Germans."

I was six days and over 2,500 miles into the annual Race across America (RAAM), a 3,000-mile event that includes 170,000 feet of elevation change and every possible weather condition conceivable. "The Germans" were the four-person German team with whom we (my race partner and I) had been battling against for the past three days. Their rider was approaching at double my current speed in what looked like would be a permanent move. I had begun this most recent section of the race at the very last strand of my physical rope. My head and shoulders were slumped, my legs barely pedaling – and then only when necessary to keep the bike from stopping altogether. I was spent physically, and any remnants of what I thought was my mental strength appeared to be long gone. Unfortunately, we still had 500 miles to the finish line, and my teammate was lying prostrate in the follow-vehicle and was in no better position to pick up the slack.

The purpose of this autoethnography is to portray and connect my personal experiences of competitive endurance sport through both information and my opinions of what happened over the course of five months and three endurance challenges (win RAAM, qualify for the Hawaii Ironman World Championship, and run a sub-three-hour marathon). By revealing real stories, I hope to evoke "in readers a feeling that the experience described is lifelike, believable, and possible" (Ellis & Bochner, 2000, p. 751). Moreover, I aim to analyze my tales in the context of existing psychological literature to help me (and the reader) understanding the psychological nuances that both facilitated and impeded my performance and how

these changed as a function of a variety of person-situation interactions. I came to understand these nuances in terms of my fluctuating mental toughness.

Mental Toughness

Before considering my story, it is essential to introduce the concept of mental toughness. Athletes, coaches, and sports fans have long acknowledged the idea that mental toughness is important for performance. While mental toughness may be a controversial topic in some respects (i.e., a "catch-all" for numerous positive psychological constructs: Jones, Hanton & Connaughton, 2002); we refer to the lexical hypothesis and assert that because mental toughness is part of athletes and coaches' language it is relevant to that group and is therefore worthy of study. Furthermore, the fact that mental toughness has been encoded into a succinct phrase (rather than listing subordinate constructs) also suggests that mental toughness is important to athletes and coaches.

Gucciardi, Hanton, Gordon, Mallett, and Temby (2015, p. 28) defined mental toughness as "a personal capacity to achieve consistently high levels of subjective (e.g., personal goals or strivings) or objective (e.g., sales, race time, GPA) performance despite everyday challenges and stressors as well as significant adversities." Gucciardi, Peeling, Ducker, and Dawson, (2016) suggested that recently researchers (e.g., Hardy, Bell, & Beattie, 2014) have focused attention on the observable behaviors or actions that are typically demonstrated in challenging or demanding situations. For example, mental toughness might be associated with perseverance, effort, and persistence in the face of adversity. Gucciardi (2009) suggested that rather than treating mental toughness as an objective personality construct or a post hoc explanation of a given behavior, researchers should consider mental toughness as a process that involves person-situation interactions. These

interactions influence an athlete's sport participation and lifestyle and ultimately make significant contributions to one's ability to achieve goals (or not as the case may be). Therefore, it makes sense to examine athlete's real-world experiences across ranges of person-situation interactions that are appraised as both positive and negative experiences to help scholars and practitioners understand mental toughness processes. Despite these suggestions, few researchers have examined mental toughness or mentally tough behavior in the context of real world (i.e., not lab-based) endurance sport (notable exceptions include Crust, Nesti, & Bond, 2012; Jaeschke, Sachs, & Dieffenbach, 2016). Jaeschke et al. interviewed 12 ultramarathon runners and provided a snapshot of the challenges and demands ultra-runners face. For example, Jaeschke and colleagues identified perseverance and persistence, overcoming adversity, perspective, life experiences, psychological skills use, and camaraderie in the ultra-community as salient experiences of ultramarathon runners' mental toughness. Similarly, Crust et al. (2012) interviewed 12 ultra-endurance walkers and revealed that in the context of ultra-endurance walking being stubborn and tenacious, totally committed to goals, objective, humorous, challenges focused, able to maintain perspective in adversity and possessed humility were identified as key components of mental toughness. The differences in mental toughness experiences and perceptions across separate endurance events suggest that mental toughness could be situation specific. Moreover, how endurance athletes report their experiences of mental toughness may support Gucciardi's (2009) contention that person-situation interactions influence an athlete's sports experience. Thus, rather than describing mental toughness development or the traits associated with mental toughness, researchers may better serve athletes and practitioners by exploring specific situations in which perceived mental toughness did (or did not) manifest.

An additional consideration for scholars and practitioners is the crucial difference between real-world experiences and arbitrary lab-based behaviors, namely the personal meaning ascribed to the action. It is highly likely that real endurance events involve different motivations processes (compared with arbitrary behaviors) that change how individuals interact with the environment and utilize their psychological resources. For example, a runner may compete in marathons because of more internalized motives (i.e., enjoyment or identity) and that same participant may not have the same types of behavioral regulations to lift a static weight (i.e., Crust and Clough, 2005). Thus the application of psychological resources (e.g., coping) might be different (for example approach vs avoidance coping) in the two scenarios which could result in very different "mentally tough" behaviors. Specifically, perseverance when running and quitting when holding a weight. The person-situation interaction influences the outcome of a given event. The contention that person-situation interactions drive the mental toughness process highlights a problem with existing research where there is a propensity for between-person (rather than within-person) comparison, which mostly ignore the salience of a given situation.

A further limitation with existing (qualitative) mental toughness research in sport is that participants often create a hypothetically mentally tough straw man rather than discussing real-world experiences (Anderson, 2011). Anderson (2011) stated that mental toughness was an idealized, selective, and fantasy construct detached from realistic accounts of human experience. With this statement in mind, Andersen (2011) critiqued Jones et al. (2002) by suggesting that Jones and colleagues' participants used a set of social imperatives to list what mentally tough athletes should (or should not) do rather than personal tales of what the participants

do. There are exceptions to this in the qualitative mental toughness research (e.g., Swann, Crust, & Allen-Collinson, 2016), in which actual lived experiences of mental toughness were studied. Swann and colleagues (2016) examined the lived experiences of mountaineers who had survived an avalanche on Mount Everest in 2015 and revealed the mountaineer's psychological responses to the disaster. Despite providing an excellent account of the lived experiences of the event, Swann et al., (2016) identified those extreme expeditions such as the one studied involved adverse and traumatic circumstances that are unlike conditions in most other sports settings. Furthermore, this study looked at the overall role of mental toughness in response to the avalanche rather than the situational variability of reaction and how the individuals on the expedition reacted.

Within-person state differences in mental toughness is not a new concept. Gucciardi, Hanton, Gordon, Mallett, & Temby (2015) collected data on mental toughness, thriving, psychological health, and goal progress from university students over a 10-week period. Results revealed 56% of the variance in mental toughness was attributed to the within-person variability across the ten weeks. The remaining 44% of the variation in mental toughness was due to between-person differences. Gucciardi et al. (2015) suggested that the results of their study supported Harmison's (2011) belief that that mental toughness is a mindset that varies across situations and over time and that people bring a dispositional aspect of mental toughness to their interactions with the environment.

By reflecting on several different events and specific situations during a 5-month period and the subsequently perceived variability in the perceived mental toughness that I experienced during the races and in training, I hope to overcome the critical point that Andersen (2011) identified (i.e., real vs idealized mental

toughness). Also, I hope to provide evidence that mental toughness is not about superhuman performance but is reflected in the everyday events and that mental toughness is dependent upon what I bring to the event and my interaction with the environment. By focusing on the within-person variability of mental toughness in a generally depleted physiological state rather than between-person comparisons in a single-session performance measure (i.e., shuttle test), I aim to help build on the established research and set the stage for continued development of mental toughness as a process rather than an outcome (or label).

Methods

Epistemology, Ontology, Data Analysis, and Autoethnography

Regarding epistemology and ontology, this study is built on the interpretivist perspective with the integration of subtle realism, which focuses on confidence in validation rather than certainty (Angen, 2000). My clinical and athletic background had included extensive training in exercise physiology, kinesiology, and anatomy, which I applied across a wide range of endurance events over thirty years. My extensive experience as an endurance athlete, physical therapist and athletic trainer meant that I was confident, but not certain, that variation in my performance during training and competition was psychological as well as physiological. The interpretive approach inherently integrates the concept that meanings attributed to such experiences effectively reflect the mental constructions of the participant (Smith, Sparkes, Kirkby & Phoenix, 2012) who, in the case of the autoethnography was also the researcher.

At the time of the events noted in this autoethnography, I had spent the better part of three decades, initially as a licensed physical therapist and certified athletic trainer and later as an employee wellness company CEO trying to help others

optimize their physical potential. At age 49 years, I had more recently made an effort to do the same in my own life as a Masters athlete. The original intention of pursuing the events described here was to focus on optimizing that same physical piece of the equation I had been helping others enhance for 30 years. However, it was in the midst of those physical pursuits that the critical nature of the mental element came to the forefront. While experiencing moderately positive race results within the context of my limited athletic background, I have never been a professional, only competed in high school track because the coach was generous, have no name recognition beyond family, friends, and clients, and would likely be considered "average" in terms of inherent physical gifts and talents. This provided a baseline from which to more effectively examine the concept of mental toughness in a real-world setting that steers clear of the "elitist ideal, constructed along the lines of the romantic narrative of the 'Hollywood hero' athlete" (Caddick & Ryall, 2012, p. 137). Instead of a retrospective, revisionist history to explain a dramatic victory, this experience focuses on the variation in mental toughness within the realities of three specific endurance events in an otherwise regular individual. The intention of this autoethnography was not to draw a comparison between my mental toughness and that of others but rather to study and potentially expand upon the within-person variability previously noted in the literature (Gucciardi et al., 2015) during three related yet unique settings over a 5-month period.

Within this autoethnography, I recount and analyze my experiences of endurance sport and mental toughness and explore how mental toughness functions when engaged in extreme endurance activities. In this way, the current study can be construed as analytic autoethnography (Anderson, 2006) with a flavor of evocation (Ellis, 1995) to familiarize the reader with my experience and provide both

researchers and practitioners with a valuable resource on which to build further investigation and study. The format of the autoethnography "offers a way of giving voice to personal experience to extend sociological understanding" (Wall, 2008, p. 38). It is a form of study effectively utilized to study athletes (Allen-Collinson & Hockey, 2001; Stone, 2009) and provides a valuable methodology to examine mental toughness variability and related aspects. The autoethnography approach provides a complement to quantitative and other qualitative research into mental toughness, such as phenomenological interviews.

To understand mental toughness (or the variability thereof) and to bring beneficial research issues to the fore it is important that a researcher is reflective of his or her approach. Brackenridge (1999) stated that reflectivity (i.e., taking account of the effect of the personality or presence of the researcher on the investigation) helps the researcher locate him /herself within the power dynamics of the research relationships and to adopt a healthy skepticism toward the truth of his or her findings. Moreover, reflectivity and introspection are legitimate sources of knowledge, and important research skills (Sparkes, 1995). Reflectivity is a meta-cognitive skill that is unobservable, existing within the individual. Despite being unobservable, methods exist by which reflectivity can become explicit. One critical aspect of this reflection involved the contribution the other two authors made as critical friends. They consistently questioned and helped clarify the findings throughout the process.

I have spent almost two decades involved in endurance sport, and much of my interpretive approach stems from these years in the competitive setting where I view success and failure as subjective but measurable. This stance then produces an axiological state in which my values around competition and improving performance naturally created a strong sense of value in identifying initial causes or catalysts

toward providing a higher level of mental toughness. While this could cause the reader to make assumptions about the impact of culture on the mental toughness described in this document (Coulter, Mallett, & Singer, 2016), the focus of this study takes a different route. There is not a between-person comparison made between my level of mental toughness and that of others. Instead, this study remains focused on identifying the presence of the within-person variability of a single individual, the primary author. It then goes on to identify potential mental toughness optimizers related to those situations during which an increase in the level of mental toughness being accessed.

The current reflections, data collection, and analysis benefitted from a variety of tools and resources. Of primary benefit was the stimulated recall enhanced by a documentary film of my experiences in the RAAM (Butler, 2016) that was shown in over 500 theaters across the United States (1-night event) in May of 2018. The film, which has been viewed by all three authors and on multiple occasions by the primary author, provided an aide memoir to facilitate recall of important events and to evoke the emotions and cognitions that I felt and thought while racing (Ellis & Bochner, 2000). As part of the production of the film, the producer interviewed me at length both during and after the conclusion of the event. This stimulated recall was enhanced further through extensive discussions with family and friends who participated as crewmembers for the event as well as radio, TV and print media outlets who conducted further interviews about all three of the events noted. This multi-layered recall process was complemented by a detailed review of GPS and race result data provided additional insights into the occurrences and pacing patterns throughout the Ironman and marathon events. The second and third authors contributed challenges and critical considerations of my story that helped to funnel

my accounts and possible representations of experience into a single story of how I became aware of mental toughness and its importance in endurance sport. This interaction also provided a "reliability check" (Ellis & Bochner, 2000) which offered new insights and reflections.

Results and Discussion

The Trilogy of Endurance Events

Before the race, I had not spent any significant time thinking about my psychological preparation. I generally thought of myself (as most athletes likely do) of having a reasonably high level of mental toughness, but I had not considered it in great depth. However, throughout the endurance trilogy, the importance (and frailty) of my psychological state came to the fore. Over time, I was able to create a taxonomy of psychological states, skills, strategies, values, and virtues that were present or absent and were employed or forgotten at various points before, during, and after events. As I read more of the psychological literature, I began to see similarities with my emerging taxonomy and potential sub-dimensions of mental toughness.

The journey began when a friend approached me about competing in RAAM as a two-person team. At this point, the longest ride of my life was less than 150 miles. Despite my limited experience of long-distance cycling events like RAAM, I knew endurance sport as a triathlete and runner. My curiosity peaked, and a three-pronged goal developed to win RAAM, qualify for the Hawaii Ironman World Championship, and run a sub-three-hour (Boston-qualifying time for anyone at any age) marathon, all within a five-month period. How would the body of a 49-year-old respond to the physiological demands of trying to compete at the highest amateur levels in three very different endurance events over such a short timeline? It turned out that what I

had planned to be a test of personal physiological limits took me down the rabbit trail of exploration into something completely different: mental toughness. However, it almost never happened.

Initial Glimpse into Mental Toughness: The Wreck

A freak bike wreck just six weeks before the start of RAAM resulted in eight fractures to ribs, clavicle, and pelvis along with a concussion. The surgeons convened over several days and decided I would be allowed to continue (after surgery) but only if all remaining training was completed on an indoor bike trainer where there would be no risk of an additional crash. That meant rides of up to twelve hours at a time (and 30 hours over a three-day period) in my basement. Twelve hours, on a bike, in a basement, repeated multiple times over the final six weeks of training. While I likely would have seen this as an insane form of medieval torture that I could not have possibly endured six months earlier, the reality was instead an insight into personal mental toughness. Having faced a possible verdict that I was out of the race due to the fractures, my mind suddenly reframed these twelve-hour indoor rides to be an opportunity for which I was grateful. I have always been a bit of a "grinder," willing to put in whatever work is necessary to get the job done. However, this enhanced feeling of gratefulness that the opportunity to race was still alive in spite of the seeming disaster appeared to produce a level of mental toughness in the final six weeks of 100% indoor training of which I had not previously been aware. This was the beginning of my education into mental toughness variability and the potential causes of that variability.

The average amateur Ironman triathlete or ultra-cyclist may spend 20-25+ hours/ week swimming, cycling, running and strength training, invest thousands of dollars each year on equipment and supplements, and even pay a coach to design the

perfect training program. However, the time, energy, and funds devoted to developing the psychological components of performance (if they are addressed at all) are dwarfed by these physiological, technical, and technological pursuits. I was no different. I did my best to dial in every possible piece of the puzzle: Power to weight ratios, pace/mile, the percentage of time in the aero position, calorie intake, (and macronutrients)/hour, optimal sleep strategies, and even the best chain lube to enhance power output. Tapping into optimal levels of my mental toughness reservoir? Not even on the radar screen.

However, a lack of awareness does not equate to lack of impact. In a race of 3,000 miles, the bank of physiological toughness quickly runs dry, bringing the mental components to the forefront as a primary differentiator (between success and failure, enjoyment and misery, and personal growth and stagnation). A range of emotional responses surprisingly became the catalyst for accessing unexpected and illogical (physiologically speaking) levels of mental toughness throughout RAAM. Combining these with the other variations in mental toughness experienced across the broader five-month endurance trifecta pursuits brought the potential for a shifting, state-like form of mental toughness to the forefront.

The Race Begins

RAAM incorporates multiple races into a single event. While the solo riders start several days earlier, all teams (two-person, four-person and eight-person variations) launch from the starting line in Oceanside, California on the same day. There were six teams in our two-person category, with an experienced team from Denmark expected to be the strongest. After we gave up an early lead, we then caught and passed them as the race progressed through the desert and temperatures reached record highs (120 degrees F, 49 degrees C). The next day we were informed

that one of the Denmark team members was taken to the hospital with severe dehydration. He recovered, but this had unfortunately ended their race. We were now alone in the lead, with almost 100 miles between the next two-person team and us.

That is where the mental side took a strange turn. As I look back, while the external motivators (i.e., competitors in front of us on the road) were virtually absent, my focused intensity remained at a high level. Barring a complete mechanical or physical disaster, a conservative approach to the remainder of the event would result in victory. There was no longer any tangible benefit to be gained by pushing beyond our comfort zones. Due to a mental perspective shift, however, nothing changed regarding the internal drive to keep pushing.

With our direct competition essentially out of the picture, we created new targets. Two nearby four-person teams (made up of four rotating riders, rather than our team of just two riders), one from Germany, suddenly took the place of our "real" competition and became the intense focus of every waking moment of the race from that time forward. With each passing mile, physiologically, the body had less and less to give. Each day's "worst" became worse than the previous day's "worst." Something kept pushing us past the body's desperate plea to stop (or at least let off the gas).

Competition plays an influential role in performance. For example, it has been shown that riders who were told that they were competing head-to-head virtually with another rider had a faster performance and maintained a higher level of power in the last half of a cycling test (Corbett, Barwood, Ouzounoglou, Thelwell, & Dicks, 2012). Inadvertently, by shifting our focus to an (albeit) artificial competitor when our real competitors had dropped out or fallen behind, we were able to maintain our

overall level of intensity. Perhaps there was also an avoidance of social loafing (Haugen et al., 2016) at work here as well. High mental toughness individuals have been shown to continue a high level of effort even when individual results will not be identified. The strategy of artificially inserting ourselves into a different category (four-person team competition even though our results would only appear in the two-person category) may have been a subconscious mental toughness-related strategy to move past the siren's call toward letting off the gas.

Interestingly, while this internal drive continued, the ability to tap into the maximum level of mental toughness was far from being a constant throughout the 3,000-mile race to the finish line. Looking back, one essential element tied to accessing that higher level of mental toughness at the moment was linked to a variety of specific emotional responses. At times, the emotional response was competitive ("not on my watch!"). Other times it was a fulfilling a personal role in my head or coming to the virtual defense of a loved one. On separate occasions, a burst of anger created a spark that was then fanned into a blazing, powerful fire of mental focus and intensity. The various emotional responses came unexpectedly, yet powerfully – and they produced a variation in mental toughness that reared its head time after a wonderful time.

Anger

The anger catalyst was the first to show itself positively. My teammate and I had structured our shifts to ride 30-60 minutes at a time during the twelve daylight hours (one rider on the bike while the other tries to rest/eat). Then during the twelve nighttime hours, we would follow a 2/4/4/2 hour on/off schedule with some of the long rides extending to five hours. This would allow my teammate to rest up heading into his long pull, during which I would then try to sleep for a few hours.

The process would then be reversed, as he would get some sleep during my long pull and then provide me with a two-hour recovery period on the backside. We were midway through day three, and I was coming off my long (five hour) night pull, desperately in need of some downtime. After I (very slowly) made my way to the transition on little more than fumes, my teammate took over, and I crawled into the back of the car planning to soak in a couple of hours of much-needed recovery. Due to an unexpected anomaly within the team dynamics, I was informed a few minutes later I needed to be ready to jump back on the bike at the next turn. I just about lost my head in responding. In fact, tuning into the presence of the camera crew filming a documentary probably saved me from making a fool of myself in my exhausted, sleep-deprived state.

What happened next is the fascinating part – that unexpected 90-minute pull on the bike was one of the strongest I had experienced in the race up to that point. In the midst of the intense anger, I had tuned the iPod in my right ear to a downloaded series of audio quotes from movies like Rocky and taken off on the bike with a vengeance. Brushing back tears of anger and mumbling under my breath, I remember experiencing an incredible mental focus that went well beyond anything I had felt over the first three days of the event. This was not merely physical as I was beyond exhaustion on that front, having just concluded a 5-hour pull moments before. Nor can any credit be given to a timely shot of caffeine as I strategically chose not to utilize any caffeine until the final day of the race. Instead, this emotional response had brought a secondary level of mental toughness that produced a robust physical outcome. Yes – I theoretically brought a baseline level of mental toughness into this event. However, it was non-existent just moments earlier until

something provided a catalyst to tap back into another level. This was a first-time experience for me as a rider, but it would not be the last.

The positive boost the anger provided was not unique to me. Anger has been identified (Ruiz & Hanin, 2011) as an emergency source of energy for athletes when physiological resources are running low, providing positive effects on performance. It has also been noted that rugby players viewed controlled anger as facilitating improved performance (Robazza & Bortoli, 2006) and that purposeful unpleasant emotions can provide beneficial outcomes (Stanley, Lane, Devonport, & Beedie, 2012). Lazarus (2000) also indicated that there were times when constructive anger could mobilize performance enhancement.

Love

The following day of the event provided a period with similar unexpected, yet incredibly productive levels of (variable) mental toughness. However, the genesis of this mental toughness access was almost 180 degrees from the previous day's anger catalyst. We had passed the four-person German team early in this pull, and I was enjoying pushing the pace of this long morning section through the flatlands of Kansas. A five-hour time for an Ironman bike section (112 miles) is a substantial time. Therefore, to provide an extra personal boost, I had mentally reframed this pull to see how close I could get to that mileage figure during my five-hour portion. Unfortunately, 90 miles into my own personal "Kansas Ironman," our follow vehicle pulled up next to me and hesitantly shared the bad news: "We took a wrong turn back there."

In RAAM, the rules are precise about wrong turns. Teams cannot just redirect their course to get back on track. Instead, riders are required to return to where the wrong turn was made and continue forward from that original point. Caught early, a

wrong turn was discouraging but not disastrous. This was not one of those, as we had taken the wrong turn 25 miles back, thrusting the four-person German team back in front of us by at least that same distance.

As we scrambled to get back on track, I overheard my 19-year old daughter (who was watching over the map when we took the wrong turn) say to one of our other crewmembers, "I just ruined Daddy's race."

There was the spark.

I tried my best to remind her it was not our first wrong turn and how thankful I was that she was out there with us on this adventure. Nevertheless, that did little to shift her disappointment. Therefore, I went with the only thing left that I could think of, promising her we would catch that German team no matter what it took, and that any wrong turns would not matter by the end of the day. For the next several hours, each time I hit the bike, my daughter's voice, and face were in my head. Once again, the level of available mental toughness and push that came to the forefront made no sense physiologically, yet it was affecting the outcome. We caught and passed the German team by that afternoon, bringing a smile back to my daughter's face, and settling back to normal intensity levels for Dad.

In the Individual Zones of Optimal Functioning (IZOF) model (Hagtvet & Hanin, 2006), emotional experiences in athletes and their functional tie to performance are taken into account. The model connects the hedonic tone of pleasure or displeasure with the functional performance (positive/negative) to classify emotions into four categories. These include pleasant-optimal, unpleasant-optimal, unpleasant-dysfunctional, and pleasant-dysfunctional. The connection I am fortunate to have with my family (and in this case, specifically with my daughter) appeared to play a significant role in setting the scene for this functional-pleasant emotional

response. The IZOF model indicates this is associated with optimal readiness and effective energy utilization. A second potential explanation tied to my response might be related to the core value connection of being a Dad, which was brought to the forefront at that point in the race. Schmeichel (2009) noted that thinking about core values helps facilitate self-control when resources are depleted, which they certainly were at this point in the race.

Competition

Negative, unforeseen incidents have been highlighted as enhancing mental toughness in athletes (Connaughton et al., 2010). Interviewed athletes indicated these experiences contributed to a clarifying of perspective, and an enhanced sense of their personal "why" tied to the pursuit and achievement of their goal. This brings us back to where I started this account; day six with the Germans approaching. I had checked out mentally and could not care less about my speed (or anything else) at this point. However, when the four-person German team rider passed me, something snapped. The next 15 miles were the strongest I had experienced over the previous two days. By the end of that pull, we were back in front by at least a mile (or two), a lead we never again let go (in this artificially contrived, objectively meaningless "race" between two teams from completely different categories who technically weren't even racing each other.)

Competition is a widely recognized element of enhanced performance related to mental toughness. In a review of world-class athletes (Jones, 2007), mentally tough performers ranked love of the pressure of competition at the top of the list in dealing with the stress of competition. Hardiness, which is closely aligned with mental toughness, has "challenge" at its core. This is the level to which one views challenges as opportunities (Kaiseler, Polman, & Nicholls, 2009). The

psychobiological model of endurance performance (Blanchfield, Hardy, De Morree, Staiano, & Marcora, 2014a) states that exhaustion is a conscious decision to reduce intensity output rather than merely muscle fatigue. This puts a premium on the individual's motivation level regarding the resultant outcome, even six days into a 3,000-mile race.

Was the immediate response to the passing German team member the result of a competitive drive that had been sharpened over decades of competition? Perhaps it was merely an ageing Dad making a desperate push to be more than he is with his 16-year-old son sitting shotgun in the follow-vehicle? Alternatively, was it the culmination of thousands of training sessions and races where "one more time" was just part of what we sign up for? Alternatively, maybe it was something completely different altogether. One thing we know: it was not an indicator of my current physiological status nor a reflection of a trait-like level of mental toughness. Whatever the sudden variation in "it" was, "it" came from that vast space between the ears, changed on a dime, and was influenced, impacted and optimized by a multitude of elements; some visible and others left forever unseen.

The actual finish line of the race was somewhat anticlimactic. Of course, we were delighted to cross that line finally. It was a beautiful morning, and the sun was starting to rise. The announcers, our friends and family were all there to greet us. Once we knew we were going to stay ahead of all two-person and the pair of four-person teams we had been racing, there was only one goal left to chase: finish by a specific time. That potential opportunity did stir up one last internal fire and the accompanying physical benefits. However, once it was clear that the goal was out of reach, I mostly stopped caring about speed, and any level of mental toughness

became insignificant. The last few hours were merely survival mode. Get across the line. Just finish, regardless of the pace.

Encouragement

RAAM was over, but the broader goal was far from complete. I still had the Hawaii Ironman World Championship qualification (0.7% in our category would qualify), and the small task of running a sub-three-hour marathon (something less than 2% of marathoners across all ages accomplish, with the odds significantly lower for 49-year-olds) in front of me. Also, due to the bike wreck that resulted in multiple fractures to the ribs, clavicle and pelvis, I had not done any swim or run training in months, so this pursuit would not be following the traditional training strategy. During the Ironman race that followed RAAM, several occurrences during the initial 90 minutes of the race had me on the ropes, significantly reducing any potential for earning the coveted Kona (World Championship) qualification. The 2.4-mile swim, from which I typically exit in a competitive position at just over an hour, took me almost ten extra minutes, dropping me into the 147th place spot as I moved out of the swim and onto the bike. Things did not get any better once on the bike, as the power meter I use to guide my level of effort over the 112-mile ride was malfunctioning and would not provide any valuable data for the duration of the bike section. It appeared my odds of earning that Kona slot had shifted dramatically in the wrong direction.

However, two specific elements allowed me to tap into a different level of mental toughness at that moment. First, my wife of 23 years had repeatedly gone beyond merely providing "supportive words." Instead, she had communicated a belief in me that far exceeded my confidence in myself. Throughout the event, thoughts of that belief acted like a mental toughness buoy during the most challenging periods. Add to that the presence of our 21-year-old daughter, who had

flown down for the event. Encouragement flows naturally and genuinely from her and seeing her regularly during the race influenced the level of mental toughness throughout the daylong competition. As an interesting mental toughness-related side note, this year's event marked the highest DNF (Did Not Finish) in the history of the event; at 26.4%, (average DF has historically averaged approximately 15%). In the end, I finished 18th overall (out of 2,500 total competitors), a comfortable 25 minutes ahead of the time (place) needed to earn the Kona qualification, in spite of being the oldest athlete in the 45-49-year-old category.

This increase in mental toughness makes sense in the context of research showing encouragement from significant others was seen as an enhancement to the development of mental toughness in both the early and middle years for elite performers (Connaughton, Wadey, Hanton, & Jones, 2008). More specifically, the significant others were identified as those who were a resource of knowledge and inspiration to the athlete, qualities that my wife and daughter certainly brought to the proverbial table.

Last Chance

In the marathon, there was just one final opportunity on the calendar to close out the tri-fold five-month goal with a sub-three-hour finish. It took place only two weeks after the Ironman, and a post-Ironman knee issue had limited me to only a handful of runs over the two weeks that separated the events. The rolling hills and winds on race day were less than conducive. Nevertheless, the knee held up and something happened in the closing miles that resulted in a final time of 2:59:48, just twelve seconds under the target (over a 26.2-mile event – a buffer of less than .5 second/mile). The sense of "last chance" seemed to spur on that next level of mental toughness, to ring out every drop of energy as the clock ticked down during the final

miles. I was never in a position to win the race (ironically, I also finished 18th overall in this event) and the only person even remotely aware of my finish time was my son, who accompanied me to the event to run the half marathon. Therefore, there was no "heroism" involved. However, knowing this was the only opportunity to reach this goal within the calendar year influenced the level of mental toughness at a critical juncture. There would be no second chance.

The drop-off in pace in the final six miles of the marathon have been well documented (March, Vanderburgh, Titlebaum, & Hoops, 2011), and a review of my splits via GPS tracking showed I was no exception to this pattern. After starting fast over the first half of the race, my average pace from miles 16-18 settled in at 7:06/mile but then slowed dramatically to 7:26/mile from miles 21-23. At mile 24, the level of mental toughness driven by this sense of "last chance" resulted in a dramatic improvement back to 7:07/mile average pace over the final 3.2 miles at a time when physiological reserves were at their most significant levels of depletion. This extended push resulted in reaching the goal by the previously noted sliver (12 seconds total) of a time buffer under the goal.

Persistence, effort or perseverance appear to represent a behavioral signature of those with higher levels of mental toughness (Gucciardi, Peeling, Ducker, & Dawson, 2014). Similarly, in a qualitative study of ultra-runners (Jaeschke et al., 2016), the theme that rose to the top regarding traits of mentally tough runners was a single word: persistence. It appears that idea shone through on this day as well.

Limitations and Future Research

The Autoethnography as a methodology is not without critics (Das & Mullick, 2015) and limitations within this form of research indeed do exist. This autoethnography was no different, as it had inherent limitations. The primary author's

memory was supported by a full-length film of the first event (RAAM) and family recollections for the second and third events and objective, reviewable data was collected for each of the events. However, outside of the film, no ongoing audio or journalized recordings were made during the events. Lab tests were not performed during or immediately afterwards, to confirm the author's premise that the variability noted was more related to mental toughness variability than physiological changes. Finally, the concept of specific optimizers of mental toughness identified within this study is a new concept in the mental toughness literature and thus did not have prior data on which to draw. This naturally points to the value for future research to investigate the possibility of measurable variation in mental toughness and the variety of optimizers that may enhance or deplete the level of that construct.

Conclusion – Why It Matters

The concept of mental toughness is frequently viewed as a potentially malleable (Middleton et al., 2004) but generally constant trait-like construct (Hardy et al., 2014; Horsburgh et al., 2009). An individual's level of mental toughness is said to be generally set. My findings were explicit - it is variable expanding upon the results pointing to within-person variability (Gucciardi et al., 2015a). The repeated within-person spikes noted throughout this autoethnography – and particularly throughout RAAM - were not physiologically oriented. They did not correspond with caffeine intake (which was avoided entirely altogether until the final day of the race) or changes in blood sugar (I was eating consistently throughout the event, both on and off the bike). Instead, multiple unplanned, yet useful optimizers temporarily increased my level of mental toughness. I went into this trio of endurance pursuits with no pre-conceived notions about mental toughness variability. Instead, I was there to race, to pursue and potentially achieve a series of (I thought physical-

oriented) goals. Instead, the discoveries tied to the experiences (in spite of a multitude of personal constants present within each event) further opened the door to the concept of within-person mental toughness variability. While this study is ultimately the account from a single athlete, it provides additional data on which to continue the discussion around and stimulates discussion of the investigation into the within-person variability and potential catalysts.

Rather than looking to identify or measure some hidden (from the outside world) element that differentiates the very best athletes from the pack, we can stop making between-person mental toughness comparisons altogether. We can stop attempting to determine what percentage of the outcome was due to mental toughness (versus physiology, team contribution, or just plain luck). Instead, we can turn the focus of the conversation and associated research toward assisting each in optimizing his or her level of mental toughness. We can reduce the importance of asking which of two people has the higher level of mental toughness and start working toward helping both improve their ability to access, enhance, and utilize that mental toughness. At the same time, this also opens the door to the additional application beyond sport (Tibbert, 2013). If within-person mental toughness is pliable and an increase thus improves performance, why would it not have a similar impact on all aspects of health and wellbeing? For now, these questions remain unanswered. However, the findings developed in this autoethnography provide a broadened continuation of these conversations initiated by the researchers who came before us and sets a potentially new course going forward. Future research is needed to identify how common this variation is across a much broader range of athletes and non-athletes, as well as what choices, decisions and outside influences impact the level of individualized mental toughness.

Overall Thesis Contribution of Study I

- Explored presence of repeated within-person variability over small windows of time (same event, same day and even same hour)
- Noted mental toughness variability may be unrelated to physiological changes such as fatigue
- Within-person mental toughness variability findings begin to shift the mental toughness discussion from how person #1 compares to person #2 to instead investigating how mental toughness levels in person #1 compare from moment to moment, day to day, week to week, etc.

This initial study investigated within-person variability in mental toughness and identified potential optimizers of that mental toughness in a single elite Masters endurance athlete (the author). By identifying within-person variability and potential optimizers, it set the stage to next investigate (and specifically measure) within-person mental toughness variability and potential optimizers in multiple elite Masters endurance athletes.

Chapter Four: Study II

Cooper, K. B., Wilson, M. R., & Jones, M. I. (2019). An Exploratory Case Study of Mental Toughness Variability and Potential Influencers over 30 Days. *Sports, 7, 156*. doi.org/10.3390/sports7070156

An Exploratory Case Study of Mental Toughness Variability and Potential Influencers over 30 Days

Abstract

The purpose of this study was to explore whether mental toughness varies across a 30-day training block and whether such variability is associated with specific antecedents. This exploratory case study research investigated mental toughness variability using the Mental Toughness Index (MTI) with thirteen elite Masters runners across a series of self-selected training sessions, followed by interviews and follow-up questionnaires to identify primary influencers of variability. There were significant differences in the MTI scores between baseline (before the training period), and the minimum and the maximum reported score over five self-selected training sessions (p's < .004). The proceeding follow-up interviews and questionnaires then provided insights into factors influencing this intra-individual variability. These higher-level themes included foundational wellbeing, specific preparation, and actions utilized in the moment. This study is the first to demonstrate within-person MTI variability across specific training sessions and provides initial insights for both athletes and practitioners into potential influencers of mental toughness.

Key Words: Masters Athletes, Running, Within-person Variability, Qualitative

An Exploratory Case Study of Mental Toughness Variability and Potential Influencers Over 30 Days

> In every race, something within each athlete poses a simple question: 'How bad do you want it?' To realize your potential as an athlete, you must respond with some version of this answer: More. And then you have to prove it (Fitzgerald & Marcora, 2015, p. 15).

How much drive and effort individuals put down in pursuit of their goals, how they control their attention and emotions, remain optimistic and hopeful, and resist the urge to lay down in the face of obstacles can influence what Fitzgerald and Marcora (2015) refer to as athletic potential. Mental toughness, "a state-like psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal-directed pursuits" (Gucciardi, 2017, p. 18), is an umbrella term that encompasses these positive psychological constructs that may determine whether an individual can 'prove how bad they want it'. However, our understanding of this relationship is limited by a lack of longitudinal research that considers to what extent mental toughness varies naturally over time as well as how each of these psychological constructs can influence potential, and it is unlikely that each works in isolation. Instead, positive psychological constructs like motivation, optimism, hope, attentional control, and emotional regulation accumulate and integrate over time to produce what athletes, coaches, and practitioners label mental toughness. Importantly, Gucciardi (2017) stated that although mental toughness is a multidimensional "umbrella term" for several subordinate constructs, recent evidence indicates that participants do not make subtle conceptual distinctions between unique psychological dimensions when interpreting their experiences. Therefore, one way to 'prove it' in the context of the opening quote, is to accumulate and integrate a range

of adaptive thoughts, emotions, and behaviors; or in other words, to enhance and utilize your reserves of mental toughness.

Researchers have debated whether mental toughness is a state or trait; however contemporary definitions of mental toughness have reinforced the state-like nature of the construct. For example, Gucciardi (2017, p. 18) defined mental toughness as "a state-like psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal-directed pursuits." Based on the presupposition that mental toughness is state-like, researchers could consider the antecedents in the variability in mental toughness across various states. Our hypothesis and the purpose of this study was to examine potential within-person variability and then to explore personal and environmental factors that may be associated with that variability. The aim of the current study was therefore to identify whether variability in mental toughness existed across a 30-day period in which individuals chose to integrate several high-intensity training efforts that would require behavioral perseverance and thus mental toughness (Gucciardi, Peeling, Ducker, & Dawson, 2014).

While the predominant focus of mental toughness research has been on inter-individual comparisons (Gucciardi, 2017), Harmison (2011) suggested that mental toughness may vary based on setting, situation, and scenario. For example, notable variability in mental toughness was found to be present in elite youth tennis players across various situations (Weinberg et al., 2017). The tennis players identified various components ranging from emotion to specific behaviors when perceiving a sense of mental toughness (vs. mental weakness) and indicated they experienced both mentally tough and mentally weak responses in their training and competition. Gucciardi, Hanton, Gordon, Mallett, & Temby (2015) also found that within-person

differences explained 56% of the mental toughness variance in a sample of university students, with the remaining 44% due to between-person differences. Finally, in a recent autoethnographic study, Cooper, Wilson, and Jones (2018) suggested that mental toughness varied across states within a series of ultra-endurance events, and also reflected upon potential antecedents (i.e., influencers) to the variation in this state-like nature of mental toughness. Identified influencers included emotional responses (anger, love), competition, encouragement, and a sense of 'last chance' opportunity.

In closing, Gucciardi (2009) encouraged researchers to consider this within-person aspect of mental toughness rather than treating it as something that was a predetermined trait. Doing so would expand the opportunity for scholars, practitioners, and individuals across various settings to enhance the potential for goal achievement. To this end, this exploratory case study research was designed to examine variation in mental toughness over a training period and to ask the participants to consider the antecedents of any reported change in mental toughness. The first hypothesis was that significant within-person variability in mental toughness would exist over the 30-day study period. Following the quantitative data analysis, we explored the athletes' perceptions of the antecedents of this perceived variability to try to develop a greater in-depth understanding of variation in mental toughness from the perspective of the athletes themselves.

Methods

Exploratory Case Study Design

The methodology selected for this study was that of an exploratory case study with a combination of written questionnaires and extensive oral open-ended semi-structured interviews. Case studies are utilized to "investigate contemporary

phenomena in their natural context" (Runeson & Host, 2009, p. 30). Rather than setting up a laboratory environment, phenomena are studied in their chosen surroundings and pursuits to provide a more accurate context. More specifically, we elected an exploratory case study to look at, for the first time, elite Masters athletes and their level of mental toughness variability and, if identified as variable, the potential influencers of that variability. This design allowed participants to express their judgments, experiences and personal strategies without limitations and allowed the researchers to garner insight into real life experiences with mental toughness. The exploratory case study is designed to investigate phenomena that allows formulated hypotheses to be tested where preliminary research is limited or lacking (Mills, Durepos & Wiebe, 2010). The exploratory case study provides "a broad discussion approach that enhanced the researchers learning from participants through exploration to fill in literature gaps" (Lakunze & Strom, 2017, p. 151). The focus of our unique exploration into mental toughness variability focused on elite Masters runners.

The Case

Following ethical approval from the authors' university research ethics board, we recruited thirteen high-level Masters runners (see Table 2) to serve as participants. The selection of this population for this exploratory case study was made for several key reasons. First, as elite Masters athletes, they would be familiar with the need for (and the ability to reflect upon) the value of mental toughness in their athletic pursuits. Second, their lives would more closely represent the lives of the general population (e.g., careers, children, family, financial stressors) compared with many professional athletes. Lastly, they would have regular training sessions

planned that would allow for reflection about mental toughness utilization (or lack thereof).

Acceptance was based on inclusion criteria of being high-level amateur athletes between 40 and 60 years of age who conducted high intensity training sessions and had completed a race time for an established distance event between one and 26.2 miles over the past 12 months placing them at 75% (upper level of Regional Class) or higher Age-Graded Performance. Participants (eight men and five women; mean ± SD, age = 48 ± 5.4 years, age-graded performance = 81 ± 6.3%) first referenced a qualifying race score based on http://www.mastersathletics.net/index.php?id=2595, to assess whether they met the inclusion criteria for the study. Potential participants then completed an initial screening questionnaire including the Holmes-Rahe Life Stress Inventory (Noone, 2017). We required a score of fewer than 150 points in this inventory to help limit additional stress-related variables, based on an indication that ≤150 suggests a lower probability of developing a disorder related to stress (Noone, 2017). Finally, participants identified five specific, self-selected high-RPE training sessions planned for the month of December and completed a baseline Mental Toughness Inventory (Gucciardi et al., 2015).

Procedure (During 30 Days)

Following the initial selection process and baseline inventory the participants then received a daily email directing them to a link where they completed a brief (<5 minute) survey about various aspects from their life over the past 24 hours and a second link within the same email to be used on the days of their five high-RPE sessions. The purpose of the daily survey was to stimulate reflection about a range of potentially salient influencing factors (Gucciardi, Gordon, & Dimmock, 2009a) and to act as an aide memoir for future data-prompted interviews (Kwasnicka,

Dombrowski, White, & Sniehotta, 2015) while the 30-day period provided a broader sampling within the life of each individual participant.

The factors tracked included sleep (Brand et al., 2014; Onen, Abdelkrim, Gross, Eschallier, & Dubray, 2001), caffeine intake (Beedie, 2010), nutrition (Tomporowski, 2003), stress (Moore, Vine, Wilson, & Freeman, 2015), training fatigue (Mccormick et al., 2015), connection with significant other (Schmeichel & Vohs, 2009) and current injury or illness status (Gucciardi et al., 2009). Specifically, participants were asked to report on sleep quantity (in hours), sleep quality from 1 (*poor*) to 10 (*excellent*), nutrition from 1 (*poor) to* 3 (*excellent*), stress from 1 (*low)* to 5 (*high*), training fatigue from 1 (*low*) to 3 (*high*), connection with significant other from 1 (*poor*) to 5 (*excellent*), caffeine intake (in mg), and current injury/illness status from 1 (*none*) to 3 (*affecting training*). Not all these data were analyzed statistically in the current study.

We asked the participants to self-select their five planned high RPE sessions to allow them to continue their current training regimen, as well as to provide for the naturalistic approach, which studies the phenomena in its natural context (Bradshaw, Atkinson, & Doody, 2017). On the five days of their self-selected, high RPE sessions within the 30 days, we invited the participants to complete a pre and post-session Mental Toughness Index (MTI).

Mental Toughness Index (MTI). The MTI is an eight-item measure of mental toughness scored using the sum of items of a 7-point Likert scale from 1 (*False, 100% of the time*) to 7 (*True, 100% of the time*). We modified the wording of the original eight items (Gucciardi et al., 2015) to match the context for the athletes without affecting the outcome of the assessment. For example, question one of the MTI states “I believe in my ability to achieve my goals” as a general question. For

this study, it read “I believe in my ability to achieve my goals in this session.” Previous studies examining MTI internal reliability demonstrated both a high Cronbach’s α (.900) and composite reliability (.906) levels (Jones & Parker, 2018).

Procedure (Post 30 Days)

Following the completion of the 30-day baseline assessment, athletes were divided into two groups based on a combination of mental toughness variability and consistency of data provided. The division into two groups was to gather additional qualitative data related to the antecedents of variability in mental toughness noted during the initial data collection period in those showing the most notable within-person variability. Having demonstrated within-person variability in mental toughness from low to high days across the group of participants, we then sought to conduct exploratory research to consider whether participants identified antecedents of changes in state-like mental toughness. We adopted an exploratory and descriptive methodological framework, underscoring the epistemological position of qualitative research, meaning the real world does not exist independent of our knowledge (Grix, 2004). This framework was utilized to guide this phase of data collection because exploratory research offers “new ways of seeing and perceiving how this segment of reality works, how it is organized, or, more specifically how and in what way different factors relate to each other causally” (Reiter & Director, 2017, p. 139). The emphasis of exploratory research is on the causal mechanisms resulting in social phenomena, which was our primary purpose in this study. We adopted a qualitative description (Sandelowski, 2010) methodology to direct sampling, data collection techniques, and data analysis decisions because it provided an effective means of garnering additional data for review and analysis.

Regarding the interview data, qualitative subjectivism was utilized. In line with the nature of qualitative description, we adopted elements of a grounded theory approach (e.g., open and axial coding, memoing, diagramming, constant comparison). This allowed the concepts to be derived from the data collected and open coded during this portion of the study (Corbin, 2017) across two separate groups of participants.

Group One interviews. Five of the 13 athletes (two females and three males) were purposely selected for more detailed follow-up interviews based on the stated inclusion criteria of higher variability in MTI scoring and ongoing consistency of data provided. These five athletes and their maximum variation in MTI included (participant initials) TS (27), JB (20), RW (18), MR (16) and DM (16: see Table 3). The remaining eight athletes reported variation in MTI of six (RS, WM, SS and NO), 14 (PB), 15 (TR), 16 (GR) and 22 (EK) but demonstrated either less MTI variability or consistency in their data reporting. The interviews focused on participants' mental toughness variability insights and their experiences during the study participation. We developed the interview questions based on concepts from prior mental toughness literature and the daily survey data that the participants collected over the 30-day training period from phase one. Finally, the authors discussed the interview guide and challenged one another on the appropriateness of questions to develop the final guide.

The first author conducted the interviews by telephone because of the geographical diversity of the participants, and these were arranged at a time that was convenient for each participant. The interviews averaged 41 +/- 4.9 minutes in length and comprised the following topics: (a) role of mental toughness, (b) thoughts about the mental toughness variation they experienced and potential causes, (c) steps they

take to increase their mental toughness, (d) thoughts about session-specific variation in mental toughness, and (e) potential application of mental toughness outside of athletics. Throughout the interview, the interviewer performed additional probing or clarification of responses (Rubin & Rubin, 2005).

Following the initial review of the transcribed interviews, a set of six clarification follow-up questions were then sent to each of these five interviewees to incorporate into the qualitative analysis for additional insights. These questions were: 1) What does being mentally tough mean to you? 2) Describe a time when you demonstrated mental toughness 3) Describe a time when you were not mentally tough 4) What do you believe are the top two elements that fuel or increase your mental toughness for/during a tough session or event? 5) What would you identify as your mental toughness "kryptonite"? Identify 1-2 elements that negatively influence your mental toughness for/during a tough session or event 6) Why do you care personally about influencing your mental toughness?

We achieved data saturation to the point at which no additional data was being collected through further analysis. Saturation was initially completed through the process of the detailed initial qualitative interviews, which sought to determine the influencers of the mental toughness variability. Data saturation was then confirmed further through the inclusion of qualitative data garnered through the additional brief follow-up surveys with the other participants as noted below. The feedback provided by these additional athletes helped confirm data saturation (Côté, Salmela, Baria, & Russell, 1993) on the insights collected about mental toughness variability from the interviews.

Group Two questionnaires. The other eight athletes from the initial population were comprised of those with less consistent daily tracking data provided

(i.e., missing data) and lower maximum high to low MTI variability. These eight Group Two athletes completed a brief, five-item email follow-up questionnaire: 1) How do you define mental toughness? 2) What external factors in your life (things outside of your control) influence your mental toughness positively or negatively? 3) What internal factors (choices/decisions/plans) influence your mental toughness? 4) When you sense your mental toughness is lower than desired, are there things you can do to improve it? 5) Have you seen times in your life when your mental toughness seemed lower and if so, can you point to things you were doing differently or choices you were making that may have led to that lower mental toughness? Comments and descriptions were similar or supported those provided by the Group One athletes.

Data Analysis

At the completion of the 30-day survey period, self-reported data for each participant was collated from the online database. We first assessed variability in MTI scores by running a repeated measures ANOVA on highest and lowest score from the five high-RPE training sessions and the baseline value from the beginning of the 30 days. Follow-up comparisons were run using Bonferroni corrected *t*-tests and effect sizes are reported using partial eta squared. Analyses were run on Jamovi (version 0.9.1.7). We also computed a coefficient of variation (SD/mean, expressed as a percentage) for the most pertinent survey data (i.e., those providing consistent responses); sleep quality, sleep quantity, stress, and significant other connection, for illustrative purposes.

All interviews were recorded and transcribed verbatim, resulting in a total of 51 single-spaced pages from the five Group One athletes. An additional five pages of unformatted email responses from the other eight (Group Two) athletes were

compiled and spreadsheets summarizing low MTI comments, MTI patterns and answers to brief follow-up questions were gathered from all participants. With a focus on achieving qualitative description, the interview transcriptions and questionnaire response documents were repeatedly reviewed, analyzed and coded to identify themes and critical insights from the participating athletes about potential influencers of mental toughness. The goal was to "seek to discover and understand a phenomenon, a process, or the perspectives and worldviews of the people involved" (Bradshaw, Atkinson, & Doody, 2017, p. 1). Responses to questions were coded, categorized and then developed into descriptive concepts. We moved beyond the participants' literal descriptions in an attempt to interpret the data within the context of those literal descriptions (Bradshaw et al., 2017), and raw data themes, first order grouping, and higher order themes were identified as shown in Figure 2. These were then summarized in a way that would translate the participant in-depth discussions and feedback provided in an easily understood language (Sullivan-Bolyai, Bova, & Harper, 2005).

Results

We had incomplete MTI data from three athletes, therefore ten athletes were included in the subsequent MTI analysis. The results demonstrated a significant main effect for MTI variability: $F(2,26) = 31.4$, $\eta^2=0.707$, $p < .001$. Bonferroni follow-up tests revealed significant differences between each level; baseline to minimum MTI score = -7.5 increments on MTI, (SE = 1.72, $t(26) = 4.35$, $p \leq .001$, $d= 1.14$); baseline to maximum MTI score = 6.14 increments on MTI, ($SE = 1.72$, $t(26) = -3.56$, $p = .004$, $d= -1.07$); and minimum to maximum MTI scores = 13.64 increments on MTI, ($SE = 1.72$, $t(26) = -7.91$, $p \leq .001$, $d = -1.95$). The MTI data are presented in Table 3. Coefficient of variation (CV) data for each participant from the four most

pertinent daily survey items are presented in Table 4. CV demonstrated a range of 9-22% for sleep quantity, 11-29% for sleep quality, 20-74% for stress and 0-34% for significant other connection.

Coding of transcribed qualitative interviews that followed resulted in three higher-order themes, labeled as Thrive, Prepare and Activate with multiple secondary and tertiary themes identified, as shown in Figure 2.

Thrive

Thrive was identified to summarize the value placed by study participants on overall foundational well-being, which included both mind and body. The concept of thrive or thriving in this context is similar to that of being "engaged in person-context regulatory processes that eventuate in healthy and productive adult personhood" (Lerner, Brentano, Dowling, & Anderson, 2002, p. 25) or a process of development that leads to attaining an ideal state of personhood (Csikszentmihalyi & Rathunde, 1998) rather than that of a successful outcome (Fletcher & Sarkar, 2013). Participants described the various elements going into this high-level theme as a form of cornerstone factor in their lives that, when present, would then allow them to store and then access a more considerable amount of mental toughness in pursuing a specific training session or event. For example, participant TS discussed the impact of general stress on overall mental toughness levels in saying:

> External things – this was December, so I was thinking about races I have coming up in April, and all the planning is going on in December and thinking through that. I think it was wearing on me a little bit and probably some family stress coming into the holidays. Just what are we getting the kids and family stuff. Nothing revolutionary or ground-breaking or heart-breaking but just a different level of heightened anxiety through that month.

Interestingly, participants often referenced the elements under Thrive when there was a gap present. To "thrive" was to be in an optimal mental and physical state – the desired baseline from which they could then utilize mental toughness to move closer to their goal. The descriptions provided by participants typically referenced not necessarily a bonus, but rather something that was missing (from the desirable baseline) and would thus limit available levels of mental toughness, such as fuel or hydration noted here by RW:

> If I am not adequately fueled - and that includes hydration - then I just can't suffer. I know going into that workout that is an issue, and that is a tough one to overcome. There are certain things you can sometimes put behind you, but those are areas – my sleep and nutrition that are tough to overcome. If I am significantly dehydrated or significantly under-rested, I do not care. It is so much harder to push through that pain level. And in turn, going into it, it is harder to focus because it is always in the back of your head.

As noted above, the elite Masters runners were selected in part due to the inclusion of the realities of life in their experiences and responses. Rather than living in a relatively protective bubble (often experienced at least in part by professional athletes), they faced the pressures of careers, marriages, children, mortgage payments, and more in addition to the pressures related to their high-level athletic pursuits. MR commented about the impact of stress on the amount of mental toughness available with the following thoughts:

> When I was in college, there was that type of stress. When I was married to my ex-wife, there was that stress. I am married now, and there's mostly less stress. But yeah – we only have so much mental energy. If I go in at a much happier, stress-free baseline, then I think there's more to tap into. I think that

> reservoir is far deeper than if you're sort of running on an emotional drought. Then all of a sudden you just need something (and) then it is just not there.

There have been multiple references to several of the sub-themes noted here in prior mental toughness literature. Attitude (Gucciardi et al., 2014), identifying as "tough" (Jones, 2007), values (Gucciardi & Jones, 2012) and even self-efficacy (Thelwell, Weston, & Greenlees, 2005). However, they are generally seen in prior literature as characteristics demonstrated by those who already possess mental toughness rather than a driver of mental toughness variability and thus present the potential for a "chicken or egg" discussion about whether the cause of the variability or the presence of the mental toughness came first. While it is likely some combination of the two, the current study demonstrates the variability brought about by each theme appears to influence the level of mental toughness.

Prepare

The second of the high-level themes identified in this study was Prepare, based on the inclusion criteria of "make ready beforehand for some purpose, activity or use" (Merriam-Webster's dictionary, 2019). This high-level theme included a variety of items identified by the participants that would benefit from advanced thought, planning and practice. The identification of a clear vision or specific goal was commonly mentioned and ranged from immediate (workout plan for that day) to longer-term projections, as described here by RW:

> The other thing that was a limiter or caused me some issues is I just didn't have that specific race or specific goal. I did not have something six weeks out of 'this is what I am going to do.' So it was trying to maintain motivation when I did not have that set goal other than to be in shape.

Not only did the vision or goals need to be clear, but it was also vital that they were meaningful to the individual, as noted here by EK:

> If my heart is in a goal that I have set for myself, then I can be very mentally tough. There have been times that I do not have a goal set in front of me or one that my heart is not in, and I find that my mental toughness decreases.

Mental toughness awareness, practicing and some form of "callusing" (or putting oneself in a situation that requires an increased level of mental toughness) was also part of the preparation aspects noted by the participants. GR points to the awareness piece:

> By simply thinking about being "mentally tougher," I think I was tougher during the hard efforts when I needed to be… Recording/reporting or at very least mentally checking in with myself before each harder effort day will be something I use to focus my efforts. (GR - questionnaire)

This was supplemented by feedback from NO, who noted the mental preparation component:

> In training, I try to put myself in a tough position, specifically to create the opportunity to push through it. This gives me mental toughness for the actual event. I may not gain the desired result in training, but I can reflect to know what alteration needs to be made to achieve the success I want. (NO - questionnaire)

Some of the elements initially referenced under the theme of Thrive also demonstrated further benefits within the Prepare theme, in relation to task-specific application. For example, while athletes indicated the general (day by day) importance of nutrition, sleep, and hydration to building the foundation, they also pointed to the importance of specific planning leading up to the event or training

session. GR (questionnaire) summarized such thoughts based on his own discoveries as a study participant, saying: “I will also concentrate on sleep 3-5 days before my A-races, and will use caffeine on the morning of big efforts/races more regularly.”

Similarly, while general self-efficacy (Thelwell, Lane, & Weston, 2007) was noted as essential to overall thriving, task-specific self-efficacy and the necessity to integrate a focus on enhancing it in the moment played an essential role in the preparation phase, as RW indicated:

> One of the big limiting factors is the thought ‘oh man – I do not know if I want to hurt that bad.’ It is eliminating those kinds of negative thoughts. Those thoughts defeat the purpose. Pain is part of the game, and sometimes I know I allow that to limit how far I push it. So the approach that I would take would be just kind of saying ‘Hey – this is just fine. It is better than being in the dirt. Push as hard as you can because the pain makes you more alive.’

A review of previous mental toughness literature provided similar results to what was revealed under the combined higher-level themes of Thrive and Prepare. The connection between mental toughness and the pursuit of or overcoming of a specific challenge tied to a goal pursuit is commonly referenced in the literature (e.g., Bell, Hardy, & Beattie, 2013). Similarly, as noted above with generalized self-efficacy (Thelwell et al., 2007), a connection between mental toughness and task-specific self-efficacy has been noted (Smith, Kass, Rotunda, & Schneider, 2006). Also, studies on the value of strategic sleep, caffeine intake and other task-specific planning are common but none that relate these back to intra-individual variability in mental toughness. In contrast, studies tying together mental toughness with practice setting, coaching (Driska, Kamphoff, & Armentrout, 2012) and self-awareness (Cowden, 2017) have been previously presented. In the case of self-awareness, the

research was more generalized and not specific to awareness of mental toughness, but the conceptual overlap has been provided.

Activate

The final high order theme is Activate, which accurately summarized the tools and resources utilized by, or impacting, individuals during an activity to affect their ability to draw on available levels of mental toughness needed to achieve a specific outcome. Broadly, the primary sub-themes covered by Activate were attentional control, self-talk, and feedback. Attentional control (Corbetta & Shulman, 2002) looks at the interaction between goal-directed (top-down) instructions and stimulus-driven (bottom-up) feedback. DM provided insight into this when sharing the following:

> I think on the days where the voice is louder, and it is harder to silence, it is because there are so many other things going on in my life. You are more worn down whether it is physically worn down or mentally worn down going into a workout or a race. It gets harder and harder just to quiet the voice (saying) 'I am going to push myself really hard.' Because the brain is also going 'well yeah – but you are also dealing with this and this and this and this and this.' It is very easy when you're just dealing with only the race, but when other things are going on around you, it is harder to quiet that voice that's telling you to slow down.

Self-talk was one of the most commonly referenced descriptors provided by the participating athletes. This self-talk generally took on two different forms: mantras and breaking down the task into pieces. JB spoke freely about the way she pulled a specific mantra from her previous battle with breast cancer that she now uses as a runner:

> During my breast cancer thing, I had the phrase ‘Be brave. Be strong. Be badass.’ And it stuck with me, and when things get really hard in a race, I am just repeating that mantra again and again until things settle back in.

MR and others provided several examples of breaking the task into smaller pieces, of which this quotation provides a clear example:

> If I am not sure, I can make it… then I will tell myself ‘go another 15 seconds.’ So rather than just saying ‘ok – it is over,’ I will say ‘no – just 15 seconds, and then I will reassess.’ And normally I can say ‘well that was not that bad… give me another 15…’ Once I get down to a minute then I start telling myself ‘I can do anything for a minute.’ So what feels like forever – 2:45 – if I can chop it down and talk myself into just doing little sections and then get myself down to a minute.

Feedback also could have a potential positive or negative impact in the form of early performance (depending on how the “callusing” from the Prepare theme is utilized). TS provided a clear example of this with the following:

> If I am doing a tempo and I start at 6:20’s (pace/mile) and (plan to) go down to 5:30’s, but I cannot even get to 5:50, that starts to play in the mental game. ‘Oh, I should be running 20 seconds faster, but I cannot do that.’ So that is where the mental thing came in, and if it is not working for me, then I am throwing in the towel.

The projecting of “future self” into the self-talk discussion based on that early feedback was often described as lifting these high performing athletes to increased levels of mental toughness. This higher level was either because they were not willing to settle for what they might later consider being a mediocre performance or

remembered how it would feel when they were done, as DM shares with the following:

> Remember that feeling you had afterward – there's no greater feeling than that. I think that is why we keep going back and keep pushing. We crave that kind of feeling. If I can hone in on that feeling before I go out the door for that workout – (knowing) I am going to feel so much better afterward. I think that is what helped pull me into mentally a good place to be able to get out the door and do it on the days when it is not ideal.

Attentional control has been identified as a critical mental toughness characteristic (Gucciardi & Gordon, 2009). However, as with many of the elements discussed earlier, previous research on attentional control points to it being a characteristic of mental toughness rather than an influencer of that mental toughness variability, as identified here. Similarly, self-talk is noted as being something mentally tough people do more consistently than others (Coulter et al., 2010) instead of the precursor to higher levels of mental toughness noted within this study. No references tying together mental toughness with thoughts of future self could be found. However, the feedback from others was seen to positively impact mental toughness in multiple studies (Connaughton, Hanton, et al., 2008; Mahoney, Gucciardi, Mallett, & Ntoumanis, 2014).

Discussion

The purpose of this study was to explore whether mental toughness varies across a 30-day training block and whether such variability is associated with specific antecedents. As hypothesized, there were significant differences in mental toughness (based on MTI assessment) both from baseline and between high-RPE sessions (Table 3). Our results, therefore, supported the state (Harmison, 2011) rather

than trait (Clough, Earle, & Sewell, 2002) view of mental toughness. These differences were identified despite the potential ceiling effects possibly caused by elite athletes reporting high scores on mental toughness inventories (Zeiger & Zeiger, 2018). Additionally, this is unlikely to be due to significant inherent variability in the measurement tool, as prior research has supported the scale reliability – both between and within levels of analysis of the MTI across three different and independent samples (Gucciardi et al., 2015). Instead, the results support previous studies indicating at least a portion of mental toughness is state-like and can change over time (Cooper et al., 2018; Gucciardi et al., 2015).

The exploratory element of the study sought to investigate potential reasons for this variability. Foundational wellbeing (Thrive) was the first of the higher order themes and incorporated all four of the items initially tracked within either the raw data or second order themes of the qualitative analysis. The second of the higher order themes (Prepare) included two of the four relevant items covered by the coefficient of variation analysis, including sleep and (indirectly) stress (Drach-Zahavy & Erez, 2002). The last of the three higher order themes (Activate) naturally did not include sleep since this theme involves what is happening in the moment. However, there was a clear connection between the raw data and the other two pertinent coefficients of variation items (Table 4). The importance of setting aside distractions (stress), focusing on the now (stress) and feedback from friends and family (significant other connection) were included in the raw data themes in this third area of emphasis.

We would, therefore, suggest a model describing mental toughness as an interaction between state and trait drivers, as described by Harmison (2011) and Gucciardi et al. (2015). Capacity mental toughness may represent the maximum

possible level of mental toughness a specific individual can attain (trait). Then, the concept of functional mental toughness (Cooper et al., 2018) represents the amount of mental toughness currently being accessed at this moment (state) based on the application of the Thrive, Prepare and Activate components identified in this study. While an individual may have a high level of trait-based inherent, or capacity, mental toughness, that does not necessarily mean that the same individual is taking purposeful steps within the themes of Thrive, Prepare and Activate to optimize the amount of mental toughness that is being utilized functionally.

Through the introduction of the terms Capacity Mental Toughness and Functional Mental Toughness, both researchers and practitioners may have an opportunity to assist individuals in optimizing their own performance and outcomes more effectively. These concepts help to build and enhance the practical application by athletes, researchers, and coaches that Gucciardi et al. (2015) and Harmison (2011) initiated. By outlining the trilogy of Thrive, Prepare and Activate, individuals, coaches, and practitioners will be able to more effectively contextualize specific action plans (e.g., practicing self-talk as part of the Prepare phase) as a specific step toward influencing the level of functional mental toughness for each. Strategies that would incorporate these specific steps provides for a much more productive discussion – and application potential – than merely comparing the mental toughness levels of person A to that of person B.

Application for Practitioners

One of the encouraging findings noted through this study was the duality of interaction both between and within each of the higher-level themes. Each of the themes (Thrive, Prepare, and Activate) positively influenced the level of available (functional) mental toughness, but that may not be the limit of the interaction.

Instead, participants indicated that each one also has the potential to impact the others (i.e., increased preparation enhanced ability to effectively activate).

A further application element is that despite the positive between- and within-theme interaction, we also propose they stand alone regarding benefit. As such, the individual who is not thriving personally and did not adequately prepare mentally for the event or session can still benefit from utilizing tools/resources within the "activate" theme. While not receiving all available benefits, there were still increases in mental toughness garnered by engaging in each one separately. This potentially provides the individual, coach or peer advisor resources through which to enhance functional mental toughness regardless of current life or situation state on that day or in that specific situation.

The combination of these may provide practitioners a framework that can be utilized to help individuals identify critical areas for improvement and necessary steps to enhance outcomes through choices that best fit their current situation, history, and future goals. For example, a practitioner could assist a client in reflecting on their current level of foundational wellbeing (Thrive), their situation-specific advanced preparation (Prepare) or the tools utilized in the midst of the specific activity requiring the mental toughness (Activate). Such reflection could lead to the identification of specific personal development aspects that could be improved over time either independently or in tandem with a coach or practitioner. While not to be over-emphasized due to the inherent limitations herein, the practical application opportunities provided through these results are encouraging.

Limitations

While the small sample size adopted was appropriate for a qualitative study involving this level of tracking by participants, it also meant that generalizability is

difficult. However, the inclusion of non-professional and middle-aged athletes brings a specific “real life” element to this exploratory case study of individual mental toughness variability and potential influencers. These individuals are considering mental toughness and the elements driving variability of that mental toughness within conditions that are familiar to many athletes (e.g., family and work pressures). Additionally, the selected one-month period over which the data collection took place meant that the athletes were at different points in their seasons rather than all pursuing similar training outcomes. Some had recently come off of their crucial race periods while others were just starting their build period for the coming year and this variation could have had an additional impact on outcomes. However, our focus on self-selected high-RPE sessions meant that the intensity of those sessions was left to the interpretation of each athlete and hence ensured individual differences in perceptions of ‘what makes a tough session’ could be identified.

Finally, while the quantitative data gathered within this exploratory case study of mental toughness variability was limited, the qualitative approach adopted enabled us to explore mental toughness variability with each participant.

Future Directions

This study sets the stage for a range of future study directions. There is an opportunity to investigate each of the three primary optimizers: Thrive, Prepare and Activate, both individually and in combination. The interaction within each of these three influencers of mental toughness could also be examined more closely (e.g., whether preparation increases mental toughness which then increases the likelihood of preparing further). Researching the impact of the specific components under the thrive, prepare and activate influencers on mental toughness across a larger sample size is essential in order to provide greater certainty of application across the general

population. This follow-up research could initially be done with a larger group of athletes and then be extended more broadly, outside of sport. The potential to investigate whether the functional enhancement of mental toughness can be applied outside of sport (i.e., military, executives, and well-being) would continue to expand the opportunity for such interventions to affect the lives of a broader population positively. The concept that foundational well-being positively influences mental toughness (and vice-versa) is an intriguing concept that could benefit society on a broader basis beyond athletics. For example, individuals could potentially put a higher priority on areas such as sleep, nutrition, and exercise if they realized these elements would benefit their level of mental toughness across other areas of their lives.

The practical implications introduced in this study provides additional traction for future research to investigate the concept of mental toughness influencers such as sleep and psychological training further. If mental toughness is merely a relatively constant trait, there is limited value tied to psychological skills training. However, the identification of variability and potential influencers means researchers, practitioners and individual athletes (and others) can integrate elements that can help improve their outcomes and their lives.

Conclusions

In conclusion, the findings from this study not only support previous research that mental toughness is state-like (Gucciardi et al., 2015), but findings also suggest that there are many potential optimizers that can be utilized by individuals to improve their mental toughness and thus their outcomes. The current study highlighted specific influencers and helped categorize these influencers into an easy to understand trilogy of themes. This format may provide researchers, practitioners, and

individuals additional tools and resources on which they can continue to build better outcomes and potentially better overall lives. There is still much to learn about how specific influencers can improve the utilization of mental toughness across a variety of settings, but this provides a starting point going forward.

Table 2: *Demographic information from the thirteen participants*

Pseudonym	Ranking Score	Age (years)	Gender (M/F)
SS	76.53	40	F
JB	76.25	41	F
WM	78.71	44	F
DM	85.3	43	F
EK	79	47	F
RS	91	59	M
PB	75.03	49	M
NO	75.5	48	M
TS	95.6	50	M
RW	85	52	M
TR	78.4	54	M
GR	77.8	46	M
MR	80	51	M
Average	81.1	48.0	
Standard Deviation	6.35	5.37	

Note: Ranking Score 100% = World record level; > 90% = World class; > 80% = National class; >70% = Regional class

***Table 3**: Mean (± SE) composite mental toughness index (MTI) score (range, 8-56) at Baseline (outset of study) compared to lowest (Minimum) and highest (Maximum) reported scores during five sessions*

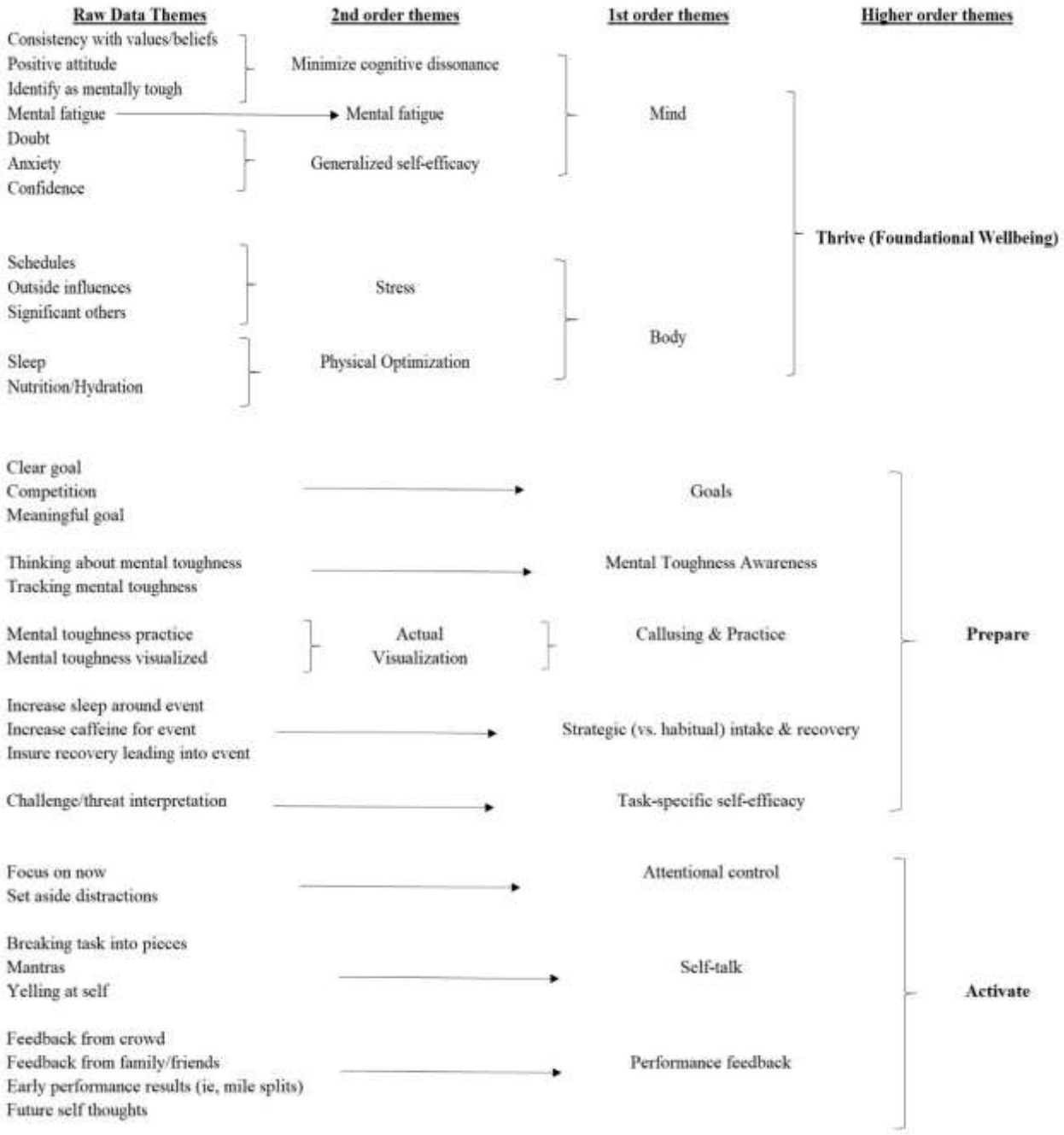
			95% Confidence Interval	
RM Factor 1	Mean	*SE*	Lower	Upper
Baseline	47.0	1.56	43.8	50.2
Minimum	39.5	1.56	36.3	42.7
Maximum	53.1	1.56	50.0	56.3

Table 4: *Overview of athlete survey data of those providing consistent responses.*

	Sleep Quantity (In Hours)			Sleep Quality (1-10 Scale)			Stress (1-5 Scale)			Significant Other (1-5 Scale)		
Participant	*Mean*	*SD*	*CV*	*Mean*	*SD*	*CV*	*Mean*	*SD*	*CV*	*Mean*	*SD*	*CV*
DM	7.53	0.66	9%	6.87	1.52	22%	3.13	0.62	20%	4.81	0.40	8%
JB	6.12	1.11	18%	6.62	1.92	29%	2.15	0.92	43%	4.96	0.20	4%
MR	8.34	0.76	9%	6.10	1.47	24%	2.34	0.67	29%	3.93	0.53	13%
RW	7.42	0.93	13%	6.33	2.12	33%	2.87	1.38	48%	2.67	0.92	34%
TS	7.63	0.92	12%	8.22	0.93	11%	2.74	0.66	24%	2.44	0.51	21%
NO	7.14	1.57	22%	7.69	1.85	24%	1.52	0.63	41%	5.00	0.00	0%
PB	8.75	0.76	9%	8.03	1.05	13%	2.21	0.57	26%	4.90	0.54	11%
TR	7.34	0.73	10%	6.87	1.28	19%	2.39	0.67	28%	3.06	0.25	8%
GR	7.79	0.85	11%	8.25	1.26	15%	3.46	0.78	23%	3.50	0.72	21%
WM	7.81	0.69	9%	8.59	1.05	12%	1.48	1.09	74%	5.00	0.00	0%

Note: Each row represents a participant. SD = Standard Deviation; CV = Coefficient of Variation (SD/mean, expressed as a percentage)

***Figure 2**: Themes uncovered from open coding of interview data (study II).*



Overall Thesis Contribution of Study II

- Study II results measured within-person variability of mental toughness across a 30-day period and multiple elite Masters athletes, building on the surmised within-person variability in a single athlete from Study I.
- Findings in Study II identified potential antecedents to mental toughness optimization.
- Results provided initial insights into concepts of Functional Mental Toughness (fMT) and Capacity Mental Toughness (cMT) for practical application by athletes, coaches and practitioners in real-world settings.

Study II effectively set the stage for Study III and Study IV by specifically measuring within-person mental toughness variability and identifying a wide range of potential optimizers of that mental toughness. The identification of these potential optimizers led to the next stage in the process: investigating the specific impact of one of these optimizers on the variability of within-person mental toughness.

Chapter Five: Study III

Cooper, K. B., Wilson, M. R., & Jones, M. I. (2019). The impact of sleep on mental toughness: Evidence from observational and N-of-1 manipulation studies in athletes. *Sport, Exercise, and Performance Psychology*. Advance online publication. doi.org/10.1037/spy0000174

The Impact of Sleep on Mental Toughness: Evidence from observational and N-of-1 manipulation studies

Abstract

Objective: The purpose of this study was to explore the direction and magnitude of the relationship between sleep (duration and quality) and mental toughness variability.

Design: Observational and Qualitative N-of-1

Method: Study 1 was a cross-sectional observational study examining the relationship between sleep quality and duration (hours) and mental toughness in 181 participants. In Study 2, we utilized a longitudinal N-of-1 influenced methodology with six participants to further examine whether manipulated time in bed (i.e. sleep duration) consistently influence mental toughness. Participants recorded sleep quality, sleep duration, and mental toughness over the five weekdays during two separate two-week periods of baseline (normal sleeping pattern) followed by manipulated time in bed (counterbalanced 9 hours or 5 hours).

Results: In Study 1, Winzorized correlations revealed both sleep duration (ρ_w = .176 [.033, .316], p = 0.016) and quality (ρ_w= .412 [.270, .541], p ≤ .001) were associated with mental toughness score. Follow-up regression analyses revealed sleep quality (b = 0.177, [0.117, 0,238], $p \leq .001$), but not sleep duration (b = 0.450, [-0.3254, 1.22], p =.256) predicted mental toughness score. In study 2, visual analysis (including determination of non-overlapping data points between baseline and intervention weeks) revealed that reduced time in bed negatively impacted mental toughness in four of the participants. Social validation interviews were conducted to further explore participants' perceptions of the sleep manipulation.

Conclusions: A cumulative effect of reduced sleep on mental toughness was noted by specific individuals as were potential buoys of mental toughness in the absence of sleep.

Key Words: Sleep, Mental Toughness, Masters Athletes, *N*-of-1, Sleep Duration

The Impact of Sleep on Mental Toughness: Evidence from observational and N-of-1 manipulation studies

Mental toughness is a personal capacity to achieve consistently high levels of performance despite challenges and stressors (Gucciardi, Hanton, Gordon, Mallett & Temby, 2015). Despite some existing conceptual disagreement about its exact nature (e.g., whether it is multidimensional or unidimensional), it is broadly agreed that mental toughness is amenable to change. If mental toughness is a state-like construct (Gucciardi et al., 2015), then research is warranted that explores the potential antecedents of changes in mental toughness across different states. Given the broad literature that reveals positive relationships between sleep quality and duration, and several components of mental toughness (e.g., attention; Lim & Dinges, 2008, and emotional regulation; Baum et al., 2014) we contend that both are potentially relevant antecedents of mental toughness that warrant further exploration.

There is ample evidence regarding the effects of sleep manipulation on physical and cognitive performance (e.g., Psychomotor vigilance: Belenky et al., 2003) as well as psychological function (e.g., social and emotional function: Goldstein & Walker, 2014). For example, mood, attentional control, and emotional regulation are shown to covary with sleep duration (Krizan & Herlache, 2016) and quality (Tempesta, Socci, De Gennaro, & Ferrara, 2018). An increase or decrease in sleep is also involved in the regulation of pain, with threshold tolerance decreasing following one night of sleep deprivation (Onen et al., 2001), or following partial sleep restrictions (Haack, Sanchez, & Mullington, 2007).

Researchers have suggested that mental toughness represents a higher order construct comprising a range of lower order variables. For example, Gucciardi, et al. (2015) referenced a mental toughness "resource caravan" (Hobfoll, 2011) or aggregation of several personal resources that interweave to drive performance. These individual resources (e.g., emotional regulation, self-efficacy, optimism, attention regulation; Stajkovic, 2006) are tied together so people high in one are usually high in others. Given the range of studies that reveal sleep disruption negatively influences several mental toughness resources (e.g., emotional regulation; Goldstein & Walker, 2014 and attentional regulation; Killgore, 2010) we believe that sleep disruption will negatively influence mental toughness, and sleep extension (or increasing sleep quality) may positively influence mental toughness.

Indeed, recent evidence demonstrates mental toughness and sleep are related. Brand et al., (2014) found mental toughness to be associated with sleep quantity in adolescents. The authors suggested that individuals higher in mental toughness achieve better sleep than their less mentally tough counterparts because mental toughness buffers stress, which can influence sleep onset latency and sleep quality. However, the question about whether a change in sleep quality or duration - constructs that individuals, coaches and others could potentially choose to adjust in their lives - influences mental toughness has not been addressed in the literature. Sleep can be reasonably hypothesized as an antecedent (and likely consequent) of self-reported mental toughness based on the previously demonstrated research on mental toughness sub-dimensions. To this end, the purpose of this two-part study was to explore the direction and magnitude of the relationship between sleep (duration and quality) and mental toughness and examine the effect of time in bed extension and restriction on mental toughness and sleep quality.

Experiment One

Methods – Experiment 1

Participants

Following ethical approval from the first author's institutional research ethics committee, 218 adult participants partaking in some version of self-selected and defined exercise at least three times per week were recruited through convenience online sampling. Participants were recruited via social media and email and additional personal details such as age or specific location were not part of the survey data. We invited the participants to complete two surveys that explored their duration and quality of their sleep and mental toughness. Determination of sample size was based on a Pearson Correlation Coefficient of .39 between sleep quality and mental toughness found by Brand et al. (2014). By stipulating a power of .80, significance level of .05 and effect size .10 using G-power, our sample size was estimated to be 100 (Faul, Erdfelder, Lang, & Buchner, 2007). Of the original 218 individuals who registered to participate, 181 completed both sleep and mental toughness measures. The remaining participants only completed one of the two assessments and were therefore excluded from subsequent analysis.

Measures

Sleep. Sleep duration was based on self-reported time in bed to the nearest 0.5 hour (e.g., Brand et al., 2014). Sleep quality was assessed using the Richards-Campbell sleep questionnaire because it provides an effective assessment of the prior night's sleep (Hoey, Fulbrook, & Douglas, 2014). The Richards Campbell Sleep Questionnaire (RCSQ) was originally developed to assess the quality of sleep in hospital patients from the previous night. It involves five questions with a score of zero (e.g., "bad night's

sleep") to 100 (e.g., "good night's sleep") for each. An average score of zero to 100 provides an overall comparison of sleep quality.

Mental Toughness. The unidimensional mental toughness index or MTI (Gucciardi et al., 2015) an eight question, seven-point Likert scale self-assessment, was utilized to assess mental toughness. It prompts participants to indicate the accuracy a specific statement, ranging from one (*100% False*) to seven (*100% True*). Total scores range from 8-56 with higher scores indicating higher mental toughness and has been shown (Gucciardi et al., 2015) to be reliable (p = 0.860 to 0.890), provide strong factor loadings and high (0.900) Cronbach's α (Jones & Parker, 2018).

Procedure

Participants were randomly assigned to complete their two assessments (Sleep duration/quality in the morning for immediate recall and Mental Toughness Index at approximately 16:00 as a review of their MT for that specific day) on one of five week days (Monday – Friday) and received an email reminder on their assigned day. The assessment was completed via a computerized assessment process, so of the 181 individuals who completed both assessments, there was no missing data because the online system prompted users to address missing data before submission.

Results- Experiment 1

Data Screening and Analysis

Data analysis was performed utilizing R. We examined the data for the assumptions of ordinary least squares regression (normality of residuals, outliers) and found univariate outliers for both sleep quality and sleep duration. A decision was made to retain the outliers as evidence for data error was lacking and the outliers appeared to be legitimate members of the population. However, the data violated the assumption of

normality and therefore we adopted Winsorized correlations with 95% confidence intervals [LLCI, ULCI] and robust regression (Wilcox, 2017) using a maximum likelihood estimator. Next, we calculated descriptive statistics and calculated internal reliability estimates from the MTI and RCSQ scores (see Table 6). Finally, our Winzorized correlational analyses demonstrated that both sleep duration (ρ_w = .176 [.033, .316], p = 0.016) and quality (ρ_w = .412 [.270, .541], $p \leq .001$) were associated with MTI score. Follow-up robust regression analyses revealed that sleep quality predicted MTI score (b = 0.177, [0.117, 0,238], $p \leq .001$); however, sleep duration did not (b = 0.450, [-0.3254, 1.22], p =.256) at the $p \leq .05$ level (See Table 7).

Discussion Experiment 1

This initial study confirmed our hypothesis that a positive association exists between mental toughness and both sleep quality and duration, suggesting that the relationship previously found for adolescents (Brand et al., 2014), holds for adults. However, the regression analysis showed that duration did not directly predict the MTI score. Tabachnick & Fidell, 1996 suggest that a significant correlation and a non-significant regression coefficient could indicate the omission of a potentially important mediating variable. Future researchers may wish to examine potential mediator or suppressor variables. For example, cognitive strategies, such as positive reappraisal could buffer the deleterious effect of sleep restriction and thus maintain perceived mental toughness (Gaudreau, Blondin, & Lapierre, 2002).

Our second study aimed to extend these findings by experimentally extending or restricting time in bed to see whether this influenced perceived mental toughness. We also aimed to examine the participants' experiences of the time in bed manipulation to

explore whether the participants used any specific psychological strategies in response to sleep extension and restriction.

Experiment 2

The purpose of this experiment was to examine the effect of time in bed extension and restriction on mental toughness. *N*-of-1 studies examine the effects of treatment by following an individual participant over time as the treatment (in this case, total time in bed) is varied from period to period (Araujo, Julious, & Senn, 2016). Conducting an idiographic analysis of the effect of time in bed extension and restriction on sleep quality and mental toughness is needed because study one revealed a relationship. However, individual differences in sleep need and sleep behavior (Spilsbury et al., 2004) mean that a group based design cannot effectively reveal the individual effects (McDonald et al., 2017). We hypothesized that lower MTI self-assessment scores would occur during the reduced time in bed period, and that higher MTI scores might occur during the period of increased time in bed. Follow-up interviews allowed us to explore the possible cause of any changes.

Methods – Experiment 2

Design

We adopted principles and practices associated with an *N*-of-1 study model (McDonald et al., 2017; Vieira et al., 2017). An *N*-of-1 methodology is a valid and efficient approach for both the development and evaluation of interventions (Lillie et al., 2011), and the testing of theory (Johnston & Johnston, 2013). Our *N*-of-1 study is individualized and not intended to infer population-level parameters. It consists of time-series data in order to measure variability within individual participants over that time and therefore, the design emphasizes real-world considerations related to the individual.

Participants

Study participants were initially recruited from among the 13 elite Masters athletes who participated in a previous study (Cooper, Wilson, & Jones, 2019). Six athletes volunteered (see Table 5 for demographic information) to participate and all six completed the entire study. A recent review of 34 different '*N*-of-1' study designs (McDonald et al., 2017), reported a mean sample size of five participants and a median of four. With potential for drop-out from the study due to the sleep manipulation over the 4 weeks, we recruited all six participants who volunteered.

Measures

Sleep duration (to nearest 0.5 hour), Mental Toughness Index (MTI) and Richards Campbell Sleep Questionnaire (RCSQ) were utilized in the same format as Experiment 1.

Procedure

Participants completed five days (Monday through Friday during the selected week) of baseline assessments, which included recording their sleep duration from the previous night to the nearest 0.5 hours and sleep quality using the RCSQ in a morning self-assessment. They then completed a mental toughness assessment using the MTI at approximately 16:00 each day. The sleep schedule during this initial five-day period was self-selected by the participants. During week two, the first of two sleep opportunity manipulation weeks, the six participants were randomly assigned to either a five-hour or nine-hour time in bed manipulation schedule (three people assigned to each group). Participants completed the same morning and afternoon self-assessments as the baseline week (also Monday through Friday). Following a four-week reset period during which no assessments or sleep manipulation was included, the process was repeated.

Participants first completed a second baseline (regular for that individual) sleep schedule week, before completing the alternative sleep manipulation schedule (five or nine hours).

The selection of five and nine hours for our manipulation follows parameters commonly utilized in the literature (Arnal et al., 2016; Belenky et al., 2003; Blagrove, Alexander, & Horne, 1995). It also limits the risk involved at the low end based on previous research lasting 7 days, which found that the minimum amount of sleep to maintain alertness and performance is four hours each night (Belenky et al., 2003). Participants were also repeatedly reminded of the clear option to withdraw from the study if the reduced sleep schedule resulted in a safety concern.

Interviews with each participant followed within three weeks of completion to identify additional details related to the impact of sleep on their perceived mental toughness. Interviews averaged 45 minutes in length with a range of 35-50 minutes and were recorded to allow for later transcription. The semi-structured interview questions included those selected from a list of ten pre-prepared questions, depending upon the results tied to each individual participant. The list of questions included; “How did it feel to have more/less sleep than usual?” “What did you notice about your thoughts, feelings and behaviors when you had more or less sleep?” and “Looking at your pattern (see Figure 3 and Figure 4 for examples, which was provided to interviewees in advance), any surprises?”

Data Screening and Analysis

We adopted a visual analysis procedure (Horner et al., 2005), and plotted individual participant scores for MTI and RCSQ over the four experimental weeks (see Figure 3 and Figure 4). We then utilized visual inspection to identify occurrence of

effect. We also identified criteria for a meaningful minimal benefit and harm (Stoové & Andersen, 2003). To calculate these criteria, we utilized data from Gerber (2012) and calculated the average differential in percent from the mean in their study on exercise and mental toughness (which came to 3.3%). The meaningful minimal benefit and harm was then calculated from the absolute lowest and highest MTI scores over the 10 days of baseline +/- this 3.3% differential. We used these criteria, modeled after Hrycaiko and Martin (1996) to determine the degree to which sleep had an influence on mental toughness. First, we looked for the presence of overlapping MTI data points at baseline compared with the treatment periods. Second, we considered the magnitude of the change in MTI during treatment periods, noting that the range would be limited due to ceiling effects of MTI scoring. Third, we examined the trajectory of change in MTI over the treatment period (Jones, Lavallee, & Tod, 2016). Social validation interviews followed this inspection to evaluate the personal interaction with the intervention. Social validity has been suggested (Wolf, 1978) as a method of examining the importance of dependent variables to the participant.

Results – Experiment 2

Results for each of the six participants were analyzed and summary graphs for the influence of time in bed on MTI and RCSQ scores are in Figure 3 and Figure 4, respectively. An individualized discussion about each participant within this *N*-of-1 study is provided below, followed by thematic coding of mental toughness influencers across the broader group. Sleep quality as measured by the RCSQ appeared to follow a pattern unrelated to time in bed (see Figure 4). This may be due to the way in which the RCSQ measures quality of the sleep period (i.e., did individual fall asleep quickly or did they wake during the night) rather than the perceived value of said sleep (i.e., did

individual feel rested upon waking?). Conversely, the end of week MTI to time in bed analysis demonstrated a notable association in four of the six participants and thus became the focus of our qualitative interviews summarized in the discussion below.

Individual Participants Insights

Participant 1. Figure 3 shows that participant one (P1) recorded the three lowest MTI scores, and five of his lowest eight scores from the entire study, during the five-hour time in bed days. This did not meet the first two of our criteria for sleep influencing mental toughness (MTI on baseline days and nine-hour time in bed days must all exceed all five-hour time in bed days). However, it did meet the third criteria (MTI on final five-hour time in bed day must be equal to or lower than any other recorded day). P1 reported during the follow-up interviews that had the MTI assessment been performed in the mid-evening (when he remembered his mental toughness being at its lowest point) rather than the late afternoon, his scores during that five-day period would likely have been even lower. He noted that the nine-hour time in bed felt like normal to him while the five-hour time in bed "felt wrong." The interviews revealed a variety of secondary influencers utilized to buoy his MTI for both his professional and personal pursuits in the absence of sleep. He, like several of the participants reported utilizing similar strategies to what he would use in an endurance event such as an Ironman triathlon or marathon. These included external support from family and friends, regular self-talk, nutritional focus and overall mindset about why he was limiting his time in bed. While he expressed a belief that these helped him throughout the five-day period of five-hour time in bed, he still demonstrated a notable reduction in MTI overall during this portion of the study. When asked specifically about his rebound (partially upward) on the third day of this period, he noted that his MTI felt like it dropped as the evening continued

> I made it through the day and by then (4 PM, when he would complete the MTI assessment), I was probably almost on the high of 'that was ok – I made it. That's not that bad.' Then later in the day it would have been down.

He also noted the cumulative deleterious effect on his MTI as the week continued: "What I found through the week of five hours (time in bed), I needed that sort of crutch each night more." This 'crutch' was a reference back to some of the tools and strategies he had mentioned previously in the discussion and helped buoy his mental toughness levels.

Participant 2. Figure 3 revealed that participant two (P2) recorded her single lowest MTI score on the final day of the reduced time in bed period. However, the remainder of her week did not appear to show an effect of reduced time in bed and MTI score. Her results adhered to our third criteria (MTI on final five-hour day being lower than/equal to all other recorded days) but did not meet the first two (MTI on baseline days and nine-hour time in bed days must all exceed all five-hour time in bed days). The follow-up interview provided insights into potential influencers of this outcome, as she expressed a preference for less sleep, a dislike of the nine hour time in bed days and noted being energized by the additional productivity during the five hour days, before her MTI dropped to its lowest level on the final day of that reduced time in bed week.

> I do better with less sleep than most people, so the decrease in sleep didn't upset me a whole lot other than being up earlier in the morning than I was used to… I was so productive during those [extra] hours!

In fact, she preferred the five-hour to the nine-hour time in bed, which may be related to her low MTI score on the first day of the longer time in bed week:

> Being in bed for nine hours was really hard for me. I found that it was a struggle on a lot of levels. I don't mind the short nights as much as I do the long ones. On the nine hour nights, I'm throwing off things (schedule) and having to get to bed so early it took longer to fall asleep sometimes. Even if it didn't take longer, I didn't stay asleep as well. I'd be awake at 11 PM and again at 2 AM.

Participant 3. (P3) demonstrated a pattern more closely related to P1, as his MTI scores on the five-hour week represented five of the six lowest MTI scores from the entire twenty days of the study. He described his experience and general mental toughness during the five-hour time in bed week as:

> That was evil. That thing kicked my butt by day two…It's amazing how that extra hour, hour and a half after a couple of days can start to wipe you out and it was a killer. That was a tough week.

However, due to one low MTI day scored during the initial baseline (which, interestingly occurred on a night when sleep quantity was below his normal baseline), he only met the third criteria (MTI lowest on final day of the five-hour week compared to all other recorded) and not the first two. P3's Interview revealed that this overall drop in MTI across the five-hour time in bed week occurred in spite of a very purposeful approach to the week including advanced planning, banking sleep, strategic activity and other attempted influencers as noted here:

> (Strategies were) a key part of me still being successful in my job. I knew this was coming up and I had banked a little bit of sleep… Within the actual job I had things written out for the entire week – I had an outline of my week… and I structured the schedule knowing that this was coming.

The concept of banking sleep prior to sleep loss has been demonstrated to be an effective strategy to maintaining performance in the literature (Rupp, Wesensten, Bliese, & Balkin, 2009). He then expanded upon these strategies with:

> The mental preparation was 'ok – I'm exhausted. It's only 7AM and it's not going to get better.' I don't drink coffee or any of those stimulants… so it was just consciously looking at and having the expectations that I was going to be a little more tired, a little bit more rundown and that I still had 8 hours of work ahead of me here at the job and to taper that out. As opposed to coming in guns ablazin' on-fire energy… It's almost like a triathlon. Instead of doing a sprint (short – one hour event), I did an Ironman. I was just as tired at the end of the day as I would have been on the sprint, but I just had to spread out the effort.

Participant 4. (P4) was one of two participants who demonstrated limited impact of time in bed on MTI scores and did not meet any of the three criteria set forth as demonstrating sleep as a primary influencer of MTI. In discussing the week involving the reduced time in bed hours, he credited the primary buoy of mental toughness while accessing limited sleep as being his work setting during that week, which he described as the following:

> I was in New York City and we were presenting to a lot of the big banks on Wall Street… Some of this (higher MTI) might be the adrenaline of 'Hey – I'm going in tomorrow morning to present to JPMorgan Chase.'

He repeatedly conveyed during the interview that the intensity of that week provided additional energy that helped him overcome his limited sleep schedule.

Participant 5. (P5), the fastest elite runner of the group who is also on an elite-level career path, started the week off with high MTI the first two days of the limited

time in bed week and thus did not meet the first two criteria. However, during the final three days of this week, his MTI scores showed a notable drop and a clear adherence to the third criteria. He described the five-hour week as:

> It was probably one of the hardest things I've done… I would much rather run a workout where I make myself puke than go without sleep like that. The first day or two I was thinking 'ok – I can make this happen – I can survive.' Then I really actually quite frankly considered bagging it (the study).

Similar to three of the other participants, he integrated multiple strategies – some being the same strategies he utilizes as an athlete to buoy his mental toughness throughout the week.

> I would say it (strategies were) similar thing I do during the course of a workout where things aren't going well and you don't feel right. It's easy to run a workout when you're feeling good and it's easy and the workout's within your capability. But it was one of those things where it felt somewhat outside of my capability and comfort zone and so I used some of the similar techniques in terms of just internal conversations with myself to get my ass moving to the point where I could still get the work done I needed to get done… that's where I just tried to pull off of what I use during the course of those workouts where I just kind of refocus and have those internal conversations with myself.

Participant 6 (P6) demonstrated results similar to P4 and did not meet any of the three criteria set out in this study for sleep as the primary influencer of MTI. Interestingly, during the qualitative portion of the study, he identified a similar buoy of his mental toughness during the reduced time in bed week as P4. He described the week in this way:

> I work as a consultant and my company was responding to an RFP (proposal). We put together what's called 'The Pursuit Team' and I was pulled into the Pursuit Team and flown out to Pennsylvania to work on our response… They're high energy, they're long days, they're go-go teams and it just happened to be during the five hour week. We were pulling 18 hours in the office anyway, so it was a fast, high-energy week trying to get the response out which made the fives so much easier because there's a group of people who are doing the exact same thing.

Similar to P2, P6 also expressed enjoying the increased productivity of the five-hour week but also related his consistent short-term MTI on reduced sleep to his identity growing up swimming and delivering newspapers:

> My background is swimming in high school and college. Morning practice starts at 5 AM and so getting up early isn't difficult. I had eight years of conditioning of doing that and so that's still there: the 'get up early – go do something'… I used to (as a kid) deliver papers and you've got to get up in the morning, get those papers out because people were calling at 6 AM asking where their paper is… So, on the five hours it was still the same thing: look at the clock, it says 3 AM. 'Ok – it's time to get up' and I usually beat my clock (alarm) even on those 5 hour [days].

Discussion – Experiment 2

The purpose of this experiment was to examine the effect of time in bed extension and restriction on mental toughness and sleep quality. In line with the results of study one, we found that sleep duration is related to changes in mental toughness in some participants but not all. Restricted time in bed appears to affect MTI, especially at

the end of a five-day period. However, given the inconsistency of change in mental toughness during the treatment periods, it is evident that sleep duration is not the only construct that influences MTI score. Sleep duration is related to mental toughness in some people, but the effect was not as pronounced as hypothesized. Additionally, despite the correlation between quality and duration in study one, we found that time in bed did not influence the sleep quality score when recorded using the RCSQ assessment.

General Discussion

The purpose of this study was to explore the direction and magnitude of the relationship between sleep (duration and quality) and mental toughness and to examine the effect of time in bed extension and restriction on mental toughness. The results of study one revealed moderate sized positive relationships between sleep quality and mental toughness and sleep duration and mental toughness; however the regression results revealed that only sleep quality predicted MTI score (at the $p \leq .05$ level). Study one also revealed that the magnitude and direction of the relationship between sleep duration and sleep quality is moderate and positive and is significant at the $p \leq .001$ level. The lack of an additional significant regression may be explained by a range of potential mediating variables. These include but are not limited to the ceiling effect with mental toughness and athletes (Zeiger & Zeiger, 2018), as this would effectively cap the available improvement with an increase in sleep above the mean. While not all participants would define themselves as “athletes,” all participants were required to be exercising a minimum of three times per week. Additionally, perhaps the “sweet spot” for sleep (Khatib et al., 2018) also has implications for the impact on mental toughness outside of the mid-range of seven to eight hours’ time in bed. Or potentially the cumulative effect of sleep restriction beyond a single day (Van Dongen, Maislin,

Mullington, & Dinges, 2003) would reveal specific variables with the greatest influence on mental toughness.

The results of study two revealed that manipulating time in bed did not meaningfully influence mental toughness nor sleep quality across all participants to the extent that we expected. Follow up interviews highlighted some of the reasons that restricted and extended time in bed did not consistently influence their perceived mental toughness, as multiple participants pointed to additional influencers that helped them buoy or at least limit the drop in mental toughness when sleep was limited. These included general mentality about sleep, purposeful strategies to elevate mental toughness throughout the day, foundational wellbeing elements (hydration and enhanced nutrition) and advanced personal planning (Cooper et al., 2019).

Variability of mental toughness was also revealed as a result of this study. This evidence supports the state-like nature of the construct previously noted in the literature (Cooper et al., 2018, 2019). It is notable that we initially recruited six participants for this *N*-of-1 study with the expectation that due to the requirements, a significant % of the participants might choose to drop-out (Fukuoka, Gay, Haskell, Arai, & Vittinghoff, 2015; Stubbs et al., 2017). However, all six of the initial participants completed the full study, which may reflect the connection between mental toughness and intention previously identified (Gucciardi, 2016).

Strengths and Limitations

This study provided a real-life basis from which to examine the influence of sleep on mental toughness. However, we did not measure behavioral consequences of sleep (e.g., changes in athletic performance). In addition to measuring changes in mental toughness researchers could also measure changes in human performance (e.g.

time to exhaustion, psychomotor vigilance) to see whether the relationship between sleep and mental toughness is meaningful rather than an epiphenomenon. The inclusion of elite but not professional Masters athletes provided grounding more closely related to the general population in terms of the realities of life (careers, children, bills and other external stressors) as compared to students or professional athletes. In addition, the inclusion of only athlete participants also likely resulted in a higher mental toughness baseline and a smaller mental toughness variability (Zeiger & Zeiger, 2018). Finally, the *N*-of-1 longitudinal design of this study, while not intended to identify population parameters, does set the stage for effective real-world analysis (Johnston & Johnston, 2013).

Using time in bed as a proxy for sleep duration is not without its limits. In particular, during the 9-hour time in bed weeks, participants reported difficulty with going to bed early, indicating the longer time in bed did not translate directly to sleep duration. Our choice of the RCSQ to assess sleep quality was an effective tool for the initial experiment and three (Baseline I, II and nine-hour time in bed) of the four weeks of the *N*-of-1 experiment. However, due to the focus of the RCSQ on the quality of the available sleep rather than total sleep, it was not an effective assessment for the five-hour time in bed week. Additionally, we learned during that the timing of our late afternoon (generally as work was ending) MTI assessment was not optimal and may have been more accurate if completed in the late evening.

Future Directions

This study sets the stage for additional future investigation into the influence of sleep on mental toughness and strategies utilized by individuals to sustain or further build mental toughness. Study one shows that sleep quality is important. If we were to

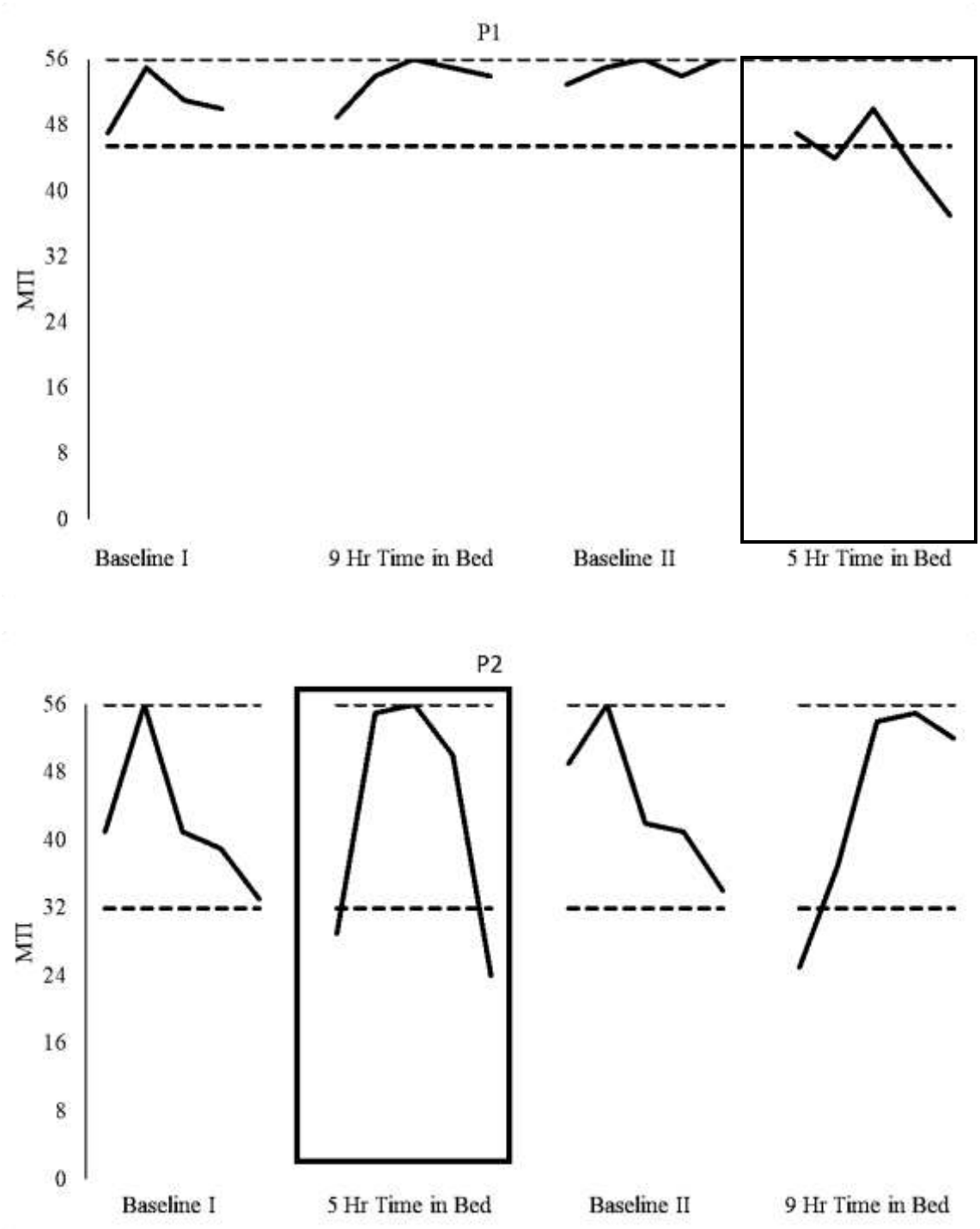
purposely manipulate sleep quality through the enhancement of sleep hygiene, time leading up to sleep and purported sleep enhancement tools such as sound machines, additional insights might be gleaned. Measuring sleep with more accurate tools such as polysomnography may provide insights into how other sleep-related variables such as sleep onset latency and time in bed are related to mental toughness (Clark & Landolt, 2017). The resources caravan concept suggests that as one resource goes up so do others. However, it may be the case that sleep positively influences some dimensions but degrades others. For example, an individual might have better emotional regulation because of REM but may recruit fewer additional mental toughness buoys due to a feeling of guilt for wasting time in bed. Expanding from the *N*-of-1 design to look at within-person changes in mental toughness and sleep across a broader population would be of value to expand upon this initial research. Further, the need for (or perceived need for) mental toughness was noted as being increased among our study participants during their low time in bed days. In moving outside of the athletic population, there would be value in determining how often during a typical day an individual outside of a sporting or military setting recognizes the need for mental toughness and how often do they choose to utilize it to achieve the stated goal and the outcome of doing so. Finally, additional opportunities exist in examining some of the other mental toughness influencers noted in this study and how individuals and practitioners can incorporate those into their approaches.

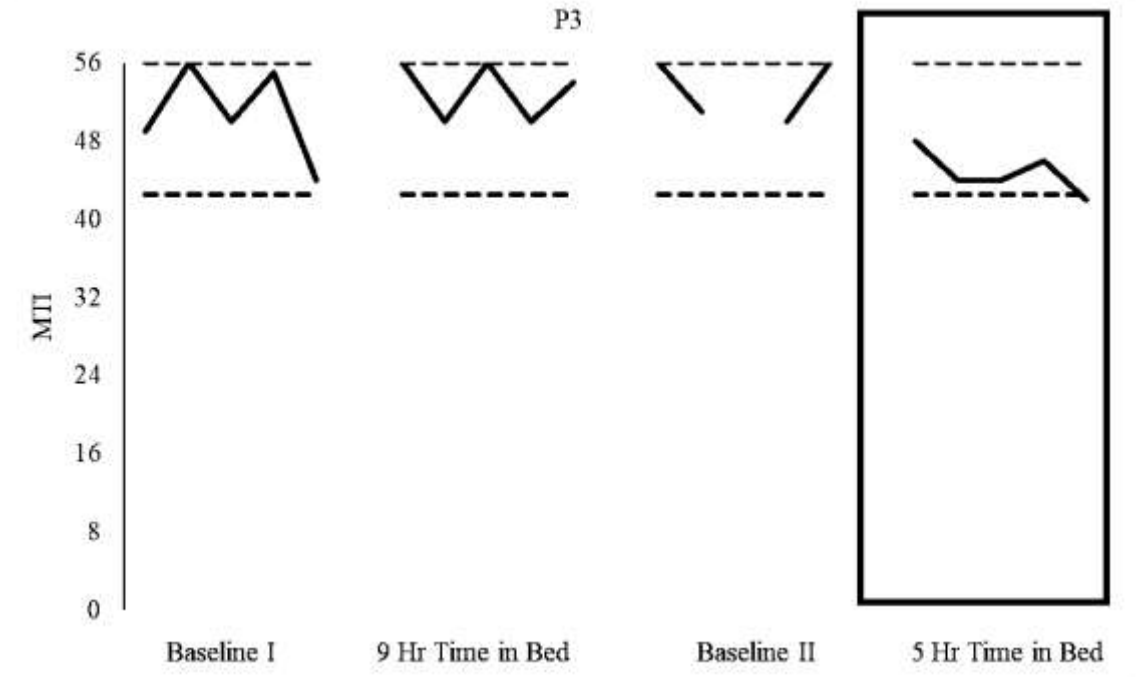
Conclusion

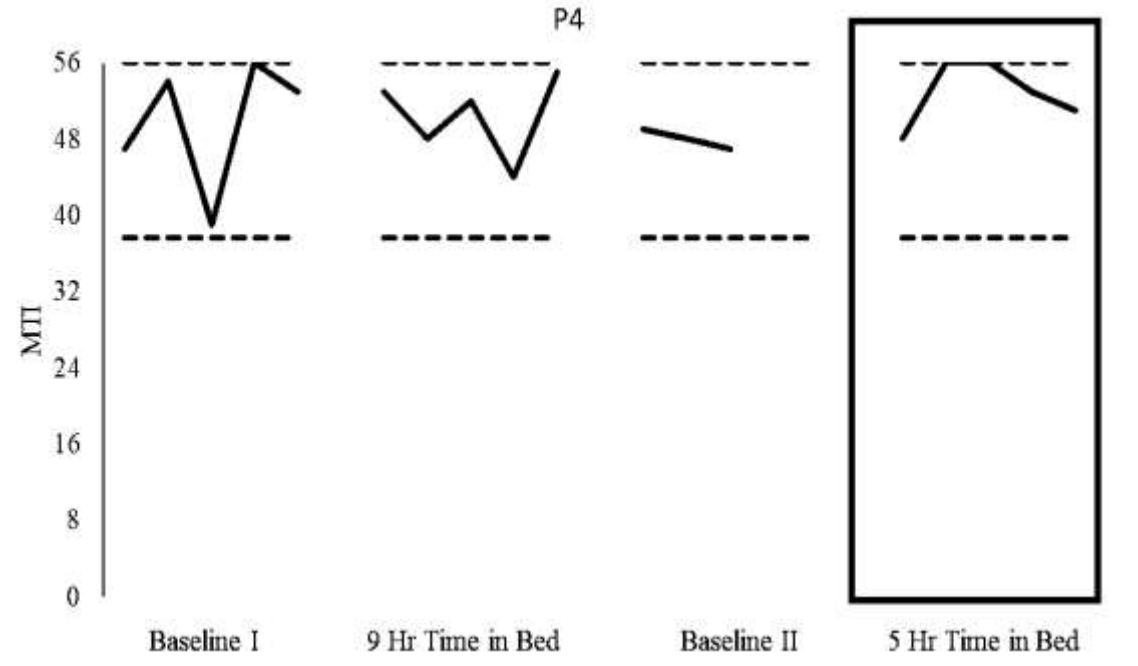
The purpose of this two-part study was to explore the direction and magnitude of the relationship between sleep (duration and quality) and mental toughness. Part one of this study revealed that sleep duration and sleep quality are related to mental toughness

however the nature of the relationship is complex (i.e., mediation, moderation, suppression). Study two revealed that restricted time in bed (i.e. restricted sleep duration) influenced mental toughness in some participants but not others and largely had no meaningful effect on sleep quality. Studies one and two provide grounds for future research in this area. For example, in addition to sleep researchers may also consider other antecedents of mental toughness that practitioners can manipulate.

Figure 3: Mental Toughness Index assessment score to Time in Bed hours




P3
56
48
40
32
24
16
8
0
MTI
Baseline I
9 Hr Time in Bed
Baseline II
5 Hr Time in Bed


P4
56
48
40
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8
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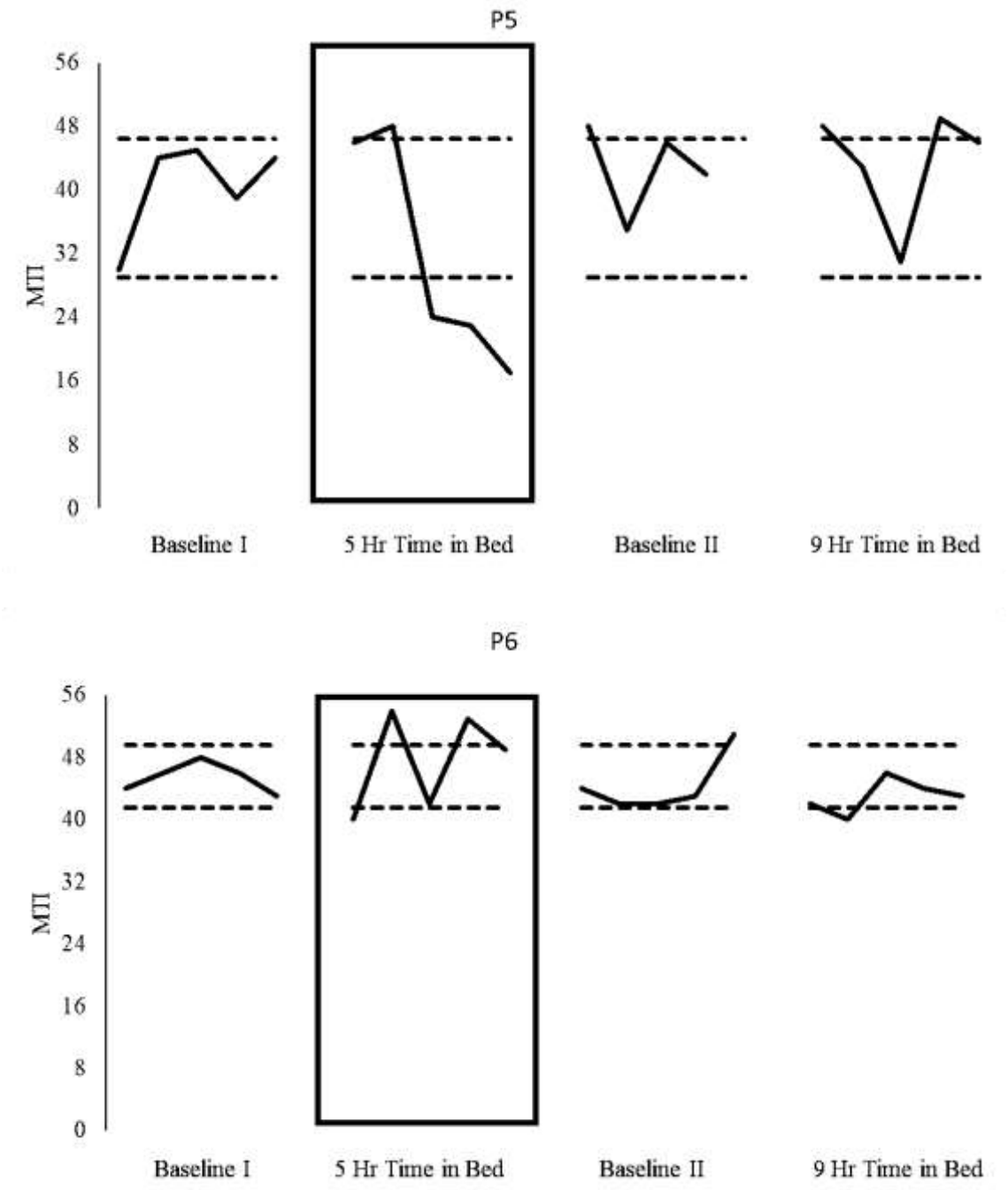
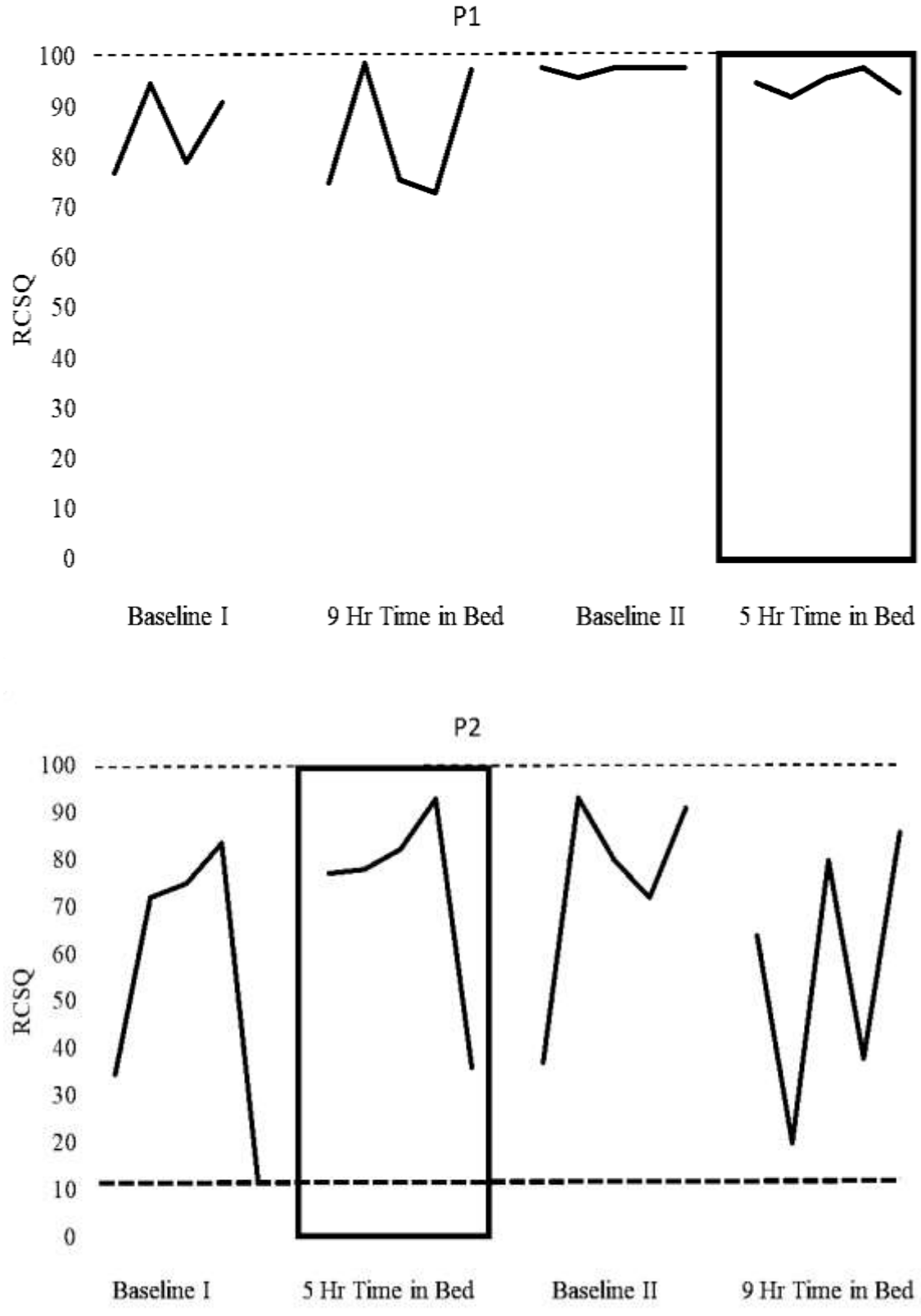
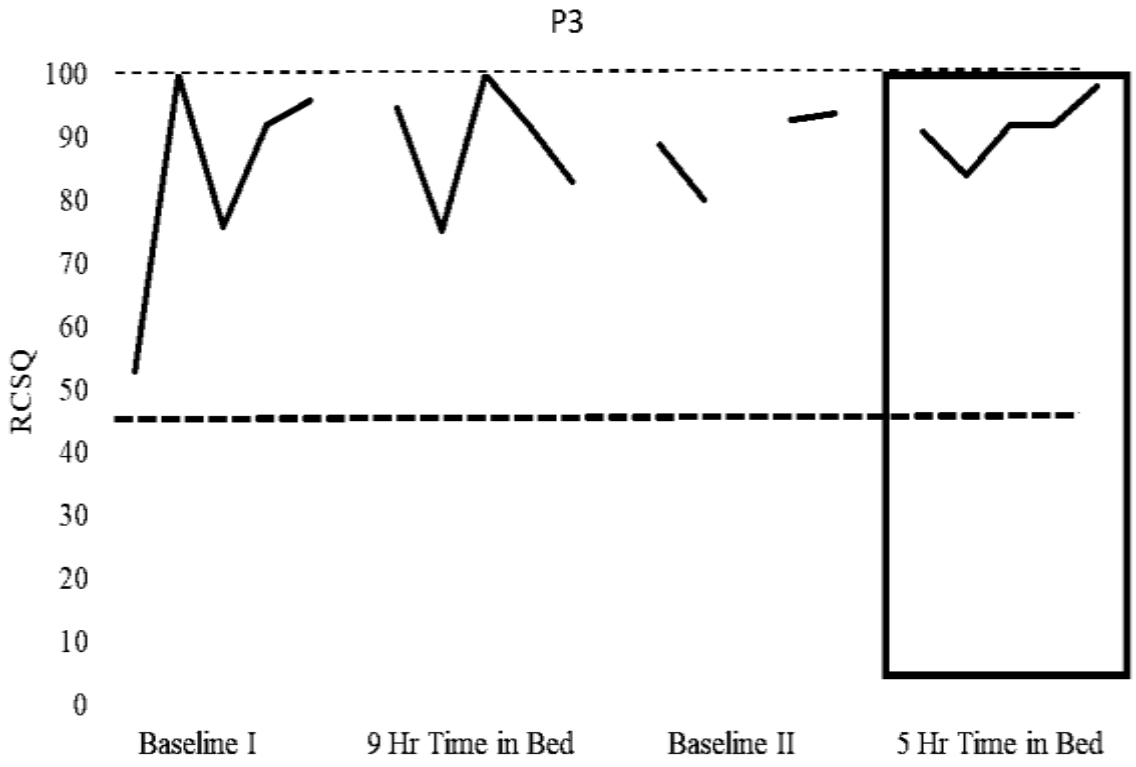
MTI
Baseline I
9 Hr Time in Bed
Baseline II
5 Hr Time in Bed

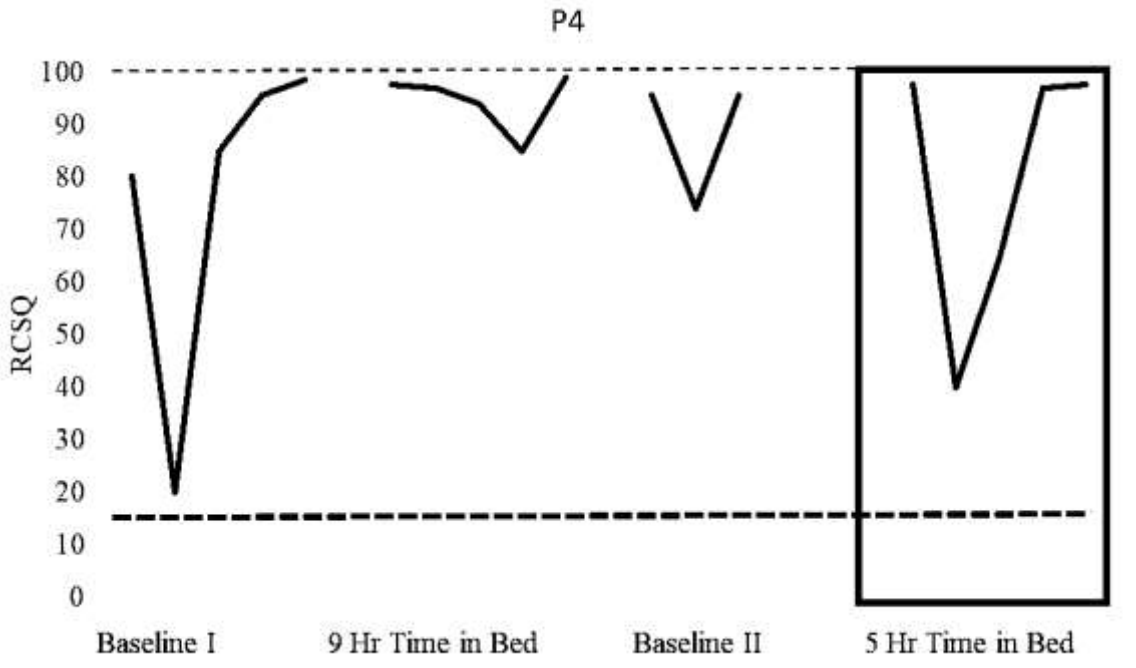


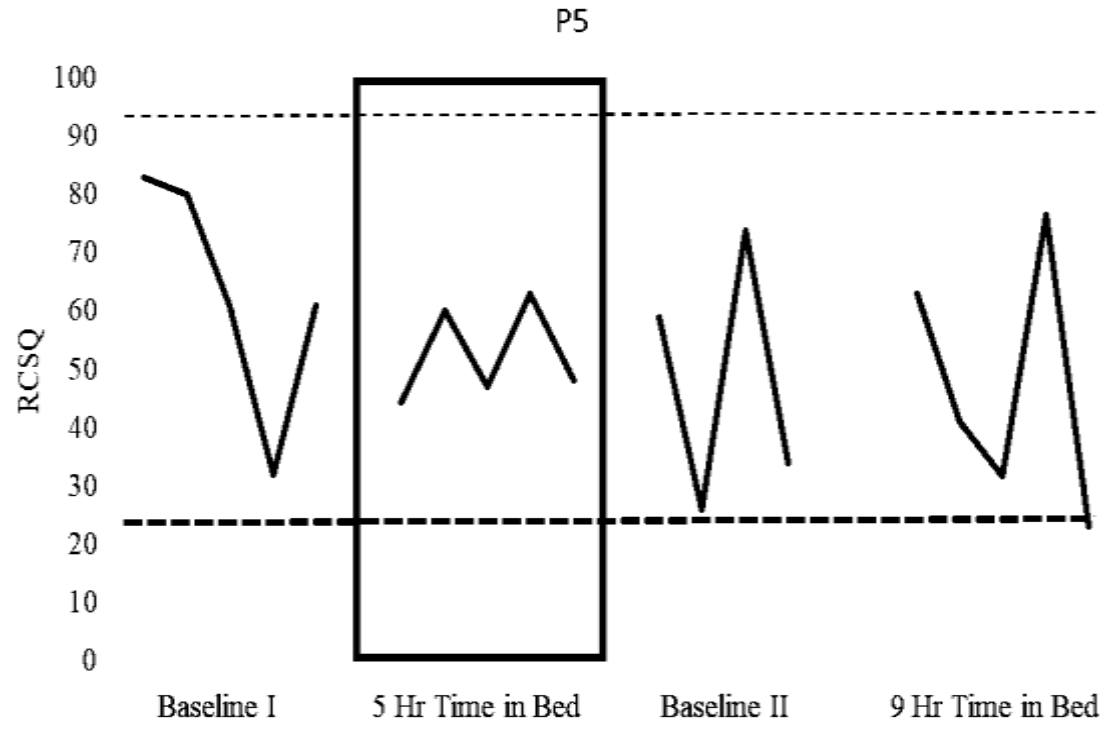
Note: Boxed section show the 5 hour time in bed treatment. Baseline represents self-selected time in bed.

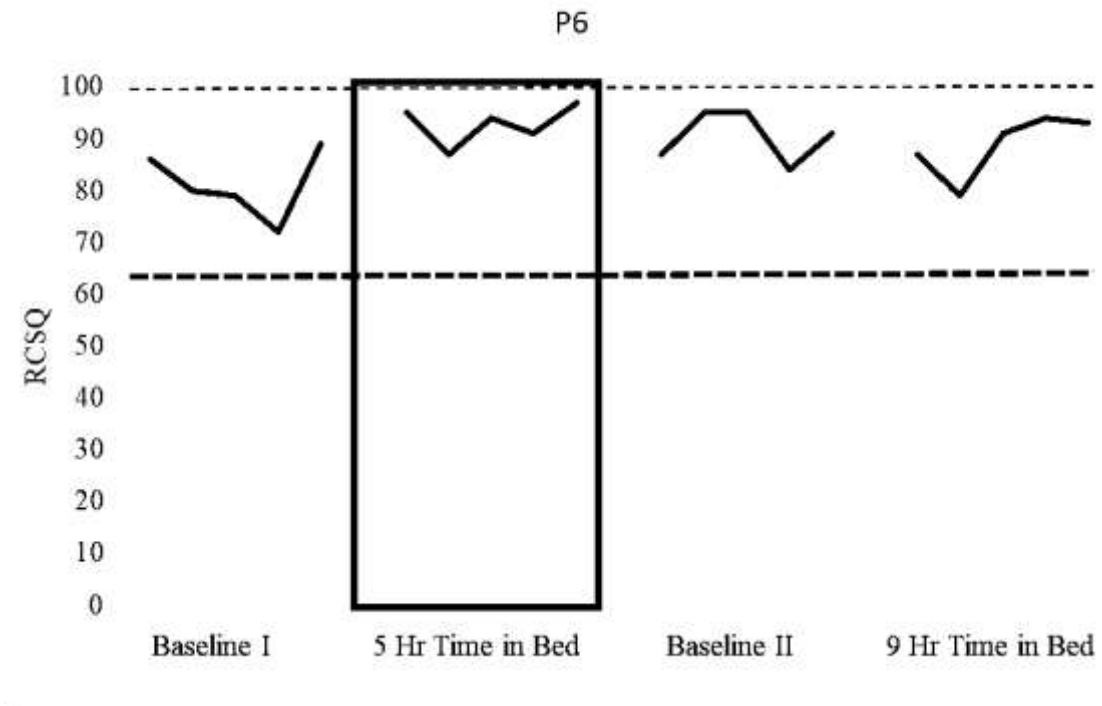
Figure 4*: Sleep Quality to Time in Bed hours*




P3
100
90
80
70
60
50
40
30
20
10
0
RCSQ
Baseline I
9 Hr Time in Bed
Baseline II
5 Hr Time in Bed


P4
100
90
80
70
60
50
40
30
20
10
0
RCSQ
Baseline I
9 Hr Time in Bed
Baseline II
5 Hr Time in Bed





Note: Boxed section show the 5 hour time in bed treatment. Baseline represents self-selected time in bed.

***Table 5**: N-of-1 Description*

Participant	Focus Event	Brief Description
P1	800M	47 year old male racing 800M – Marathon
P2	Middle Distance	42 year old female/cancer survivor -range of events
P3	Triathlon	49 year old male racing 10K - Triathlon
P4	Marathon	50 year old male racing 10K – Marathon
P5	10K	53 year old male racing mile - Marathon
P6	Triathlon	55 year old male racing 10K - Triathlon

Table 6: *Descriptive Statistics and Internal Reliability Estimates for Mental Toughness, Sleep Duration and Sleep Quality*

	Mean	Median	*SD*	Winsorized Mean	Winsorized *SE*	Cronbach's α	Composite Reliability
MT	44.193	46	6.580	44.812	0.436	.780	.869
S.Duration	7.160	7	1.176	7.257	0.073	-	-
S.Quality	63.138	67.5	15.007	65.077	1.223	.770	.811

Note: MT = Mental Toughness, S.Duration = Sleep Duration, S.Quality=Sleep Quality

***Table 7**: Winsorized Correlations between Mental Toughness, Sleep Duration and Sleep Quality and Robust multiple regression analysis predicting MTI score from Sleep Duration and Sleep Quality:*

	Winsorized correlations ρ_w [LLCI, ULCI]		*Robust Regression*				
Variables	MTI	S.Duration	*b*	95% *CI* for *b*	*SE*	*t* value	*p*
Constant	-	-	30.088	[25.006, 35.169]	2.593	11.604	≤ .001
S.Duration	.176 [.033, .316], $p = .016$		0.450	[−0.3254, 1.22]	0.395	1.139	.256
S.Quality	.412 [.270, .541], $p \leq .001$	.403 [.269, .524], $p \leq .001$	0.177	[0.117, 0,238]	0.030	5.738	≤ .001

Note: Winsorized correlation = ρ_w with 95% Confidence intervals based on 10000 bootstrapped sample and 20% Winsorizing, *b* = unstandardized regression coefficient, *CI* = confidence interval, LLCI = lower level confidence internal, ULCI = Upper level confidence interval, *SE* = standard error for the unstandardized regression coefficient, *p* = probability value

Overall Thesis Contribution of Study III

- Study III investigated the direction and magnitude of sleep duration and quality on mental toughness.
- Results from Study III highlighted additional potential buoys of mental toughness when sleep duration and/or quality are less than normal.
- Findings within Study III further establish the state-like variability of mental toughness.

Study III provided initial insights about how a single optimizer that overlaps within the Thrive and Prepare areas of the fMT model influences mental toughness. This, then, lead to investigating the potential influence of a second potential optimizer (self-talk) that overlaps parts of different areas of the fMT model – Prepare and Activate. Additionally, it was clear from the interviews in this study that participants were able to modulate the effect of sleep deprivation via self-talk, so a focused self-talk intervention had promise for increasing both mental toughness and athletic outcomes.

Chapter Six: Study IV

Submitted for publication August 13, 2019

Fast talkers? Investigating the Influence of Self-Talk on Mental Toughness and Finish Times in 800-meter Runners

Abstract

The purpose of this study was to explore whether a personalized self-talk intervention influenced mental toughness, rating of perceived exertion, sense of the urge to slow down, perceived performance and finish times in a series of 800-meter run time trials. While mental toughness has been associated with improved endurance performance, the effect of changing an individual's momentary self-talk on mental toughness and finish time has not yet been examined. This single-subject, multiple baseline design case study incorporated three participants who each ran a series of 11 – 13 maximum effort 800-meter time trials on the track, separated by a minimum of two days, across ten weeks. Following an initial series of four to six baseline sessions, they were each then provided a personalized self-talk intervention before running the seven additional sessions. Visual analysis (including review of non-overlapping data points between baseline, intervention, and follow-up sessions) demonstrated the personalized self-talk intervention positively influenced mental toughness and finish times across all three participants but did not consistently affect the rating of perceived exertion, urge to slow down or perceived performance. Additional insights were identified through the integration of social validation interviews informally after each run session and then formally after the intervention. These insights included identifying a new baseline of effort accompanied by different levels of mental toughness and an intrigue on the part of participants about the notable improvement in outcomes in spite of previously perceived "all-out" effort.
Keywords: Endurance, Athletes, Multiple baseline single subject sample design, 800 meters, RPE

Fast talkers? Investigating the Influence of Self-talk on Mental Toughness and Finish Times in 800-meter Runners

In recent years, the athletic shoe company Nike developed a running shoe purported to produce a 4% efficiency advantage over alternative shoes. These claims were legitimized in the scientific community (Hoogkamer et al., 2018; Hunter et al., 2019), and the shoes, despite a price tag more than double ($250) that of traditional running shoes, quickly became a popular choice for many runners looking to bolster their performance. However, did the average runner need to spend $250 on shoes to reap these benefits? What if, at least for the average runner, this same 4% (or more) performance enhancement was already available to each one of them without a change of shoes? Could tapping into psychological tools and resources produce similar, or even better, results? We sought to answer that question by examining the interaction between self-talk, mental toughness, and 800-meter run performance in female Masters Athletes.

Mental toughness is defined as "A personal capacity to achieve consistently high levels of subjective (e.g., personal goals or strivings) or objective (e.g., sales, race time, GPA) performance despite everyday challenges and stressors as well as significant adversities" (Gucciardi, Hanton, Gordon, Mallett, & Temby, 2015, p. 28). In endurance events, athletes experience significant adversities and stressors because of the physiologically demanding nature of the event. When running at intensities approaching one's physical VO_2max in training and competition athletes need to have personal resources that allow them to maintain effort, technique, and motivation in the presence of noxious stimuli (e.g., discomfort, fatigue, perceived effort). Previous research has shown that the ability to positively manage adverse situations such as pain and fatigue (i.e., not simply stopping) while striving toward a goal is

predicted by one's level of perceived control and one's efficacy expectations (Litt, 1988). Given that mental toughness comprises perceived control and self-efficacy (Gucciardi et al., 2015) and that mental toughness resources aggregate and integrate over time (i.e., Hobfoll, 2002) mental toughness should also help to explain how people manage adverse situations. While perceived control and self-efficacy are state-like variables that can be increased through the application of cognitive strategies (Bandura, Cioffi, Barr Taylor, & Brouillard, 1987; Litt, 1988) there remains some debate as to whether mental toughness represents a relatively stable trait-like variable or whether as a state-like variable an individual's mental toughness is amenable to change (Cooper, Wilson, & Jones, 2019). The critical practical implications about whether mental toughness can be positively changed and what specific steps can be utilized to optimize an individual's mental toughness is, therefore, a relevant research question.

There has been significant interest in developing cognitive and behavioral strategies to improve athletic performance, given the relatively small physical and skill-based differences in athletes at the elite level (Tracey & Elcombe, 2016). These same authors also note that mental toughness has been "regularly cited within and, importantly, beyond the literature as the key set of attributes for optimizing performance" (p. 1002). Within this context, there is value in identifying those cognitive and behavioral strategies that optimize mental toughness. In addition to being linked to performance (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011), self-talk has been identified as one of the potential optimizers of mental toughness (Bell, Hardy, & Beattie, 2013), with overlapping impact across both the Prepare and Activate components identified by Cooper, Wilson, and Jones (2019a). If self-talk were to be shown to influence mental toughness, it might then feed into

the resource caravan (Neal, Ballard, & Vancouver, 2017) that could provide broader benefits for individuals across other pursuits beyond athletics.

Extensive research has revealed an association between self-talk and performance and other related variables (Van Raalte, Vincent, & Brewer, 2016), and the content of self-talk is also a fundamental principle within cognitive behavioral therapies affecting the thoughts, interpretations, and behaviors of participants (Hatzigeorgiadis et al., 2011). Specifically, self-talk was defined by Hardy (2005) as "(a) verbalizations or statements addressed to the self; (b) multidimensional in nature; (c) having interpretive elements associated with the content of statements employed; (d) being somewhat dynamic; and (e) serving at least two functions; instructional and motivational" (p. 84).

Previous research has revealed that mental toughness is associated with behavioral perseverance (Gucciardi et al., 2014) and endurance performance (Blanchfield, Hardy, De Morree, Staiano, & Marcora, 2014b) and is adopted long-term by ultra-marathon study participants (McCormick, Meijen, & Marcora, 2017). However, few researchers have considered how to manipulate mental toughness through specific interventions. A series of complementary studies (Cooper, Wilson, & Jones, 2018, 2019a; Cooper et al., 2019b) specifically addressed this existing gap in the literature. The authors of these studies initially identified the presence of mental toughness variability and then investigated potential optimizers of that variability. Cooper et al. (2018) revealed that perceived mental toughness varied during a series of high-level endurance events and importantly, that perceived mental toughness could be increased by self-talk. Cooper et al., 2019a revealed that Masters Athletes also used self-talk to optimize their performance and through using self-talk, they felt that they could positively influence their perceived mental toughness (i.e.,

the belief that they could achieve their goals, control attention, control emotions). Finally, Cooper et al. (2019b) revealed that sleep-restricted athletes used self-talk as a method to offset the deleterious effects of selective sleep stage restriction. Specifically, some of the participants in Cooper et al.'s (2019b) study reported that when sleep-restricted they would use positive self-talk to redress the emotional disturbances caused by reduced sleep and to use self-talk to motivate themselves during periods of sleep-related motivational loss.

Given that self-talk is a low cost, effective intervention to improve sports performance and has been linked to changes in mental toughness, we decided to examine whether a personalized self-talk intervention could improve both mental toughness and athletic performance. We opted to use a personalized approach rather than a group-based approach because the meaning associated with a specific self-talk strategy is idiosyncratic and different for each person (Hardy, 2006). In line with the personalized nature of the intervention, we also chose to measure intervention effects using a single subject multiple baselines research methodology, because these n-of-1 type research designs researchers can explore personal changes that can sometimes be hidden in group-based designs (Vieira et al., 2017). In closing, in this exploratory study, we examined whether athletes could use a personalized self-talk intervention to increase their perception of mental toughness and to see whether using self-talk also increased their running performance. We were also interested in examining whether self-talk influenced other performance-related variables such as the urge to stop, perceived exertion, and the perceived performance. We hypothesized that a personalized self-talk strategy would positively influence mental toughness as measured by the Mental Toughness Index (Gucciardi, Hanton, Gordon, Mallett, & Temby, 2015) and performance in an 800 meter run by participants as measured by

finish time. We also hypothesized that the self-talk intervention would extend the time it takes for the athlete to feel the urge to slow down, increase the rating of perceived performance, and reduce the rate of perceived exertion while running an all-out effort.

Methods

Participants

Following ethical approval from the authors' institutional research ethics committee, participants were recruited through convenience sampling. This study adopted a multiple baseline single subject sample design with three experienced female Masters athletes. We chose to sample female Masters athletes because they are an under-researched population in the literature (Costello, Bieuzen, & Bleakley, 2014). The n-of-1 study allows hypotheses to be tested within individuals across repeated measurements to examine the influence of the variable over a specific timeframe (McDonald et al., 2017). This design ideally incorporates a baseline phase long enough to demonstrate a clear pattern of outcome values in order to clarify the differences between baseline and intervention (Hedges, Pustejovsky, & Shadish, 2012). It is a type of research for which a sample size of between one (Horner et al., 2005; Hrycaiko & Martin, 1996) and five (Jones, Lavallee, & Tod, 2011) participants is standard. In the seminal text on the topic, Barlow and Hersen (1984) compared and contrasted the benefits of single-case replications to alternative research designs; "in terms of validity or generality of findings, a series of single-case designs in similar clients in which the experiment is directly replicated three or four times can far surpass the experimental group/no treatment control group design" (p. 57).

Three female athletes volunteered for the study. All three met the screening criteria of current run training of three or more days per week; absence of any injury

that limited running for over one week in the past three months; and being over the age of 18 years. Furthermore, each participant was asked to consider whether she had availability and willingness to meet the lead researcher at a specific neighborhood track 11-13 times over a specific ten-week period. The three participants were P1 – a 43-year-old experienced Ironman triathlete, P2 – a 35-year-old All-American triathlete and P3 – a 40-year-old experienced high school track coach and trail runner.

Measures

Mental toughness was assessed following each session using the Mental Toughness Index (MTI: Gucciardi et al., 2015), an eight-item, unidimensional measure. This assessment uses the sum of items from a 7-point Likert scale ranging from 1 (*False, 100% of the time*) to 7 (*True, 100% of the time*). We adjusted the wording of the original eight items to fit the context of this setting without affecting the outcome of the assessment. As an example, question one of the MTI reads, "I believe in my ability to achieve my goals." This item was adjusted to read, "I believe in my ability to achieve my goals throughout the 800 meters." Previous studies examining the internal reliability of the MTI demonstrated both a high Cronbach's α (.900) and composite reliability (.906) levels (Jones & Parker, 2018). Perceived effort levels were collected using the 6-20 point Borg Rating of Perceived Exertion scale (Borg, 1982) and perceived quality of the performance was documented by participants through the marking of a 100 mm visual analog scale (VAS) ranging from "*Worst Imaginable Performance*" to "*Best Imaginable Performance*." Participants also received training on the use of the Sportcount 200 Lap Counter and Timer (finger click stopwatch), used to aid in the identification of when they first felt the urge to slow down. Finish times and 200-meter lap splits (available in Appendix

V) were collected for each session using an iPhone digital stopwatch application, with faster times (fewer total seconds, as shown in Figure 9) demonstrating improvement.

Procedure

Participants individually met the lead researcher at a local 400-meter track between 6:30 and 7:30 AM on 11-13 different times over ten weeks, with each session being separated by a minimum of two days. Scheduling was arranged so participants would not overlap with each another, and they were instructed to maintain a consistent morning routine leading into each session (including pre-run fuel, caffeine intake, activity levels, and pre-session warm-up). Participants initially completed four (P1), five (P2) or six (P3) baseline 800-meter runs, for which they were instructed to complete the distance as fast as they could run. Our multiple baseline design staggered the number of baseline sessions completed by each participant. Such a design helps provide compelling evidence that any change identified resulted from the intervention itself, rather than after a certain number of sessions (Rhoda, Murray, Andridge, Pennell, & Hade, 2011). This method compared positively to previous run intervention studies (Yamamoto et al., 2008) that often include a single session or no baseline performance for comparison.

During each trial, participants pressed the finger click stopwatch to indicate when they first felt the urge to slow down. Following the 800-meter run, the participant would complete the MTI, RPE, and VAS. The first author then walked the track with the participant while she cooled down and discussed the run. Questions focused on thoughts, feelings, and insights on the part of the participant. These informal interviews were not audio-recorded but lasted between 5-10 minutes, and any notable highlights were recorded on the spreadsheet related to that specific

day's data. These data were then used to prompt questions in the formal social validity interviews and to reveal participants' experiences of completing the run (and intervention).

Intervention

No instruction or coaching took place during the baseline sessions. Following the completion of the baseline sessions, participants were provided with a personalized self-talk strategy to be utilized during the intervention run sessions. The personalized version of each participant's strategy was designed based on discussions and insights provided by participants to the lead researcher following the baseline sessions. Initially, each athlete was instructed to use the following four phrases: a) "Smooth and Fast," b) "There you are pain – welcome!" c) Counting down and finally d) "Launch and Go!" progressively for each 200-meter section. This initial strategy was developed through an 18-month pilot study conducted by the first author on himself (an elite Masters athlete). The intervention drew on both instructional and motivational self-talk (Hardy, Gammage, & Hall, 2001) and was based on positive reappraisal of negative emotions (Lane, Terry, Devonport, Friesen, & Totterdell, 2017), approach for orientation motivation (Elliot & Harackiewicz, 1996) and acceptance of noxious stimuli or pain (Jones & Parker, 2018). These were gradually modified over the four intervention sessions (based on the after-trial discussions with the lead researcher) to combat the individual athletes' competing thoughts. Amended scripts provided in Appendix U.

The final three sessions (follow-up) were performed in the presence of the lead researcher to track the run splits, final finish time, and collect the assessments. While the lead researcher actively guided them with their self-talk during the intervention sessions, the follow-up sessions included only a reminder to apply what they had

previously learned. No additional instruction or coaching was provided during these sessions to replicate baseline sessions.

Social Validity Interviews

Based on the recommendations of Wolf (1978), we conducted formal social validity interviews within three weeks of the last follow-up 800-meter run session to garner additional insights from participants. Social validation interviews are recognized as an effective way to further substantiate behavioral research outcomes (Wolf, 1978), and have been used to provide valuable feedback about the practical application and experience of a psychological intervention (e.g., Jones et al., 2011). These interviews lasted an average of 55 minutes in length with a range of 47 to 65 minutes and were recorded, transcribed, and analyzed. Questions included a combination of prepared items (e.g., "How did self-talk influence your mental toughness?" or "What did you learn about yourself as a participant in this study?") and free-flowing questions related to various participant responses to previous questions.

Data Analysis Plan

A visual analysis procedure incorporating a review of level, trend, and variability at baseline and intervention (Horner et al., 2005) was utilized to determine the occurrence of an effect regarding perceived performance, strong urge to slow, rating of perceived exertion, mental toughness and finish times (Figures 5-9). Also, we identified criteria for a meaningful minimal benefit (MMB) and harm (MMH; Stoové & Andersen, 2003) by identifying the absolute highest and lowest outcome variable during the individual athlete's baseline sessions. The determination of this MMB and MMH is beneficial in interpreting the data and helping ensure the intervention is unlikely to cause harm and more likely to provide a meaningful

benefit to the individual. We also calculated a Standard Mean Difference (SMD) for each of the measured items, which has been recommended as a method for detecting the effect of interventions (Olive & Smith, 2005). SMD is calculated by subtracting the mean baseline from the mean intervention and then dividing by the standard deviation of the baseline. An SMD of .1 would represent a small effect size, while an SMD of .51 or higher would represent a significant intervention effect.

The social validation interviews were then combined with the brief individual post-session feedback notes to drive our thematic analysis about participant interpretations, findings, and discoveries that resulted from their involvement in the study. Thematic analysis 'involves the searching across a data set, be that several interviews or focus groups, or a range of texts, to find repeated patterns of meaning' (Braun & Clarke, 2006, p. 15). Transcripts were analyzed for these repeated patterns, and insights related to the data collected for each athlete were highlighted and integrated into the summary of results.

Results

Individual participant results related to finishing time, mental toughness, perceived performance, rating of perceived exertion, and urge to slow are provided visually in Figures 5-9. SMD of MTI data were 16.7, 6.6 and 1.6, and finish times were 4.5, 5.8, and 3.7, for P1, P2 and P3 respectively - all well above the 0.51 cut-off for intervention effectiveness.

Participant Results and Insights of Note

Participant one (P1). This participant was a 43-year-old experienced female triathlete. She was coming from training for Ironman triathlons and had done relatively limited speed work in recent training. As seen in the figures provided, she demonstrated an immediate learning curve improvement after her first baseline run

of 9 seconds (3.3%) and then improved a total of an additional 7 seconds (2.6%) over the last three baseline sessions. MTI, RPE, urge to slow, and perceived performance were generally constant throughout the baseline sessions. Upon initiation of the self-talk intervention, her MTI more than doubled from an average of 19 at baseline to 40 during intervention and 51 during follow-up. Her finish times also demonstrated a significant improvement, as she trimmed an additional 25 seconds (9.8%) from her best baseline session and 33 seconds (12.5%) off her baseline average. Perceived performance improved, and the timing of her urge to slow were extended with the intervention.

Interestingly, while she was running significantly faster than her baseline, her RPE remained similar to her baseline during the intervention and follow-up. She shared some of her thoughts on this occurrence as:

> I learned that there are many different levels of mental toughness. There are so many tools that we don't even know exist until they're given to us and the human body is capable of so much more than we think it is.

When comparing her eventual improvement to her baseline times, she expanded her thoughts:

> There's just a lot to take from knowing that you're basically relying on (an assumption that) 'oh well – that's my baseline – I can't go up and above what I've always done. What was it you said (during the interview) about breaking the algorithm? That we remember what we've done before and think 'I can't do better than that.' But you can do better than that. Break the algorithm. Just because that's how you've performed in the past doesn't dictate your future. Use these tools that you've been given and look at what you're capable of. Wow - that's amazing!

Perhaps most interesting with this participant was her RPE rating (Figure 7). During her baseline sessions, she rated every session as an 18 or 19 on the 20-point RPE scale. However, when she made significant improvements in her time and mental toughness levels during the intervention and follow-up sessions, her average RPE remained the same (18 average). She shared her thoughts on what was occurring as:

> The first four – as hard as I thought I was pushing myself, looking back obviously they were more on the 'easier' scale. But on each of those specific days, I felt like I was pushing myself as hard as I could. So it really blew my mind that I was then able to go 30 seconds faster throughout those middle three or four (intervention sessions).

In terms of her thoughts about the influence of the self-talk, she noted:

> The mental can overcome the physical… the physical can cause the mental to struggle and vice-versa. Having those different things (self-talk items) to focus on throughout the 800 and to perform based on those cues was very helpful. Otherwise I'm just running. I think (I had more mental toughness) because of the focus that was now enabled. You are giving me something to focus on and that, in turn, pushed that scale higher and higher because when you have tools in your toolbox to reach those goals, they feel more attainable.

Participant two (P2). The second participant was a 35-year-old female All-American triathlete who specialized in the Olympic distance events and has a triathlon coach with whom she works regularly. She described herself as very analytical. She has a college degree in chemistry/biology, a Masters' degree in health care administration, and does analytics as her profession. She completed five baseline all-out 800-meter time trial runs before moving into the intervention sessions. P2 was the fastest of our three participants, eventually running 2:58.5

during the intervention portion. However, despite her experience and emphasis on short course racing, she showed a significant improvement in both mental toughness and finish time with the self-talk intervention. Her average MTI increased by 14 (37%) from average baseline to average intervention while her run times dropped a notable 18 seconds (9.2%) from her best baseline to her best intervention. RPE did increase with the intervention, and her urge to slow was extended with the intervention. In reference to why she thought her mental toughness improved (and the urge to stop was pushed back) with the self-talk, she noted:

> Having more focus on that self-talk helped quiet down the little voices that the body might have had with the little aches and pains. Your head can wander in the wrong direction, but with mental toughness, you regain control, you steer your head in the right direction.

Before the self-talk intervention, P2 stated she was running all-out but rating her RPE between 15 and 18 (Figure 7). Once the intervention started, her RPE was consistently rated 19-20, and she was running significantly faster. When discussing this, P2 explained:

> I think on the baselines, it's just not realizing how much harder I truly could go. So looking back, yes – I would probably scale those (baseline RPEs) back. At the time that I was doing the baselines I didn't really know that I had more. Clearly, it proved I had more in me. I proved that digging deep – there's room to dig deeper. Reflecting on it, I'm in awe! I'm… wow! Maybe (it's) like a positive feedback loop – knowing that I could, I had more in me or was pushing that boundary. So then, ok – can we do it again? Can we do it a little faster? Can we do a little more?

Participant three (P3). Our third participant was a 40-year-old female runner and high school track coach who ran the 800-meter event when in high school. Similar to P2, she ran her best baseline time during session one (Figure 9). Then, as with the other participants, she demonstrated a notable improvement upon initiation of the self-talk intervention, lowering her finish time by over 17 seconds (8%) between her last baseline and first intervention session. Also, while her six baseline sessions had a range of 9 seconds from fastest to slowest, her seven intervention and follow-up sessions were all within 5 seconds of one another. Her average level of mental toughness (Figure 8) correlated closely with this pattern, increasing by 38% from baseline to intervention. Her perceived performance improved, and her urge to slow and RPE increased nominally with the intervention. When reflecting on these various elements, her thoughts included:

> That was huge to show that much improvement because I had really thought I was running at an all-out effort in those six (baseline) 800s. The (self-talk) gave me mental purpose, mental focus. I was no longer just running kind of mindless – I now had focus and purpose. As your mind starts to wander, you start to feel that pain. You just naturally start to slow down and you start that negativity. (This) gets you some focus – some positive focus. It (self-talk) would push them (negative thoughts) aside or kind of dampen them because they were still there – I could still feel them but it just felt like whatever it was in my head (mental toughness) was stronger and taking the focus more than what I was feeling physically. My mental toughness is there [pause] the motivation to use it has to be there in order for it to really work effectively. Otherwise, I was just pulling bits and pieces of mental strength to kind of 'get through' the 800.

She went on to note:

> My intention is always there, but maybe my effort's not. My effort is not always where my intentions are. Realizing that my perception is off on my physical effort that I'm putting into what I'm doing – that I could probably be stronger and be faster than I think I am – maybe I'm holding myself back somehow. The easy choice is to just cruise because you don't have all the extra thoughts or decisions you have to make. It's the comfortable choice – the comfortable path. It (mental toughness) allowed me to push those boundaries just a little bit – to get out of my comfort zone – to get out of my safe zone and allowed me to have some confidence to go outside that comfort zone a little bit and to trust that I would be ok.

She also thought she had several insights about her approach as a high school track coach:

> When I coach, it's 'no crutches' – right? We always talk about no crutches. It is what it is. This is the moment you either take it or you don't. Then in actuality (as she personally experienced it), it's eye opening. It's easier said than done – it's helping me to unpackage those pieces and kind of repackage it in a way that works for them (kids being coached). That mental piece…after having done this study, you realize it's huge – it's huge!

Discussion

The purpose of this study was to examine whether a personalized self-talk intervention could increase the perception of mental toughness and running performance in female Masters athletes. We were also interested in examining whether self-talk influenced other performance-related variables such as the urge to stop, perceived exertion, and the perceived quality of the training. Specifically, we

hypothesized that a personalized self-talk strategy would positively influence mental toughness as measured by the Mental Toughness Index (Gucciardi et al., 2015) and performance in an 800-meter run by participants as measured by finish time. We also hypothesized that the self-talk intervention would extend the time it takes for the athlete to feel the urge to stop, increase the rating of training quality, and reduce the rate of perceived exertion while training.

Self-talk was one of the strategies previously noted (Cooper et al., 2019a) as potentially influencing mental toughness, but the further experimental investigation was warranted. As hypothesized, self-talk was associated with changes in both mental toughness levels and run performance. Specifically, the self-talk intervention improved self-assessed levels of mental toughness by an average of 62% and improved 800-meter run times by an average of 9% over the baseline average. The present study is thus unique in demonstrating a specific optimizer of mental toughness levels and a concurrent relationship between mental toughness levels and run performance improvement. These results support previous research (Bandura, O'Leary, Taylor, Gauthier, & Gossard, 1987) that demonstrated training in cognitive control strengthened perceived self-efficacy and ability to withstand pain. The results also provide an additional example of the impact of psychological skills training, including that of self-talk strategies on mental toughness and resultant performance, shown previously among elite military recruits (Fitzwater et al., 2018).

In terms of perspective, it is noteworthy that a meta-analysis of one of the most recognized performance enhancers in endurance sport – caffeine – demonstrated an improvement in time trial performance compared to placebo of 2.22 +/-2.59% (Southward, Rutherfurd-Markwick, & Ali, 2018). By comparison to this popular performance enhancer (albeit only demonstrated across 3 participants),

improvements in time trial performance with the personalized self-talk strategy demonstrated improvements in average baseline to average intervention times of 12%, 9%, and 6%, respectfully. Additional studies on run performance enhancement for comparison purposes have included: a) 1.4% improvement in distance covered over one hour with carbohydrate rinse (Rollo, Cole, Miller, & Williams, 2010), b) 2.9% improvement in 3k and 5k distances with integration of strength training (Yamamoto et al., 2008) and c) varying but often no notable change with ingestion of sodium bicarbonate (Heibel, Perim, Oliveira, McNaughton, & Saunders, 2018). Further, while the three participants in our study were not 800-meter specialists, they were all experienced athletes and runners who completed not just a single but also rather a series of baseline time trials before utilization of the self-talk intervention. They all demonstrated a notable increase in mental toughness and improvement in 800-meter finish times from baseline.

The results of this study demonstrated a consistent association between a personalized self-talk intervention and mental toughness scores, 800-meter run times, and perceived performance. In reference specifically to RPE, the literature (Marcora & Staiano, 2010; Noakes, 2008) indicates that the perception of effort is one of the primary limiters of exercise performance leading to disengagement from the task. All three of our participants reported they were running “all-out” during baseline. Following the intervention, participants were able to increase their RPE and speed or hold their RPE relatively constant while running significantly faster. This pattern of indicating an ‘all-out’ effort but then exceeding that effort by a significant margin in future sessions, may provide further insights regarding the proper use of the RPE scale in future studies. While we did not find self-talk reduced RPE as has been demonstrated previously (Blanchfield et al., 2014b), it was reduced in comparison to

the relative running speed (e.g., faster running at similar RPE). Perhaps the self-talk is also helping the individual discover what the higher levels of exertion feel like for the future or influencing the ability to cope with the higher levels of exertion.

This study also continues to build upon previous research indicating that mental toughness functions more similar to a state (Gucciardi et al., 2014; Harmison, 2011) than a trait. It also provides expanded insights on ways in which that functional state can be optimized (Cooper et al., 2019a) through specific steps taken by the individual either independently or via a coach or other trusted advisor.

Limitations

One limitation might be related to the novelty of the specific event for these participants. While runners, they were not 800-meter specialists. Elite level 800-meter runners may still benefit, but not likely to this extent. Selecting participants who were not 800-meter specialists may reduce the direct application and comparison for track coaches. However, as can be seen in Figure 9, two of the three participants showed evidence of a flat performance at baseline, followed by a notable jump immediately after the initial intervention. The remaining participant (P1) did show some improvement during the baseline sessions, but her improvement post-intervention was non-linear from the baseline trend. This was our reasoning for selecting, while not specifically 800-meter specialists, individuals who were experienced runners. Additionally, the use of a series of four to six baseline runs before introducing the self-talk intervention was used to minimize the risk of a learning effect.

Completing this study outside the context of a laboratory limited our ability to integrate precise consistency regarding temperature and surface conditions. However, our goal with this study design was to create a real-world setting outside

the traditional lab, and we were able to modify the additional variables by scheduling all sessions in the early morning at the same track during generally temperate months of April – June in Colorado. The potential for participant bias is also a limitation of note. Participants knew from the information sheets the study was examining the influence of self-talk on mental toughness and finish times, and there is potential they wanted to show it "worked." While this is certainly could be considered a limitation, the significance of the change with the intervention remained notable.

Future Research Directions

The insights provided in this study provide a complement to and build upon previous research regarding the optimization of mental toughness (Beattie et al., 2018; Cook, Crust, Littlewood, Nesti, & Allen-Collinson, 2014; Powell & Myers, 2017) but there remain numerous opportunities to build further. The Thrive – Prepare - Activate functional mental toughness model (Cooper et al., 2019a) identifies a range of possible mental toughness influencers ranging from fuel and caffeine to relational support and stress facilitation. Investigating one of the influencers outside the specific context of athletics may also provide an intriguing direction of study. For example, does self-talk influence mental toughness related to an individual's chosen activity levels, high caloric food selection, or amount of screen time? Such studies could help bring the mental toughness discussion into that of the general population well-being conversation (Hannan et al., 2015).

Further, the investigation into mediation models to understand why self-talk influences performance and mental toughness is of value. Is it a result of changes in mental toughness via elements such as self-efficacy and perceived control? Alternatively, is mental toughness effectively a collection of cognitive tools and behavioral strategies that improve outcomes across a variety of individual pursuits?

Application for Practitioners

There has been increased attention on self-talk in the literature in recent years (Hatzigeorgiadis, Galanis, Beek, Hutter, & Oudejans, 2017) and a particular interest in the influence on performance and competitive outcomes (Funatsu, 2018). Based on the impact of self-talk on mental toughness and 800-meter finish times in this study, opportunities for application are likely to be of great interest to coaches, consultants, and athletes. Some of these were directly identified by one or more of our participants in terms of improving their coaching, athletic, professional, and even personal pursuits. In terms of coaching, this study highlighted the value of a consistent approach to mental toughness and its related constructs. Even our track coach participant (P3) indicated she would be translating many of her discoveries to how she is coaching her athletes differently than she had in the past. All three participants made the connection between what they learned about their mental toughness patterns and processes and both their future athletic and non-athletic pursuits. A typical comment revolved around the discovery through their participation in the study that they were capable of more than they realized, and the additional pursuits for which that discovery might now be a catalyst. Also, the need for a personalized approach to self-talk was clarified as the participants did note overlap between some of the most effective self-talk strategies but also identified others that were specific to their individual history and pursuits. Encouragingly, our findings also indicated that participants were able to maintain the majority of their improved performance during the follow-up sessions without the continued instruction from the outside advisor, providing a long-term value for potential participants.

Conclusion

Performance enhancement in athletics and other aspects of life can take many forms. The data related to the impact of alternatives noted here, such as caffeine or special shoes are of interest as individuals look for ways in which to create that enhanced outcome. Self-talk provides similar outcomes (at least in the current sample), and being volitional and non-intrusive, is not accompanied by any side effects. Our findings related to the impact of self-talk providing results consistently beyond the range of minimal benefit and harm for each of these categories appears to demonstrate a relatedness that can now be expanded upon elsewhere and with other categories seen as mental toughness optimizers.

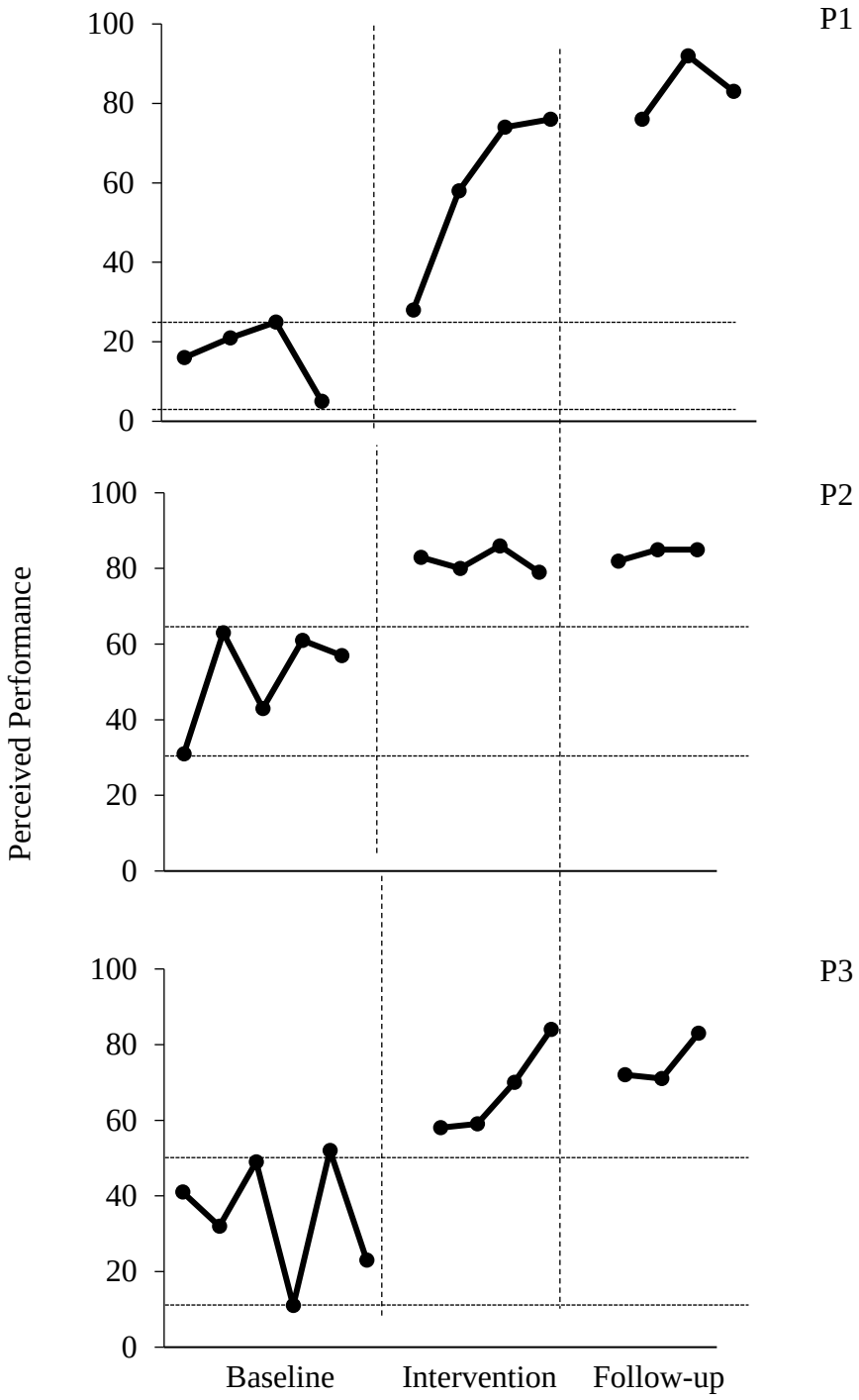


Figure 5*: Perceived Performance rating by participants in baseline, intervention, and follow-up sessions.*

Horizontal lines represent Minimal Meaningful Benefit and Harm, indicating the highest and lowest perceived performance during baseline for each participant

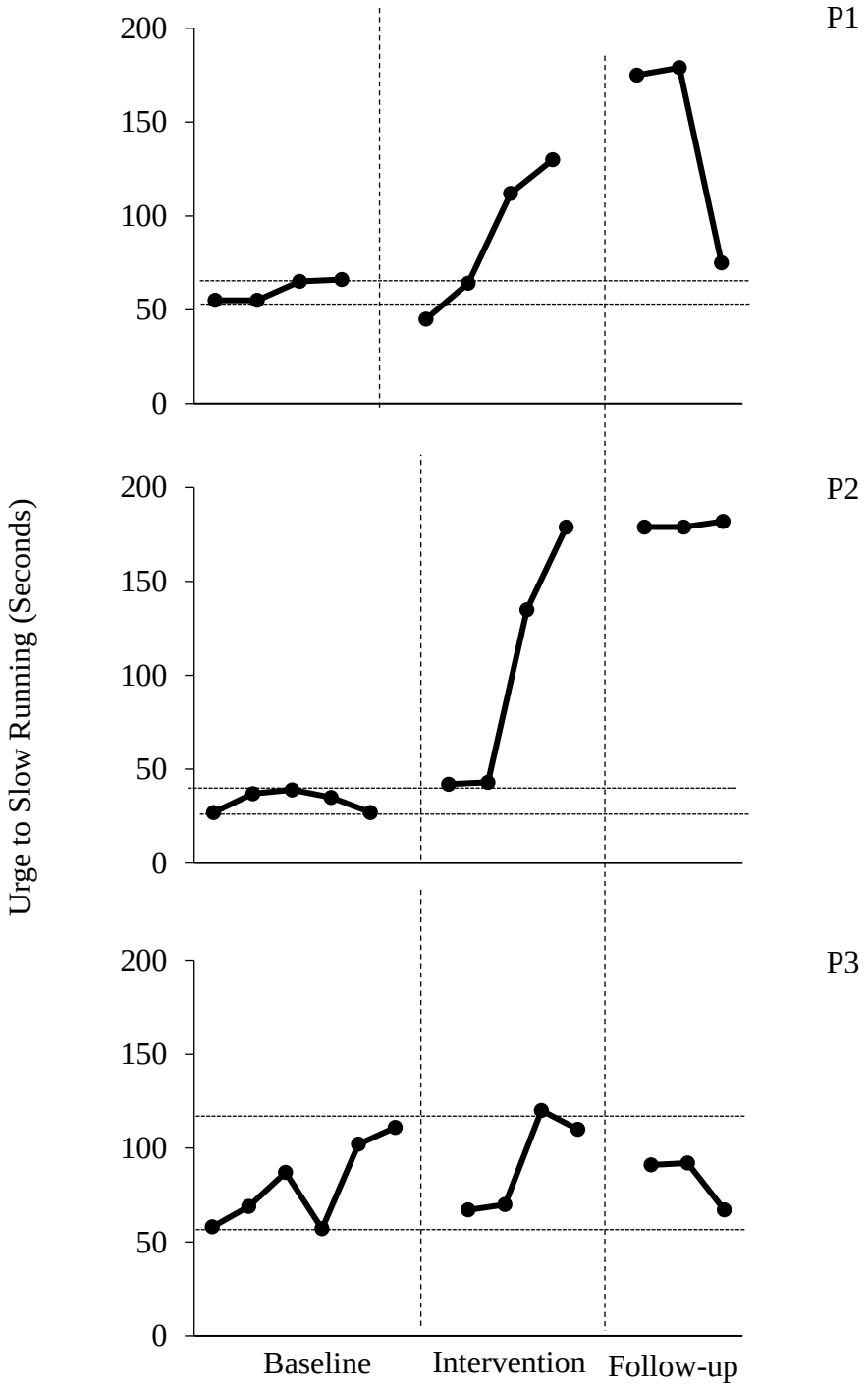


Figure 6*: Recognition of initial onset of the urge to slow down in baseline, intervention, and follow-up sessions.*

Horizontal lines represent Minimal Meaningful Benefit and Harm, indicating the earliest and latest onset of urge during baseline for each participant

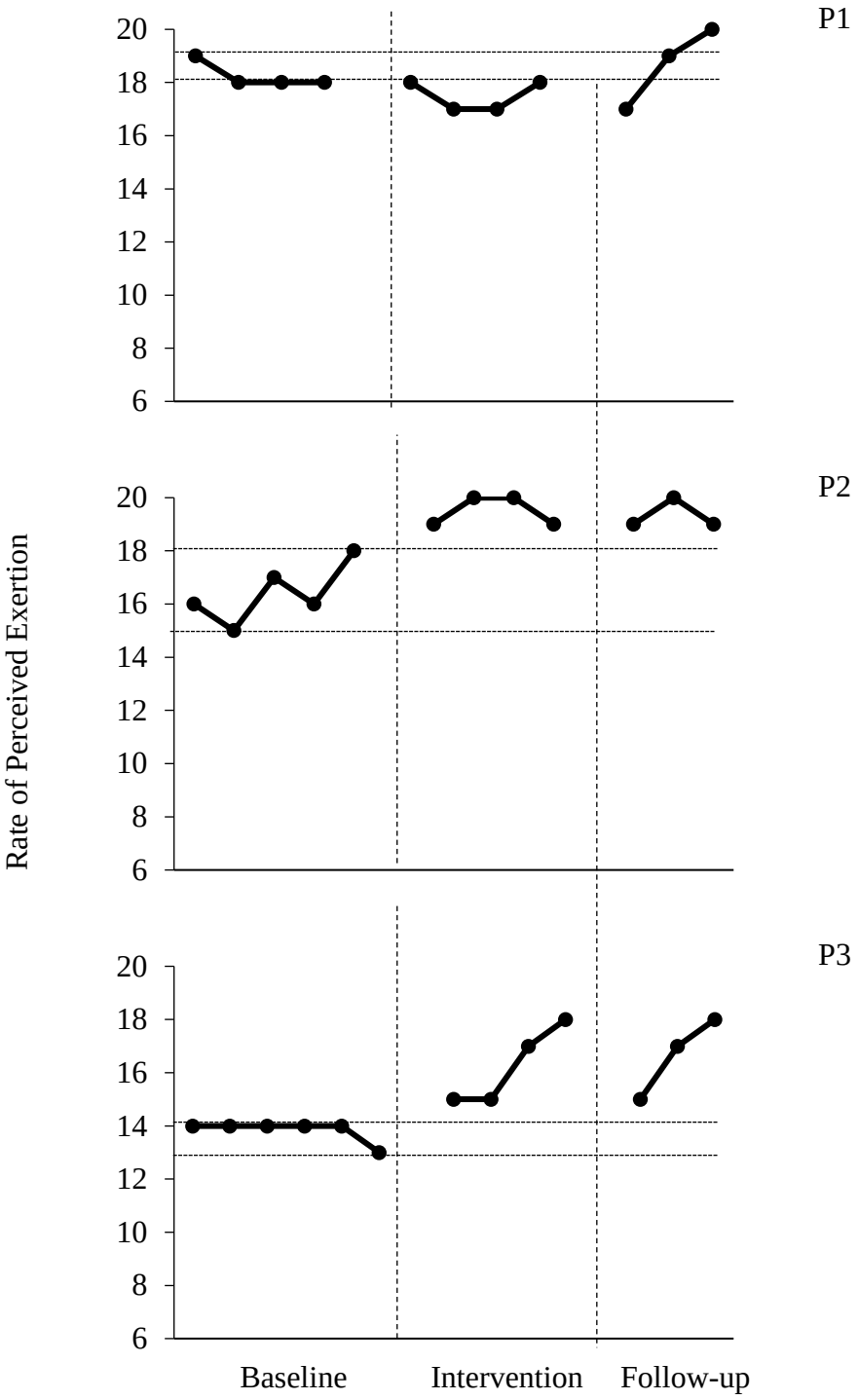


Figure 7*: Rating of Perceived Exertion (RPE) by participants during baseline, intervention, and follow-up sessions.*

Horizontal lines represent Minimal Meaningful Benefit and Harm, indicating the highest and lowest RPE during baseline for each participant.

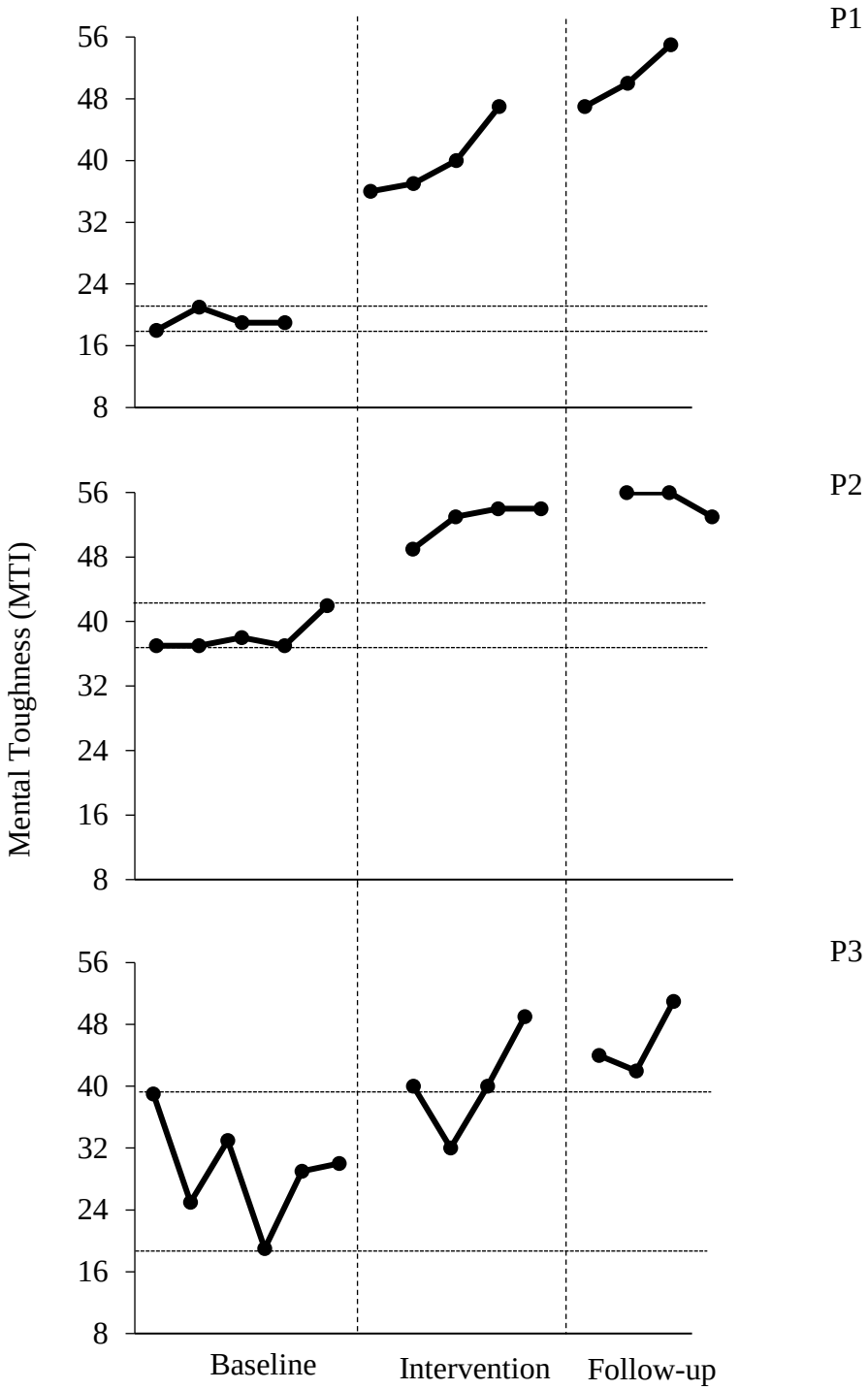


Figure 8*: Mental Toughness Index (MTI) scores provided by participants during baseline, intervention, and follow-up sessions.*

Horizontal lines represent Minimal Meaningful Benefit and Harm, indicating the highest and lowest RPE during baseline for each participant.

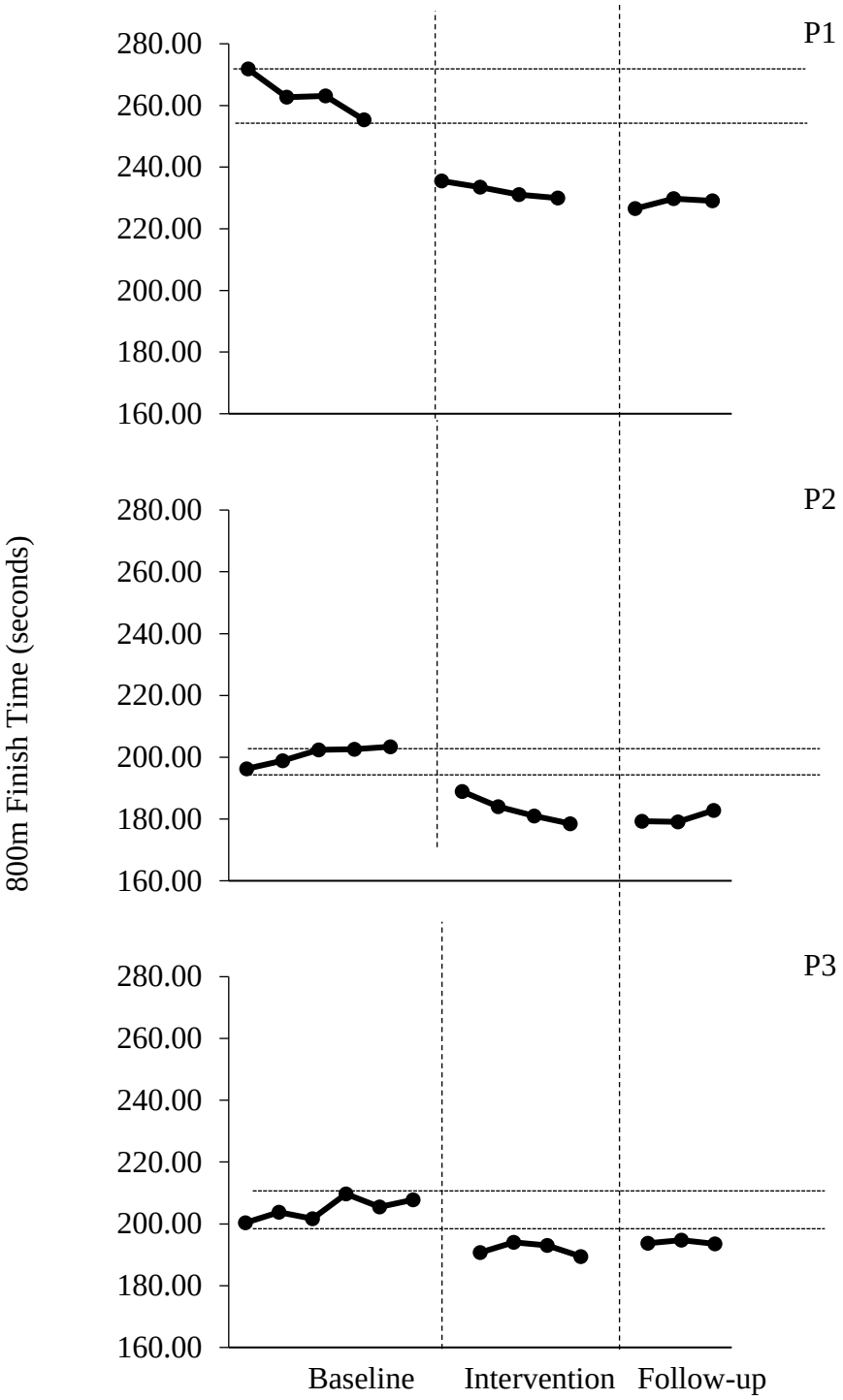


Figure 9*: Finish time in seconds (less time indicates improvement) in baseline, intervention, and follow-up sessions.*

Horizontal lines represent Minimal Meaningful Benefit and Harm, indicating slowest and fastest baseline times for each participant.

Overall Thesis Contribution of Study IV

- Study IV results further established the state-like within-person variability of mental toughness across different days in spite of same setting and pursuit.
- Study IV investigated a potential optimizer of mental toughness from a different area of the fMT model (Prepare and Activate).
- Results of Study IV demonstrated a measurable connection between mental toughness variability and performance outcomes through the use of a specific optimizer.

Study IV provided additional insights for future mental toughness research, especially related to variability of mental toughness and potential optimizers. Identifying the influence of self-talk on mental toughness and performance furthers the discussion about how mental toughness might contribute to performance across a variety of settings and situations.

Chapter Seven: General Discussion and Conclusion

Introduction

The aim of this thesis is to reflect a program of research on the variability of within-person mental toughness and identification of potential optimizers of that within-person mental toughness. The within-person variability in mental toughness was demonstrated through all four of my studies. Study I identified within-person variability in mental toughness in a single individual across and within a series of endurance cycling, triathlon and running events. Potential optimizers of this variability that were unrelated to physiological catalysts ranged from emotions (connection with daughter, last chance opportunity, anger about situation) to competitive undertakings against other teams. In addition, this initial study moved away from the traditional comparison of levels of mental toughness between teammates or competitors and put the spotlight on a single individual, and whether that individual experienced variation from one moment, hour or day to the next.

On the heels of the identification of within-person mental toughness variability and potential optimizers, our second study helped provide further clarification of both components. Study II expanded the number of elite Masters athletes to 13 (rather than one) and utilized a validated and reliable measurement tool to assess mental toughness variability. The variability initially identified in Study I was clarified in Study II, and as hypothesized, we did find significant differences in mental toughness in a majority of participants. The exploratory aspect then examined potential causes of the mental toughness variability and led to three higher order themes: Thrive, Prepare and Activate. “Thrive” referenced aspects of foundational wellbeing, including such elements as fueling, hydration, sleep and stress. “Prepare” identified strategies such as setting clear, meaningful goals, strategic caffeine use and callousing. Finally, “Activate” applied to what would be done by the individual in

the midst of the pursuit, such as attentional control, self-talk and feedback. The themes also helped develop the concept of functional mental toughness (fMT) and the model of how the various potential optimizers influence fMT as demonstrated in the following diagram:

Figure 10*: Functional Mental Toughness (fMT) Model. This figure represents the interaction between the higher level themes of Thrive, Prepare and Activate and their potential impact on fMT availability and access.*

Study III took the examination of within-person mental toughness variability and optimizers deeper still, as it not only included analysis of such variability, but then specifically examined the influence of one of the sub-themes (sleep) overlapping between the Thrive and Prepare components. Within-person variability in mental toughness continued to be noted (as it was in Study I and Study II). An

increase in sleep (based on time in bed) from baseline did not result in an increase in mental toughness, contrary to our hypothesis. However, a decrease in sleep (time in bed) did affect mental toughness in some individuals. Further examination led to identifying potential optimizers of mental toughness that could act as buoys in the absence of desirable amounts of time in bed were simultaneously identified by participants as a result. One of these buoys of mental toughness in the absence of sleep was self-talk.

The identification of self-talk as a potential optimizer of mental toughness in Study II and as a strategy to help buoy mental toughness in Study III (and noted by Dougherty, 2017) highlighted it as a valuable element to examine in the next study. This was supported by discussions with my supervisors, both of whom are applied psychologists with experience of self-talk interventions. As a result, Study IV investigated how self-talk, a separate sub-theme from the fMT model overlapping the Prepare and Activate higher level themes, influenced within-person mental toughness variability in three female Masters athletes running a series of 800-meter time trials over a period of ten weeks. Previous research (Gucciardi, et al., 2009) noted the difference between psychological skills training and mental toughness training. Our intent was not intended to encompass a comprehensive training program but rather to examine the influence of a single potential optimizer (e.g., self-talk) on performance and mental toughness measurements. As was seen in the first three studies, within-person variability in mental toughness continued to be clearly demonstrated. Results were consistent with previous findings regarding the influence of cognitive control training on ability to withstand pain (Bandura et al., 1987) and the impact of skills such as self-talk on mental toughness and performance (Fitzwater et al., 2018). Improvements, ranging from 6-12% in our three participants, exceeded that of

previously identified performance enhancers caffeine (2.22%, Southward et al, 2018), carbohydrate rinse (1.4%, Rollo et al., 2010) and strength training (2.9%, Yamamoto 2008). Mental toughness demonstrated notable increases with the self-talk and allowed participants to run at these consistently faster speeds while recording similar ratings of perceived exertion (RPE). Thus, the theme running through and across all four studies clearly addressed the thesis aim of examining within-person variability in mental toughness and potential optimizers of that variability while providing a baseline for additional research opportunities going forward.

Methods incorporated into the various components of the thesis included autoethnography, qualitative interviews, thematic analysis, exploratory and longitudinal N-of-1 case studies. One critical thread across the methodology was the emphasis on the individual. Due to the stated purpose of the thesis to examine the within-person variability and potential optimizers in mental toughness, it was imperative that the individual, rather than the group, drive the analysis. The autoethnography, exploratory and N-of-1 case study designs provided an effective context in which to examine the within-person focus. However, they also involved small sample sizes and thus make generalizability difficult. Further, the inclusion of high-level Master athletes may have resulted in a partial ceiling effect related to mental toughness self-assessment (Zeiger & Zeiger, 2018). However, the presence of this ceiling effect potentially makes any identified variability more notable. If athletes generally rate themselves within the upper range of versus the entire scale, such variability represents a larger percent of the self-reduced scale.

Mental toughness has been described by the vast majority (82%) of coaches as being critical to success and yet only a sliver of these coaches (9%) had any sense

about how to develop it in their athletes (Gould, Hodge, Petersen, & Petlichkoff, 1987). Recognition of the unsupported (and until recently, unmeasurable) concept of mental toughness appeared to have much in common with references from United States Supreme Court Justice Potter Stewart when he set the threshold for obscenity in Jacobellis v. Ohio by saying "I know it when I see it" (Gewirtz, 1996). Everyone "knew" what mental toughness was, but nobody could actually define it clearly. As a result, mental toughness filled a convenient knowledge gap for coaches, announcers, recruiters and even athletes themselves who wanted to point to "something" that differentiated one athlete from another when there didn't appear to be any other differentiator available.

With the turn of the century, mental toughness garnered expanded attention in the scientific community (Jones et al., 2002) and with that attention, a plethora of definitions (see Table 1) and assessments (Gucciardi, 2017) began providing context for this long-popular construct. There was now an ability to measure mental toughness, but the focus remained on comparing "Person A" to "Person B" – sometimes due to defining the construct as a being trait-like construct (Clough et al., 2002) that would demonstrate little if any change over time. However, even when identified as being state-like in nature, the many studies continued to put a focus on comparing the mental toughness of one person to that of another rather than focusing on the within-person variability and potential optimizers to that within-person variability, as we emphasized in this thesis.

As such, I propose the following definition of mental toughness: *A variable and malleable psychological catalyst available to enhance an individual's desired outcome beyond recent baseline performance or behavior.* This definition makes subtle, yet important adjustments to previous definitions (see Table 1). It

incorporates the variability of mental toughness, and then goes further in noting the ability for an individual to actually mold that variability through specific actions (malleability). As a psychological catalyst, it exists outside of physiological measurements and exists for the purpose of influencing other outcomes (catalyst) rather than being a goal in and of itself. Inclusion of the word "available," is critical, as an individual does not need and may not choose to access a certain level of mental toughness for all daily pursuits unless an adversity is present for the individual to overcome. However, if choosing to do so, then mental toughness can provide the previously mentioned catalyst. This "choice" can be utilized in response to either externally imposed pressure (Bell, et al., 2013) or internally selected adversity (e.g., running performance). The construct is available to enhance outcomes across a range of pursuits and is not restricted to athletics. Finally, this definition indicates that when optimized, mental toughness allows the individual to perform above their recent baseline performance. Doing so increases the focus on within-person variability and the need for optimized mental toughness only when looking to perform above recent baseline (e.g., you may run comfortably at a 7:00/mile pace and thus do not need to pull in optimized mental toughness for that activity but I may need to access optimized levels of mental toughness to do the same).

Contributions to the Literature

The purpose of this PhD was to examine the within-person variability and identify potential optimizers of mental toughness. The way in which those aims were addressed by each study individually are noted in the previous section. However, perhaps more important is the broader question about the contribution of the thesis to the existing literature. Researchers have referenced mental toughness as being potentially malleable (Middleton et al., 2004) but nonetheless trait-like (Hardy 2014,

Horsburgh et al., 2009). Our findings contradicted this understanding and supported previous literature (Weinberg et al., 2017) of ongoing within-person variability, ranging from day-to-day and even hour-to-hour. Mental toughness has traditionally been studied in elite athletes (Beattie, 2018), military personnel (Fitzwater, 2018) and students (Bedard-Thom & Guay 2018), groups that generally live life in a very structured setting. Instead, our thesis consistently examined non-professional, Masters (over age 35) athletes with a wide range of non-sport related stressors and commitments ranging from full-time careers, children, household responsibilities and financial pressures. This shift sets the stage for individuals in all walks of life (rather than just athletes, military personnel or students) to potentially benefit from the broader scientific mental toughness literature. As such, the within-person variability and potential optimizer focus throughout this thesis puts an emphasis on the individual's opportunity for better performance, better outcomes and possibly a better life instead of putting the emphasis on between-person comparisons. Rather than focusing on whether my mental toughness exceeds yours and instead shift it to how I can improve mine to improve tomorrow's results, then the construct grows in value across a wide range of settings.

Further, our chosen methodology also contributed to the mental toughness literature. The use of longitudinal N-of-1, exploratory case study methodology over time with repeated measures helped begin to address future mental toughness research recommendations regarding stability (Gucciardi, 2017) and influencers of mental toughness (Beattie et al., 2018). The inclusion of autoethnographic analysis, exploratory case study and longitudinal N-of-1 case study designs, as well as the combination of quantitative and qualitative measures may be beneficial in expanding the approach of future mental toughness research. A review of single case study

research over a 15-year period of 1997 – 2012 resulted in only 66 studies assessing sport psychology interventions (Barker, Mellalieu, McCarthy, Jones, Moran, 2013). The chosen methodologies not only place the primary focus on the individual participant rather than traditional randomized designs but also emphasized the case study design as a primary approach throughout the thesis. Randomized designs often rely on assessments completed at time points such as baseline and follow-up rather than observing variation over time (Kwasnicka & Naughton, 2019). By focusing on the individual, tracking changes over multiple time periods, and often incorporating qualitative follow-up interviews, we were able to more effectively measure the variability in mental toughness and then identify potential optimizers of that variability in the participants while keeping the focus on within-person rather than between-person mental toughness.

Practical implications

The concept of "practical application" of any concept obviously requires it to be both practical and applied. If either is lacking, the concept falls short. Statements such as "Discrepancies between evidence-based, efficacious interventions and what actually occurs in practice are frequently so large as to be labeled a 'chasm'" (Glasgow & Emmons, 2007, p. 414) bring the importance of practical application to light. One of the potential benefits of the functional mental toughness (fMT) model is the relative simplicity of its application and the way in which it can be applied across a range of (practical) settings and pursuits. The fMT model, designed based on the higher themes identified in Study II, provides an easy to understand (and communicate) visual for practitioners. The fMT bank provides a clear reference point for how the three higher order themes of Thrive, Prepare and Activate influence the benefits of the bank. The bank visual also extends an easy analogy for practitioners

in that the three primary goals an individual has for their bank are, 1) fill the account as much as possible, 2) avoid leakage through unexpected fees, and 3) be able to access the funds when needed. These three extend smoothly to mental toughness and the way in which the higher level themes of Thrive, Prepare and Activate allow the individual to increase their overall level of mental toughness, limit those things that deplete their mental toughness and then, at that moment when it is most needed, access their mental toughness.

The fMT diagram (see Figure 10) also provides a clear visual as to the influence each of the higher order themes have on one another inside and potentially outside of sport. There is opportunity going forward to build on our case study design by examining the influence of different optimizers on within-person mental toughness variability. These optimizers could include an expanded sample size to examine sleep (Study III) and self-talk (Study IV) or other potential optimizers identified in Studies I (e. g., anger, competition, sense of last chance) and II (e. g., stress, goal setting, callousing) under the Thrive, Prepare and Activate themes. Examining the influence on fitness participants rather than competitive athletes may provide insights about who may choose to engage mental toughness reserves and the influence of optimizers on that resource. Further research will help effectively clarify additional potential optimizers beyond what were identified within this thesis. Is there a difference between the optimizers utilized in team sports compared with individual sports or between those utilized by endurance athletes compared with power athletes? Finally, extending the integration of such strategies into areas beyond athletics, education and military personnel (e. g., personal or professional pursuits) offers a potentially valuable course of future study. As additional clarification is gleaned, the fMT model may help set the tone for clearly

communicating how mental toughness can benefit an individual's performance and outcomes across multiple settings, including personal, professional or organizational pursuits.

Interest in health and wellbeing within the scientific community has grown significantly in the past decade. A search of Web of Science on August 14th, 2019 using the word "wellbeing" as a topical search revealed an average of 378 published articles per year from the years 2000 – 2009 compared to an average of 2,061 published articles from 2010-2018 (and a run rate of 3,838 articles for 2019). The information gleaned from the four studies comprising this PhD may positively contribute to the discussion in two primary ways. First, with Thrive (foundational wellbeing) making up a core element of the fMT model, individuals looking to improve their performance in other areas (career, education, relationships, athletics) benefitting from an increase in mental toughness may have another reason to enhance their wellbeing to achieve these goals (e. g., reminder that skipping sleep may reduce mental toughness and thus negatively affect outcomes related to their goals).

Secondly, as someone who's spent a lifetime (30 years as a physical therapist and certified athletic trainer overlapping 13 years as a wellness company founder) working with individuals to achieve their goals, subtle enhancements can have a significant impact on results. By studying the variability of mental toughness and potential optimizers in older participants who are in the midst of real life stressors ranging from raising children to paying bills and working long hours in jobs aside from their high-end athletic pursuits, we may have effectively nudged the mental toughness conversation to its interaction with these real life variables. For example, in Study III, the two participants who did not demonstrate a notable influence of

sleep on mental toughness were both involved in fast-paced business trips and activities during the week of the study, which they indicated as being buoys of mental toughness in spite of the reduced time in bed. Subsequent studies could more closely examine the influence of these overlapping life events on mental toughness. The results of these four studies potentially lay the foundation to not only study additional sub-themes such as overall stress levels, goal setting and callousing under the Thrive, Prepare and Activate categories. Rather they may also encourage exploration of the influence of optimizing mental toughness on goals ranging from weight and stress management to relationship enhancement, professional pursuits, exercise consistency and effective follow-through in other areas of interest.

The purpose of this PhD was to examine the within-person variability of mental toughness and identify potential optimizers of this construct. All four of our studies identified variability in mental toughness, with the last three specifically measuring that variability using the Mental Toughness Index (Gucciardi, 2015). In so doing, the concepts of Capacity Mental Toughness (cMT) and Functional Mental Toughness (fMT) were developed and clarified in a manner that may be of benefit to future researchers, athletes, coaches and others struggling with the trait vs. state elements of mental toughness. Capacity mental toughness (cMT) recognizes that some individuals may simply have higher potential mental toughness due to personal history and experience. A Navy Seal who grew up working on a farm, has been through multiple tours of duty, and participates in MMA fighting will likely have a higher overall cMT than me. Our goal in this thesis did not discount the reality of cMT – that some people may be tougher than the general population. Rather, it put the focus on fMT – or how each individual, regardless of their baseline level of potential mental toughness (cMT) can optimize the amount of available, or

functional mental toughness (fMT) and the ability to draw it out when needed for a specific situation or pursuit. Our goal was to move the mental toughness conversation from "is your mental toughness better than mine?" to "can I improve my mental toughness tomorrow?"

If the answer to this individualized question is yes, and specific optimizers are identified, then we are able to not only answer the second question in the positive ("yes – you can improve"). Rather, we are able to help any individual, regardless of their historical levels of cMT and regardless of the pursuit identified, improve their functional levels of mental toughness specific to that pursuit. Returning to our Navy Seal/Farmhand/MMA Fighter example, the mental toughness comparison now takes a potentially interesting turn. Perhaps in a neutral setting not based on the skill-based experience of either person (e.g., trail marathon), it becomes the person who most effectively integrates the mental toughness optimizers and not simply the "historically tough" person who will be at an advantage when it comes to mental toughness.

While the competitive outlets of these answers are intriguing, the potentially more valuable element is the role mental toughness optimization can have in the broader community. Gucciardi (2017) provided an updated definition of mental toughness as "a state-like psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal-directed pursuits." I have proposed a definition as "A variable and malleable psychological catalyst available to enhance an individual's desired outcome beyond recent baseline performance or behavior." Note neither definition says anything about athletic or military-based pursuits. Rather, mental toughness is a catalyst for "the enactment and maintenance of goal-directed pursuits." As a licensed physical therapist/certified

athletic trainer for over 30 years and the CEO of a health and wellness organization for over 13 years, there is a significant need for such enactment and maintenance! If we as a scientific community can provide individuals with specific ways in which to optimize mental toughness, it could play a significant role in helping people improve their lives across a wide range of "goal-directed pursuits."

Overview of strengths and limitations

The goal of extending the optimization of mental toughness into the broader population was one of the reasons we chose to recruit elite Masters athletes as our study participants. In contrast with professional, youth or even college athlete populations who may have limited responsibilities outside of their sport, Masters athletes face additional life pressures related to careers, families, finances and more. While our studies did still emphasize the effect of mental toughness in athletic settings, the recruitment of this population provided an opportunity to examine the effects on mental toughness in a setting with additional real-world elements. Our sleep study (Study III) in particular brought this element to life. Two of the participants who did not demonstrate any detrimental effect on mental toughness when time in bed was reduced were in the midst of high intensity work meeting and travel schedules during the week of the study. As a result of their participation, additional potential buoys of mental toughness were identified that might not have been realized if studying a population with less life stressors built into their schedules.

The series of studies within this PhD was not without limitations. While the "real world" element was strong, the collection of additional biometric physiological data that could have been collected in a laboratory setting may have provided additional insights about how increased levels of mental toughness is influencing the

physiological side of the equation. Such data could include heart rate maximums during specific training sessions (is it reach higher levels when mental toughness is higher?), technology-based sleep monitoring (is the relationship between sleep and mental toughness seen when based on lab results rather than participant recall?), and daily heart rate variability (does a higher level of heart rate variability translate to a higher level of mental toughness?), among others. The objective data collected in such a manner could potentially aid in the preparation aspects (as in the sleep or heart rate variability) and objective measurement (via max heart rates) of mental toughness. The timing of our sleep study occurred just prior to the accuracy of individualized sleep trackers (e.g., FitBit) being enhanced and this addition, even outside of the laboratory, could have provided a beneficial element to our study. Finally, performing studies in a laboratory setting could also have reduced the number of variables such as air temperature, wind, humidity and potentially reduced the daily life variables of travel and other external elements.

Implications for future research

These four studies provide a meaningful starting point for furthering the insights into within-person mental toughness variability and practical ways in which to optimize the construct. However, they only represent a next step, as the implications and opportunities for future research and further understanding are extensive. Mental toughness has several related constructs as noted in Table 8 below. Clearly distinguishing mental toughness from these constructs continues to be an important objective for researchers (Gucciardi, 2017). In addition, social attitudes about mental toughness (Caddick & Ryall, 2012) place excessive emphasis on the "tough" aspect of the construct and consistently understate the "mental" aspect. My definition of mental toughness provided previously is "a variable and malleable

psychological catalyst available to enhance an individual's desired outcome beyond recent baseline performance or behavior." This definition, among other things, attempts to emphasize the opportunity available to anyone, regardless of background or setting, to enhance and then tap into a psychological resource.

Table 8: *Mental toughness related constructs – adapted from Sorensen, 2016, table 3-2, pp 62-63*

Related Construct	Definition	Evidence – Relationship to MT	My Comments
Resilience	a) "Protective factors which modify, ameliorate or alter a person's response to some environmental hazard that predisposes to a maladaptive outcome." (Rutter, 1987, p. 316) b) "The process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress – such as family and relationship problems, serious health problems, or workplace and financial stressors. It means	Moderate correlations ($r = .35$-$.54$ $p < .01$) (Gucciardi & Gordon, 2009)	Resilience is most pertinent in helping individuals to bounce back from difficult stressors. By comparison, MT provides the capacity to move forward to another level of potential outcome ("strive and thrive?").

	‘bouncing back’ from difficult experiences.” (American Psychological Association, 2015)		
Hardiness	a) “Persons who experience high degrees of stress without falling ill have a personality structure differentiating them from persons who become sick under stress. This personality difference is best characterized as hardiness.” (Kobasa, 1979, p. 3) b) “A personality trait that is indicative of individuals’ resilience and success in managing stressful circumstances.” (Golubovich, et al., May 2014, p. 757)	Weak to moderate correlation (r= .34 - .38, p <.05; Golby & Sheard, 2004; Sheard, 2009)	Hardiness makes up 75% of the multidimensional MTQ48 but not the unidimensional MTI. Similar to resilience, it is seen primarily in the response to outside stressors rather than the pursuit of an outcome beyond historical physiological baseline.

Grit	a) “Perseverance and passion for long term goals.” (Duckworth, et al., 2007, p. 1087) b) “The ability to strenuously pursue long-term goals despite obstacles and adversity.” (Anestis & Selby, January 2015, p. 212)	Moderate correlations (r = .42, p < .01; Joseph, 2009)	Grit is focused on the long term goals while MT is beneficial in the moment of a specific situation or circumstance.
Psychological Flexibility	a) “The ability to fully contact the present moment and the thoughts and feelings it contains without needless defence.” (Bond, et al., 2011, p. 678) b) “The ability to persist with and/or change behaviour that is consistent with personal values while allowing difficult	No direct comparisons. Conceptual similarities may exist along shared features of “emotional control” (P. J. Clough, Earle, & Sewell, 2002; G. Jones, 2002), ‘emotion regulation’ (Gucciardi, Hanton, Gordon, Mallett, & Temby,	This construct may benefit mental toughness by improving the integration of various optimizers, it is more about flexing with the difficulties more than the ability to directly overcome them.

	thoughts or feelings to occur." (Whiting, et al., June 2015, p. 415)	2015) and 'emotional flexibility' (J Loehr, 1995)	
Sisu	a) "Sisu (SIH-soo or SEE-soo): (1) inner determination; (2) courage, tenacity, stubborn determination, energy and a will and an ability to get things done (Kolehmainen, 1957, p. ix)." (Lucas & Buzzanell, 2004, p. 273) b) "The Finnish word 'sisu' is very dear to us. It is untranslatable, but it means approximately strength of will, determination, and perseverance. We want to see ourselves as modest, hard-working, no-nonsense people who do not	No direct comparisons. Conceptual similarities may exist along shared features of 'determination' and 'courage' (Bull, Shambrook, James, & Brooks, 2005; Gucciardi, Gordon, & Dimmock, 2008; G. Jones, 2002, Lahti, 2013; Lucas & Buzzanell, 2004; Ryba, et al., 2009)	Sisu appears to emphasize broader cultural values rather than an individualized concept.

	bow or resign to anyone." (Sinkkonen, March 2013, pp. 49-50)		
Mental Fitness	"Mental fitness is the changeable capacity to utilize resources and skills to psychologically adapt to environmental challenges or advantages to meet psychological needs." (Robinson, et al., 2015, p. 56)	No direct comparisons. Conceptual similarities may exist along shared features of 'personal resources' (Gucciardi, et al., 2015; Robinson, et al., 2015), 'strength' (Pickering, Hammermeister, Ohlson, Holliday, & Ulmer, 2010; Robinson et al., 2015; Tenenbaum et al., 1999), 'flexibility' (Loehr, 1994; Robinson et al., 2015)), and 'endurance' (Crust & Clough, 2005; Robinson et al., 2015).	Focus is on psychological needs rather than specific pursuits.

Further, future research can build on the within-person focus provided in this thesis by extending the length of time during which repeated measures are collected and the number of participants studied. Settings could also be expanded. While our integration of Masters athlete participants likely incorporated additional wellbeing components, wellbeing outcomes were not specifically part of our studies. There would be notable value to examining the influence of mental toughness on various aspects of wellbeing. For example, does an increase in mental toughness improve the likelihood of an individual managing their weight, improving their biometric screening numbers such as blood pressure or blood sugar levels, changing sleep patterns, or increasing their activity levels? These insights could provide value across the broader population in need of help. According to the Office of Disease Prevention and Health Promotion, less than 25% of the population in the United States met guidelines for physical activity and obesity rates, which now exceed 38% in the country, while total vegetable intake totals just .76 cups/1,000 calories nationally (HealthyPeople 2020). If mental toughness does indeed demonstrate a positive influence on health and wellbeing, it could contribute not only enhancing performance in athletes, military personnel and students but to the broader population.

In the context developed within this thesis, capacity mental toughness (cMT) is hypothesized to represent the upper range of an individual's level of mental toughness while functional mental toughness (fMT) represents the opportunities to access as much of that upper range as possible through the integration of specific optimizers under the Thrive, Prepare and Activate themes of fMT. Future research could build upon this hypothesis further by examining average levels of mental

toughness over extended time, periods of a year or more, standard deviations of the variability, and potentially identifying external (e. g., daily weather, holidays, travel requirements) and internal (e.g., optimizers provided in Study II) variables influencing both cMT and fMT. Additional questions in need of answers, both inside and outside the mental toughness research community, are extensive. These questions include but are not limited to A) How the optimizers may compliment and facilitate one another? B) Is the effect of an optimizer reduced over time as it becomes a standard practice for the individual? C) Does personal coaching on mental toughness increase the development and utilization over time? D) Can individuals consistently recognize, in advance versus retrospectively, when increased levels of mental toughness will be beneficial? E) What is the relationship between challenge and threat interpretations (Jones, et al., 2009) and the level of mental toughness?

Conclusion

The central purpose of this PhD was to examine the within-person variability and identify potential optimizers of mental toughness. These aims were achieved by completing the following related to the objectives of the research program:

- A succinct literature review was developed and is included within this thesis. It provided a brief overview of the concept of mental toughness but focused on the potential variability and malleability of the construct.
- The initial study (Study I - Autoethnography) was the stimulus for this PhD and investigated the potential variability of my own mental toughness across a series of high-end endurance events. This study identified clear variability in mental toughness and potential optimizers in this single athlete and thus lead to Study II.
- The second study looked at multiple (13) elite Masters athletes over a 30-day period using an exploratory case study design. Mental toughness was assessed using the Mental Toughness Index (Gucciardi, et al., 2015) in the context of high RPE training or racing sessions. Additional qualitative data that followed the initial 30-days provided more specific insights about potential optimizers of mental toughness. The qualitative data was reviewed, analyzed and coded to develop higher level optimizer themes of Thrive, Prepare and Activate.
- Study III then investigated sleep, one of the potential mental toughness optimizers that was identified as overlapping the Thrive and Prepare themes. While reduced time in bed did not negatively influence mental toughness in all participants as hypothesized, it did influence the majority. Study III also confirmed within-person mental toughness variability seen

in the previous studies and identified potential buoys of mental toughness used when sleep was limited.

- Finally, Study IV examined the influence of self-talk, another potential optimizer noted as overlapping between the Prepare and Activate themes. Participants demonstrated within-person variability in mental toughness, confirming previous findings. Self-talk was shown to positively influence mental toughness and performance.

This thesis makes a unique contribution to the literature by a) emphasizing longitudinal N-of-1 and exploratory case study with repeated measures and autoethnographic study design to examine mental toughness variability and potential optimizers; b) focusing on the within-person rather than between-person variability in mental toughness; c) recruiting Masters (age 35-60) athletes (and in Study IV, specifically female Masters athletes) with a multitude of life stressors outside of what might be experienced by those individuals traditionally involved in mental toughness research (elite athletes, military personnel and students); d) introducing the functional mental toughness (fMT) model, including specific potential optimizers, providing practical guidance and an implementable strategy for individuals and practitioners seeking improved performance across all walks of life, from personal health and wellbeing to professional and athletic pursuits.

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Table of Appendices

Appendix A: Pre-selection Participant Questionnaire (Study II)

Items A, B and C will be utilized to determine whether the individual is a good fit for Study 1a. Item D will be unrelated to selection process but will provide a baseline for future outcome comparison and item E provides contact information and confirms age matches up with study parameters.

A. The Holmes-Rahe Life Stress Inventory

- *The purpose of this inventory is to identify individuals who may be in midst of high stress levels and at higher risk for illness or injury. Score of <150 required for study inclusion)*

INSTRUCTIONS: Indicate "Yes" or "No" for each of the items that have happened to you during the previous year (points indicated will automatically be tallied for participants).

1. Death of spouse 100
2. Divorce 73
3. Marital Separation from mate 65
4. Detention in jail or other institution 63
5. Death of a close family member 63
6. Major personal injury or illness 53
7. Marriage 50
8. Being fired at work 47
9. Marital reconciliation with mate 45
10. Retirement from work 45
11. Major change in the health or behavior of a family member 44
12. Pregnancy 40
13. Sexual Difficulties 39
14. Gaining a new family member (i.e. birth, adoption, older adult moving in, etc.) 39

15. Major business adjustment 39

16. Major change in financial state (i.e. a lot worse or better than usual) 38

17. Death of a close friend 37

18. Changing to a different line of work 36

19. Major change in number of arguments with spouse (i.e. a lot more or less) 35

20. Taking on a mortgage (for home, business, etc.) 31

21. Foreclosure on a mortgage or loan 30

22. Major change in responsibilities at work (i.e. promotion, demotion, etc.) 29

23. Son or daughter leaving home (marriage, college, military, etc.) 29

24. In-law troubles 29

25. Outstanding personal achievement 28

26. Spouse beginning or ceasing work outside the home 26

27. Beginning or ceasing formal schooling 26

28. Major change in living condition (i.e. new home, remodeling, deterioration, etc.) 25

29. Revision of personal habits (i.e. dress, associations, quit smoking, etc.) 24

30. Troubles with the boss 23

31. Major changes in working hours or conditions 20

32. Changes in residence 20

33. Changing to a new school 20

34. Major change in usual type and/or amount of recreation 19

35. Major change in church activity (i.e. a lot more or less) 19

36. Major change in social activities (i.e. clubs, movies, visiting, etc.) 18

37. Taking on a loan (i.e. car, tv, freezer, etc.) 17

38. Major change in sleeping habits (i.e. a lot more or less) 16

39. Major change in number of family get-togethers (i.e. a lot more or less) 15

40. Major change in eating habits (i.e. a lot more/less, eating hours, surroundings, etc) 15

41. Vacation 13

42. Major holidays 12

43. Minor violations of the law (i.e. traffic tickets, jaywalking, etc.) 11

B. Utilizing this website (http://www.mastersathletics.net/index.php?id=2595) and your race results from the previous 12 months, please indicate:

- Your highest Age Graded Performance Score: _____
- Date/Result/Name of race utilized to identify score: _____

C. List 5 or more planned high intensity training sessions or events over the next 30 days (include brief description such as 10K or 12 x 400 on track or 2 x 3 mile tempo run as well as expected date).

- Session/Event #1:
- Session/Event #2:
- Session/Event #3:
- Session/Event #4:
- Session/Event #5:

D. Personal Importance Rating Assessment – the following will have absolutely no influence on your selection as a participant into this study. Rather, it simply sets a baseline for future comparison.

Using a 1-3 scale (1 = Not at all important to my performance, 2 = Potentially but nominally important to my performance, 3 = Very important

to my performance), how would you rate each of the 7 items noted below in terms of their impact on your athletic performance?

1. Sleep quality/quantity: _____
2. Caffeine intake: _____
3. Daily nutrition: _____
4. Life/Work stress level: _____
5. Weather conditions (wind, rain, temperature): _____
6. Use of Music (headphones): _____
7. Significant Other belief/support/connection: _____

E. Name, email, phone number and date of birth

Appendix B: Daily Participant Questionnaire (Study II)

<u>Daily Journal</u> ("The Daily Eight" – 8 questions plus general thoughts to be completed on each of the 30 days) – *An email reminder/link will be sent to participant each morning to make this a quick and easy (and consistent) process.*

1. How many hours did you sleep last night? (enter to the nearest .5 hour) _____
2. How would you rate the quality of your sleep last night on a scale of 0 ("best possible sleep") to 10 ("worst possible sleep") _____
3. Select the response that best indicates the general quality of your nutrition over the past 24 hours:
    a. Poor
    b. Moderate
    c. Excellent
4. On a scale of 1 ("Not a all") to 5 ("Very much"), how would you rate the level of stress over the past 24 hours? _____
5. Which of the following best describes your current level of physical training fatigue?
    a. Physically drained from training
    b. Moderately tired from training
    c. Normal weekly recovery level
    d. Extra recovery but not tapered
    e. Fully tapered and rested
6. Rate the connection with/support from your "most significant other" over the past 24 hours on a scale of 1 ("complete disconnect") to 5 ("fully connected and supported")
7. How many mg of caffeine did you/will you consume today: _____

a. Use this website to determine caffeine content of common items: https://cspinet.org/eating-healthy/ingredients-of-concern/caffeine-chart

8. Select the answer that most accurately describes your current injury/illness status

    a. Unable to train due to illness/injury and plan to take 1+ additional days off
    b. Minor illness/injury – taking today off but expect to be back tomorrow (at reduced intensity)
    c. Tail end of illness/injury – training but at reduced intensity
    d. Illness/injury resolved but still not quite at 100%
    e. No illness/injury

Please note any other elements that you think might have an impact on your mental toughness and/or performance:

_____

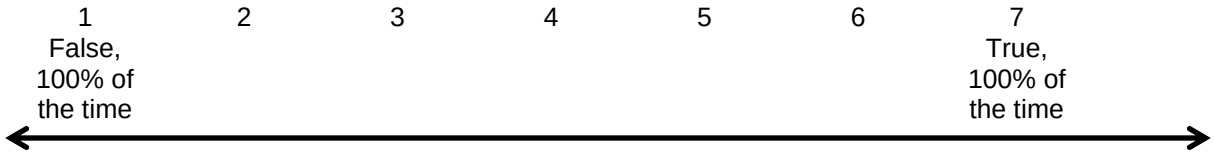
_____

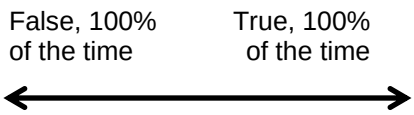
_____

Appendix C: High RPE Pre-session Survey (Study II)

Two additional links labelled "Big Day – Pre" and "Big Day – Post" will be included within the daily email participants receive. If that day is 1 of the 5 days identified by the athlete as a High RPE session or event, they will complete the Pre-session beforehand and the Post-session immediately after the session.

A. Session-specific Mental Toughness Index (MTI) Using scale below, please indicate how true each of the following statements is an indication of how feel about your expected mindset **throughout today's** planned session or event. *Remember there are no right or wrong answers so be as honest as possible.*





1	I believe in my ability to achieve my goals in this session/event	1	2	3	4	5	6	7
2	I will be able to regulate my focus when performing this session/event	1	2	3	4	5	6	7
3	I will bounce back from any adversity throughout this session or event	1	2	3	4	5	6	7
4	I will strive for continued success throughout this session/event	1	2	3	4	5	6	7
5	I will find a positive side to situations throughout this session/ event	1	2	3	4	5	6	7
6	I will use my emotions to perform the way I want to	1	2	3	4	5	6	7
7	I will maintain high levels of performance when challenged	1	2	3	4	5	6	7
8	I will effectively execute my knowledge of what is required to achieve my goals during this session/event	1	2	3	4	5	6	7

E. Which of the following statements most accurately describes the presence of a training partner and/or competitor for this session?

    A. No training partner/competitor

    B. Training partner/competitor present but different speed/pace

    C. Training partner/competitor present who is equal or slightly faster

F. Rate the weather conditions for the session event on a 1 ("Just the way I like it") to 3 ("Ugggh – I hate these conditions") scale: _____

G. Which of the following statements accurately describes your caffeine intake for this session/event

    1. No caffeine

    2. Same amount as typical session (choose this response if you never use caffeine)

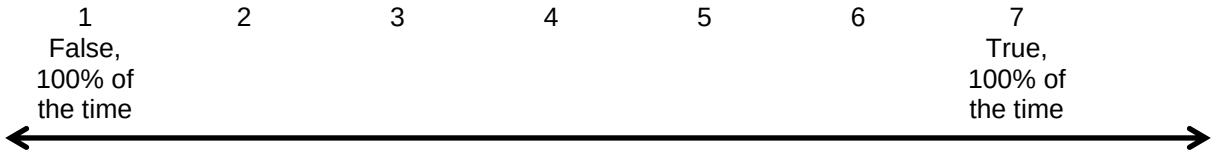
    3. More caffeine intake than typical session/event

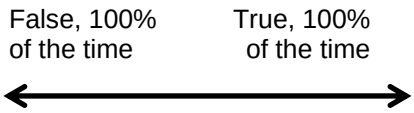
H. Indicate whether you are listening to chosen music during session/event – Yes or No? _____

Appendix D: High RPE Post-session Survey(Study II)

Completed immediately following session/event

A. **Session-specific Mental Toughness Index** (MTI) Using scale below, please indicate how true each of the following statements is an indication of how you felt about your mindset **throughout today's <u>entire</u>** session or event. *Remember there are no right or wrong answers so be as honest as possible.*





1	I believed in my ability to achieve my goals throughout this session/event	1	2	3	4	5	6	7
2	I was able to regulate my focus when performing this session/event	1	2	3	4	5	6	7
3	I bounced back from any adversity throughout this session or event	1	2	3	4	5	6	7
4	I strove for continued success throughout this session/event	1	2	3	4	5	6	7
5	I found a positive side to situations throughout this session/ event	1	2	3	4	5	6	7
6	I was able to use my emotions to perform the way I wanted to	1	2	3	4	5	6	7
7	I maintained high levels of performance when challenged	1	2	3	4	5	6	7
8	I effectively executed my knowledge of what is required to achieve my goals during this session/event	1	2	3	4	5	6	7

D. Rate your performance on a scale from -5 ("extremely poor vs. realistic goal") to +5 ("extremely strong vs. realistic goal"), with 0 indicated "performed as expected")

E. Indicate which of the following most accurately describes your use of purposeful self-talk

1. 1 = No self-talk
2. 2 = Occasional self-talk
3. 3 = Focused and planned self-talk

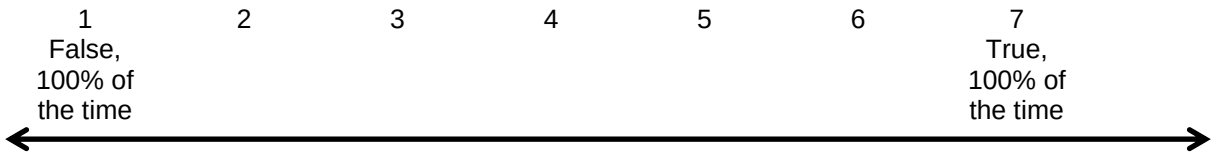
F. This session's outcomes were seen by/shared with
    1. Training partner and/or event competitor
    2. Virtual accountability partners (via email, Strava, Facebook or other similar outlets)
    3. Nobody (beyond participation in this study)

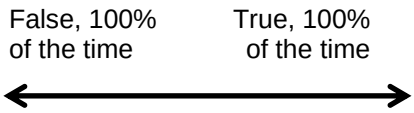
G. Please share any additional thoughts you may have regarding reasons for potential variation in MT and/or performance, including but not limited to
    1. Briefly describe your experience during today's session
    2. Do you think there was a variation in your personal mental toughness today?
    3. If so, to what would you correlate that variation?

Appendix E: Mental Toughness Index (MTI: Study II)

Using the scale below, please indicate how true each of the following statements is an indication of how you typically think, feel, and behave as an athlete.

Remember there are no right or wrong answers so be as honest as possible.





1	I believe in my ability to achieve my goals	1	2	3	4	5	6	7
2	I can regulate my focus when performing tasks	1	2	3	4	5	6	7
3	I bounce back from adversity	1	2	3	4	5	6	7
4	I strive for continued success	1	2	3	4	5	6	7
5	I can find a positive side in most situations	1	2	3	4	5	6	7
6	I can use my emotions to perform the way I want to	1	2	3	4	5	6	7
7	I maintain high levels of performance when challenged	1	2	3	4	5	6	7
8	I effectively execute my knowledge of what is required to achieve my goals	1	2	3	4	5	6	7

Appendix F: Participant Informed Consent Details (Study II)

Study: **An exploration of the within-person variability of mental toughness across a 30-day training cycle within masters level runners**

Principal Investigator: Brad Cooper Researcher: Brad Cooper

Organisation: The University of Exeter

Version: #1.

November ___, 2017: reviewed by The University of Exeter ethics committee

Participant Identification Number: ____

Informed Consent Form for Participants

1. I confirm that I have read and understand the information sheet version #1 dated _____ for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.
3. I understand that any information given by me may be used in future reports, articles or presentations by the research team.
4. I understand that my name will not appear in any reports, articles or presentations.
5. I understand that I will be asked to complete a pre-participation baseline survey completely and honestly prior to selection into the study and may not be selected for the study.
6. I understand that I will be completing a brief (<10 min) daily diary covering a range of variables and am committed to completing this consistently each day for the 30 day period.

7. I understand that on 5 or more occasions, I will be providing additional survey data both before and after my self-selected, pre-planned high perceived exertion training sessions.
8. I understand that this study is tapping into my pre-planned, self-selected training sessions that I was already planning to complete. Neither the researcher or the organisation had any input on the specific training and/or racing sessions chosen by me to be a part of this study.
9. I agree to take part in the above study.

_____ _____

_____

Name of Participant Date Signature

_____ _____

_____

Researcher Date Signature

Sport and Health Sciences College of Life and Environmental Sciences

St Luke's Campus Heavitree Road Exeter Devon Telephone: +44 (0)1392 26

Email: sshs-schooloffice@ex.ac.uk Web: www.ex.ac.uk/sshs

Appendix G: Participant Information Sheet (Study II)

An exploration of the within-person variability of mental toughness across a 30-day training cycle within Masters level runners

You are being invited to take part in a research study investigating whether there is variation in functional levels of mental toughness across higher intensity training and racing sessions in running. Taking part in the study is entirely up to you so before you decide, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information and to discuss it with other people to decide whether you wish to take part or not. Thank you for taking the time to read this information.

What's involved? The proposed research study is being undertaken as part of a dissertation that is a requirement of a PhD pursuit. There has been a vast amount of research in the past twenty years on the concept of mental toughness. However, there remains a significant amount of debate about whether mental toughness is a constant (trait) or varies based on different internal and external factors (state). As a result, it is important to study whether such variation exists. If it does, it's important to begin the process of identifying correlating factors tied to that potential variation. The aim of this study is to identify whether high level Masters runners demonstrate such variation across their higher intensity training and/or racing sessions; and if so, record potential correlating elements.

What types of participants are needed? We are looking for Masters runners between the ages of 40-65 who are working full time, in the midst of a training block that will include 5 or more high RPE (8-10) training and/or racing sessions over the next 30 days. To qualify, you must have demonstrated a racing performance over the past 12 months that scores you in the 75% or higher in the following table: http://www.mastersathletics.net/index.php?id=2595. In addition, to take part you

should be a non-smoker, free of illness or infection, not be under extreme stress and have no known family history of cardiovascular or respiratory disease. You will have the opportunity to ask questions and clarify any issues before deciding whether you want to take part.

What would taking part involve? If you qualify and agree to take part in this study, you will complete 5 or more of your self-selected and previously planned high (8-10) RPE training/racing sessions over a 30-day period. This will be preceded by the completion of a baseline questionnaire. Barring any disqualifiers within the baseline, you will then engage in a 30 minute 1:1 or group (conference call) session to walk through the details of the process and have any questions answered. You will then be completing a brief (<5 min) daily journal of various internal/external factors. Then, immediately prior to and after your 5 or more high RPE training/racing sessions, you will be completing an additional brief questionnaire (approximately 5 minutes in length).

What are the possible benefits to you of taking part? The main benefits of the proposed research are to help advance the field of research regarding key mental toughness indicators. However, the process of being involved in the study will likely provide you with additional personal insights about your own mental toughness. You will also have the option of receiving written feedback in reference to your results.

What are the possible disadvantages and risks of taking part? Since you will be completing training/racing sessions that you had already self-selected and planned, there should not be any necessary variation in or negative impact on your training. There will be a minor time commitment to record the daily and session-specific insights tied to the ongoing data collection.

Further supporting information:

Do I have to take part? Please remember that participation in this study is entirely voluntary. It is up to you to decide whether you would like to take part or not and if you

decide to take part you are free to leave the study at any time without giving a reason as to why you wish to do so. If you do decide to participate in this study you will be asked to sign a consent form before you start. You will be given a copy of the consent form and this information sheet for your own records.

Are my results confidential? If you consent to take part in this study you have a right to privacy. Your name will be linked to an ID number on a password protected database and only these IDs will be used as labels during data analysis.

What will happen to the results of this study? Your physiological and psychological data will all be obtained during the time periods described above. Your performances on the time-trial will also be recorded. Any information that is obtained with this study will remain confidential and will only be disclosed with permission by the participant. Upon completion of the study, the data collected will be securely stored in such a way that only the researchers involved in this investigation will be able to gain access to it. At this point, you are most welcome to request a copy of the results of the project should you wish and we will be available to explain and interpret your specific data. Results of this project may be published but any data included will in no way be linked to any specific participant.

Who has reviewed this study? All research activity at the University of Exeter is examined and approved by an ethics committee to protect your interests. This study has been approved by the Ethics Committee of Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter.

Contacts for further information If you would like more information or if you have any further questions about the study please contact the investigators using the details below:

Brad Cooper – Bcooper@USCorporateWellness.com

Dr Martin I. Jones - M.I.Jones@exeter.ac.uk

Dr Mark Wilson - Mark.Wilson@exeter.ac.uk

School of Sport and Health Sciences - St. Luke's Campus

Exeter University

Appendix H: Email/Facebook script for participant recruitment (Study II)

Sample email script:

Hello _____ (name),

Congrats! You were recommended as a potential candidate for participation in a PhD-level study on the mental toughness of high level Masters runners based on your background and athletic reputation.

We are looking for 12 top level Masters runners who are in the midst of a 30-day training block that will involve at least 5 high intensity (8-10 on a 10-point scale) training sessions and/or races over a 30 day period. We'll be asking each participant to track a handful of daily items as well as some additional survey data before and after the high intensity sessions/events.

The specifics of your training/events are not critical to the study as long as there are a minimum of 5 over the 30 day period. They can include a track session, tempo run session or a race. For this particular study, we are focused on intensity, so are seeking runners training for distances of the mile up to the marathon and everything in between (including but not limited to traditional distances of 5K/10K/ and half marathon).

If you're interested in participating in the study and would like to determine whether your race times qualify you as a participant, you can access the following link and plug in your details from any race within the past 12 months -- http://www.mastersathletics.net/index.php?id=2595. If your rating puts you at the 75% level (which suggests elite regional performance) or higher, then you qualify for the study!

Interested but have additional questions? Feel free to contact Brad at BCooper@uscorporatewellness.com. Your time commitment for the ongoing surveys is less than 5 min/day over the 30 days plus the additional pre/post survey on your 5 high intensity days (approximately 10 minutes total for each of those days).

Sample Facebook script:

We are looking for 12 top level Masters runners to participate in a PhD level study on mental toughness. Don't worry – no torture sessions. We'll simply be asking you to complete some survey data before/after your higher intensity training sessions and complete a brief daily tracker.

Interested and wonder if you qualify? Plug in your details from any race from the past 12 months here-- http://www.mastersathletics.net/index.php?id=2595. If your rating puts you at the 75% level or higher, then you qualify for the study.

Questions? Feel free to contact Brad at BCooper@uscorporatewellness.com.

Study III - List of Appendices

Please note: all questionnaires will be provided to participants in electronic format for ease of use and optimization of time involved for completion.

- Appendix A – DASS-21 Assessment
- Appendix B – Mental Toughness Index (MTI)
- Appendix C – Participant Informed Consent
- Appendix D – Participant Information
- Appendix E – Email/Facebook script for participant recruitment
- Appendix F – Richards Campbell Sleep Questionnaire

Appendix I: Depression, Anxiety, Stress Scale (DASS-21)

The following will be completed once by each participant.

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement. The rating scale is as follows: 0 Did not apply to me at all 1 Applied to me to some degree, or some of the time 2 Applied to me to a considerable degree or a good part of time 3 Applied to me very much or most of the time

1 (s) I found it hard to wind down 0 1 2 3

2 (a) I was aware of dryness of my mouth 0 1 2 3

3 (d) I couldn't seem to experience any positive feeling at all 0 1 2 3

4 (a) I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion) 0 1 2 3

5 (d) I found it difficult to work up the initiative to do things 0 1 2 3

6 (s) I tended to over-react to situations 0 1 2 3

7 (a) I experienced trembling (e.g. in the hands) 0 1 2 3

8 (s) I felt that I was using a lot of nervous energy 0 1 2 3

9 (a) I was worried about situations in which I might panic and make a fool of myself 0 1 2 3

10 (d) I felt that I had nothing to look forward to 0 1 2 3

11 (s) I found myself getting agitated 0 1 2 3

12 (s) I found it difficult to relax 0 1 2 3

13 (d) I felt down-hearted and blue 0 1 2 3

14 (s) I was intolerant of anything that kept me from getting on with what I was doing 0 1 2 3

15 (a) I felt I was close to panic 0 1 2 3

16 (d) I was unable to become enthusiastic about anything 0 1 2 3

17 (d) I felt I wasn't worth much as a person 0 1 2 3

18 (s) I felt that I was rather touchy 0 1 2 3

19 (a) I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat) 0 1 2 3

20 (a) I felt scared without any good reason 0 1 2 3

21 (d) I felt that life was meaningless 0 1 2 3

Appendix J: Consent form (Study III)

Participant Identification Number:

CONSENT FORM

Title of Project: An exploration of the association between sleep and mental toughness

Name of Researcher: K. Bradford Cooper

Please initial box

1. I confirm that I have read the information sheet dated 25/10/2018 Version 1.0 for the above project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my legal rights being affected. ☐

3. I understand that relevant sections of the data collected during the study may be looked at by members of research team & individuals from University of Exeter where relevant to my taking part in this research. I give permission for these individuals to access my records. ☐

4. I understand that taking part involves adjusting my sleep schedule up and down between 5 and 9 hours and tracking details such as an assessment on a daily basis. ☐

5. I understand that my data will be used for the purposes of reports published in an academic publication, public engagement and other activities involving the research materials and outcomes I agree that my contact details can be kept securely and used by researchers from the research team to contact me about future research projects ☐

I agree to take part in the above study. ☐

Name of Participant Date Signature

Name of researcher taking consent Date Signature

When completed: 1 copy for participant via email; 1 copy for researcher/project file

Appendix K: Participant Information Sheet (Study III)

Title of Project: An exploration of the association between sleep quantity and mental toughness

Lead researcher name: K. Bradford Cooper

You are being invited to take part in a research study investigating whether the manipulation of sleep is correlated with the results of a self-scored mental toughness index assessment. Taking part in the study is entirely up to you so before you decide, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information and to discuss it with other people to decide whether you wish to take part or not. Thank you for taking the time to read this information.

What's involved? The proposed research study is being undertaken as part of a dissertation that is a requirement of a PhD pursuit. While there has been a lot of research in the past twenty years on the concept of mental toughness, the effect of sleep on how mentally tough an individual feels is less well understood. The aim of this study is to research the answer to that question.

What types of participants are needed? We are looking for individuals 21 years of age and older, from all walks of life and backgrounds and fit a brief list of other exclusion/inclusion criteria noted below. You have been approached due to your possible interest in participation.

What would taking part involve? Participants will be tracking their sleep and completing a morning RCSQ assessment (<5 minutes) late afternoon/early evening mental toughness assessment (<5 minutes) on Monday – Friday over a split four week period. The baseline tracking will take place during week one and three and then participants will be adjusting their Time In Bed (TIB) for 5 consecutive days during weeks two and

four, with one week being increased to 9 hours time in bed and the other week (randomly ordered) being decreased to 5 hours time in bed. The total time involved to complete the assessments over the 20 days is expected to be less than 200 minutes (3 hours and 20 minutes spread across four weeks).

What are the possible benefits to you of taking part? The main benefits of the proposed research are to help advance the field of research regarding key mental toughness indicators. While you will not receive payment for your participation, the process of being involved in the study will likely provide you with additional personal insights about your own mental toughness and also help you identify beneficial discoveries about your personal sleep pattern. You will also have the option of receiving a link to the research study if it is published in a peer reviewed professional journal.

What are the possible disadvantages and risks of taking part? Participation involves tracking your baseline sleep during week one and then adjusting your sleep pattern up and then down between 5 and 9 hours over two consecutive weeks consistently completing a tracking and self-assessment tool over the three weeks of the study. There is a risk with the decreased time in bed due to feeling both physically and cognitively fatigued. Participants will be asked to carefully assess their daily risks and withdraw from the study if levels of fatigue are perceived to potentially influence safety and wellbeing.

Further supporting information:

Do I have to take part? Please remember that participation in this study is entirely voluntary. It is up to you to decide whether you would like to take part or not and if you decide to take part you are free to leave the study at any time without giving a reason as to why you wish to do so. If you do decide to participate in this study you will be asked to sign a consent form before you start. You will be given a copy of the consent form and this information sheet for your own records.

Are my results confidential? If you consent to take part in this study you have a right to privacy. Your name will be linked to an ID number on a password protected database and only these IDs will be used as labels during data analysis.

What will happen to the results of this study? The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University will endeavour to be transparent about its processing of your personal data and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing dataprotection@exeter.ac.uk or at www.exeter.ac.uk/dataprotection.

Any information that is obtained with this study will remain confidential and will only be disclosed with permission by the participant. Upon completion of the study, the data collected will be securely stored in such a way that only the researchers involved in this investigation will be able to gain access to it. Results of this project may be published but any data included will in no way be linked to any specific participant.

Who has reviewed this study? All research activity at the University of Exeter is examined and approved by an ethics committee to protect your interests. This study has been approved by the Ethics Committee of Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter.

Contacts for further information. If you would like more information or if you have any further questions about the study please contact the investigators using the details below. The Senior Academics for this study are Dr Jones and Dr Wilson and their contact information can also be utilized if you are not happy with any aspect of the study and wish to complain.

K. Bradford Cooper – Bcooper@USCorporateWellness.com

Dr Martin I. Jones - M.I.Jones@exeter.ac.uk

Dr Mark Wilson - Mark.Wilson@exeter.ac.uk

School of Sport and Health Sciences - St. Luke's Campus

Exeter University

Appendix L: Email/Facebook script for participant recruitment (Study III)

Sample email script:

Hello _____ (name),

Are you interested in how your sleep influences your daily actions and response to challenges in your life? Would you be willing to track some basic information for 20 days over four weeks and adjust your sleep up or down during 10 of those days? Please note – this isn't a "test" of mental toughness and you don't have to "survive" anything beyond the sleep schedule adjustments. You'll simply complete a brief self-assessment about your day and how you perceived your own mental toughness when addressing personal challenges you faced that day along with tracking your time in bed. Then on 5 days (Sunday night through Thursday night) of weeks two and four, you'll either increase (to 9 hrs) or decrease (to 5 hours) your time in bed and track the same self-assessments.

If you're interested in participating, please click here [Link], fill out the basic details and then you'll receive an email link in the coming days to complete. Thank you for your interest and please feel free to share this opportunity for participation with others.

You can contact me anytime with any questions at
BCooper@USCorporateWellness.com

Sample Facebook script:

Are you interested in how your sleep influences your daily actions and response to challenges in your life? Would you be willing to track some basic information for 20 days over four weeks and adjust your sleep up or down during 10 of those days? Please note – this isn't a "test" of mental toughness and you don't have to "survive" anything beyond the sleep schedule adjustments. You'll simply complete a brief self-assessment about your day and how you perceived your own mental toughness when addressing personal challenges you faced that day along with tracking your time in bed. Then on 5 days (Sunday night through Thursday night) of weeks two and four, you'll either increase (to 9 hrs) or decrease (to 5 hours) your time in bed and track the same self-assessments.
If you're interested in participating, please click here [Link], fill out the basic details and then you'll receive an email link in the coming days to complete. Thank you for your interest and please feel free to share this opportunity for participation with others.

You can contact me anytime with any questions at

BCooper@USCorporateWellness.com

Appendix M: Richards-Campbell Sleep Questionnaire (RCSQ)

The following will be completed once by each participant. Scoring for each question ranges from 0 to 100, as noted.

(Hoey et al., 2014)

1. **Sleep depth:** My sleep last night was: light sleep (0) ... deep sleep (100)
2. **Sleep latency:** Last night, the first time I got to sleep, I: just never could fall asleep (0) ... fell asleep almost immediately (100)
3. **Awakenings:** Last night, I was: awake all night long (0) ... awake very little (100)
4. **Returning to sleep:** Last night, when I woke up or was awakened, I: couldn't get back to sleep (0) ... got back to sleep immediately (100)
5. **Sleep quality:** I would describe my sleep last night as: a bad night's sleep (0) ... a good night's sleep (100)

Appendix N: Borg RPE Scale for overall run

Score	Level of exertion
6	No exertion at all
7	
7.5	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Borg GA . Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982;14:377–381.

Appendix O: Mental Toughness Index (MTI) – modified to be specific to mental toughness during the just-completed 800M run being assessed by the participant

A visual analogue scale may be used for ease of completion by athlete immediately after run is completed.

(Gucciardi et al., 2015c)

Using the scale below, please indicate how true each of the following statements is an indication of how you thought, felt and behaved in reference to your 800M run. *Remember there are no right or wrong answers – you <u>are not being compared to or ranked</u> with others, so please consider your own level of mental toughness today – in <u>comparison to your own typical level of mental toughness</u> (and not compared to others in any way). Be as honest as possible about your own personal response to the events you faced/experienced today.*

1 2 3 4 5 6 7
100% False 100% True

		100% False Today						100% True Today
	Compared to my <u>optimal</u> response, during today's session…							
1	I believed in my ability to achieve my goals throughout 800m	1	2	3	4	5	6	7
2	I regulated my focus throughout the 800m	1	2	3	4	5	6	7
3	I overcame any adversity that occurred throughout the 800m	1	2	3	4	5	6	7
4	I strove for continued success throughout the 800m	1	2	3	4	5	6	7
5	I found a positive side throughout the 800m	1	2	3	4	5	6	7
6	I used my emotions to perform the way I wanted throughout the 800m	1	2	3	4	5	6	7
7	I was able to execute appropriate skills or knowledge when challenged throughout the 800m	1	2	3	4	5	6	7
8	I effectively executed my knowledge of what was required to achieve my goals throughout the 800m	1	2	3	4	5	6	7

Appendix P: Consent form (Study IV)

Participant Identification Number:

Title of Project: *Does a self-talk intervention influence mental toughness & endurance performance?* Researcher: K. Bradford Cooper Please initial box

I confirm that I have read the information sheet dated 15/04/2019 Version 1.0 for the above project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my legal rights being affected. ☐

I understand that relevant sections of the data collected during the study may be looked at by members of research team and individuals from the University of Exeter where it is relevant to my taking part in this research. I give permission for these individuals to access my records. ☐

I understand taking part involves completing an 800 meter full effort run on 11-13 separate occasions, separated by at least 2 days over a 5-7 week period. I understand I will complete various brief questionnaires and discuss my experience of run with researcher on each occasion ☐

I understand that I will receive an individualized mental skills coaching programme. ☐

I understand that my data will be used for purposes of reports published in an academic publication, public engagement and other activities involving research materials and outcomes ☐

I agree that my contact details can be kept securely and used by researchers from the research team to contact me about future research projects ☐

I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of researcher	Date	Signature

Appendix Q: Participant Information Sheet (Study IV)

Title of Project: *Does a self-talk intervention influence mental toughness & endurance performance?*

Lead researcher name: K. Bradford Cooper

Invitation and brief summary: You are being invited to take part in a research study investigating whether a specific coaching strategy is correlated with the results of a self-scored mental toughness index assessment related related to an 800 meter run session. Taking part in the study is entirely up to you so before you decide, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information and to discuss it with other people to decide whether you wish to take part or not. Thank you for taking the time to read this information.

Purpose of the research: The proposed research study is being undertaken as part of a dissertation that is a requirement of a PhD pursuit. While there has been a lot of research in the past twenty years on the influence of thoughts, emotions and behaviours on performance, the effect of specific coaching strategies on how an individual feels and performs is less well understood. The aim of this study is to research the answer to these questions.

Why have I been approached? Either one of the researchers or someone in contact with you felt you have the background and interest that would make you eligible and interested in participating in this study. What types of participants are needed? We are looking for individuals 18 years of age and older, from all walks of life and backgrounds and fit a brief list of other exclusion/inclusion criteria noted below.

What would taking part involve? Participants will meet the lead researcher at a local running track up to 13 times over a 5-7 week period. After a self-selected warm-up, they will complete an 800 meter run at the individual's fastest possible speed. Immediately

following the session, participants will complete a brief series of self-assessments (approximately 5 minutes).

Leading into 4 of the sessions, participants will receive a personalized mental skills coaching session. They will practice using these tools outside of the specific 800 meter sessions and then apply the training to the next session. The total time involved to complete the sessions over the five to seven weeks is expected to be less than 250 minutes (just over 4 hours spread across five to seven weeks) plus travel time. Participants will be asked to reduce their training intensity in the 36 hours prior to each session, but are welcome to continue their standard run training.

What are the possible benefits of taking part? Will I receive any payment for taking part? The main benefits of the proposed research are to help advance the field of research regarding key coaching strategies and indicators. While you will not receive payment for your participation, you will receive personalized and customized one-on-one sports mental coaching that you can then apply to your broader run training and personal pursuits at no cost to you. In addition, the process of being involved in the study will likely provide you with additional personal insights about your own mental toughness and also help you identify beneficial discoveries. You will also have the option of receiving a link to the research study if it is published in a peer reviewed professional journal.

What are the possible disadvantages and risks of taking part? There is a consistent time commitment involved, as well as a commitment to completing the regular 800 meter sessions at your highest sustainable effort level (physical discomfort).

What will happen if I don't want to carry on with the study? Please remember that participation in this study is entirely voluntary. It is up to you to decide whether you would like to take part or not and if you decide to take part you are free to leave the study at any time without giving a reason as to why you wish to do so. If you do decide

to participate in this study you will be asked to sign a consent form before you start. You will be given a copy of the consent form and this information sheet for your own records.

How will my information be kept confidential? If you consent to take part in this study you have a right to privacy. Your name will be linked to an ID number on a password protected database and only these IDs will be used as labels during data analysis.

What will happen to the results of this study? The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University will endeavour to be transparent about its processing of your personal data and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing dataprotection@exeter.ac.uk or at www.exeter.ac.uk/dataprotection

Any information that is obtained with this study will remain confidential and will only be disclosed with permission by the participant. Upon completion of the study, the data collected will be securely stored in such a way that only the researchers involved in this investigation will be able to gain access to it. Results of this project may be published but any data included will in no way be linked to any specific participant.

Who is organizing and funding this study? This study is being organized by K. Bradford Cooper, a PhD candidate at the University of Exeter. Funding is being provided internally.

Who has reviewed this study? All research activity at the University of Exeter is examined and approved by an ethics committee to protect your interests. This study has

been approved by the Ethics Committee of Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter.

Contacts for further information. If you would like more information or if you have any further questions about the study please contact the investigators using the details below. The Senior Academics for this study are Dr Jones and Dr Wilson and their contact information can also be utilized if you are not happy with any aspect of the study and wish to complain.

K. Bradford Cooper – Bcooper@USCorporateWellness.com

Dr Martin I. Jones - M.I.Jones@exeter.ac.uk

Dr Mark Wilson - Mark.Wilson@exeter.ac.uk

School of Sport and Health Sciences - St. Luke's Campus

Gail Seymour, Research Ethics and Governance Manager

g.m.seymour@exeter.ac.uk, 01392 726621

Exeter University

Thank you for your interest in this project.

Appendix R: Email/Facebook script for participant recruitment (Study IV)

Sample email script:

Hello _____ (name),

Are you interested in discovering how your thoughts, emotions and behaviours influence your outcomes when running and racing? Would you be willing to commit to a consistent schedule of brief track sessions and sports mental coaching over a 5-7 week period?

Please note – everything will remain confidential, but you'll receive personalized, one-on-one coaching that will be specific to you and your tendencies – completely free of charge to you. During the process, you'll complete some brief assessments and receive feedback on your progress.

If you're interested in participating, please click here [Link], fill out the application to be considered. If selected as one of the participants, you'll receive an invitation to schedule the initial session and other information in the coming week. Thank you for your interest and please feel free to share this opportunity for participation with others.

You can contact me anytime with any questions at BCooper@USCorporateWellness.com

Sample Facebook script:

Are you interested in discovering how your thoughts, emotions and behaviours influence your outcomes when running and racing? Would you be willing to commit to a consistent schedule of brief track sessions and sports mental coaching over a 5-7 week period? Please note – everything will remain confidential, but you'll receive personalized, one-on-one coaching that will be specific to you and your tendencies – completely free of charge to you. During the process, you'll complete some brief assessments and receive feedback on your progress.
If you're interested in participating, please click here [Link], fill out the application to be considered. If selected as one of the participants, you'll receive an invitation to schedule the initial session and other information in the coming week. Thank you for your interest and please feel free to share this opportunity for participation with others. You can contact me anytime with any questions at BCooper@USCorporateWellness.com

Appendix S: Additional Post-session Data Collection (Study IV)

The following will be collected by the lead researcher at the completion of each session in addition to the various items noted above

1 – **Initial onset of desire to reduce effort**: This will be identified by the participant utilizing a miniature index finger stopwatch. It will be started at the start of the run and clicked when the participant identifies a sensation of "a strong desire to slow down."

2 – **Total time**: Researcher will record a total time it takes participant to complete the 800 meter run during each session.

3 – **Perceived performance**: While being blinded to actual time, how would individual rate their performance on a 0 to 10 scale, with 0 being worst imaginable performance and 10 being best imaginable performance.

Appendix T: Test of Performance Strategy (TOPS) Assessment (Study IV)

(Completed as part of the preliminary screening data to select participants)

Directions: Each of the following items describes a specific situation that you may have encountered in your training and competition. Think back on your training and racing, read each statement, and circle the appropriate number to the right of the statement to indicate how you usually felt.

Rate each one from 1 – 5 with 1 = Never 2 = Rarely 3 = Sometimes 4 = Often 5 = Always

1. I set realistic but challenging goals for practice. 1 2 3 4 5

2. I say things to myself to help my practice performance. 1 2 3 4 5

3. During practice, I visualize successful past performances. 1 2 3 4 5

4. My attention wanders while I am training. 1 2 3 4 5

5. I practice using relaxation techniques at workouts. 1 2 3 4 5

6. I practice a way to relax. 1 2 3 4 5

7. During competition, I set specific result goals for myself. 1 2 3 4 5

8. When the pressure is on at competitions, I know how to relax. 1 2 3 4 5

9. My self-talk during competition is negative. 1 2 3 4 5

10. During practice, I don't think about performing much – I just let it happen. 1 2 3 4 5

11. I perform at competitions without consciously thinking about it. 1 2 3 4 5

12. I rehearse my performance in my mind before practice. 1 2 3 4 5

13. I can raise my energy level at competitions when necessary. 1 2 3 4 5

14. During competition, I have thoughts of failure. 1 2 3 4 5

15. I use practice time to work on my relaxation technique. 1 2 3 4 5

16. I manage my self-talk effectively during practice. 1 2 3 4 5

17. I am able to relax if I get too nervous at a competition. 1 2 3 4 5

18. I visualize my competition going exactly the way I want it to go. 1 2 3 4 5

19. I am able to control distracting thoughts when I am training. 1 2 3 4 5

20. I get frustrated and emotionally upset when practice does not go well. 1 2 3 4 5

21. I have specific cue words or phrases that I say to myself to help my performance during competition. 1 2 3 4 5

22. I evaluate whether I achieve MY competition goals. 1 2 3 4 5

23. During practice, MY movements and skills just seem to flow naturally from one to another.

25. When I need to, I can relax myself at competitions to get ready to perform. 1 2 3 4 5

26. I set very specific goals for competition. 1 2 3 4 5

27. I relax myself at practice to get ready. 1 2 3 4 5

28. I psych myself up at competitions to get ready to perform. 1 2 3 4 5

29. At practice, I can allow the whole skill or movement to happen naturally without concentrating on each part of the skill. 1 2 3 4 5

30. During competition, I perform on 'automatic pilot'. 1 2 3 4 5

31. When something upsets me during a competition, my performance suffers. 1 2 3 4 5

32. I keep my thoughts positive during competitions. 1 2 3 4 5

33. I say things to myself to help my competitive performance. 1 2 3 4 5

34. At competitions, I rehearse the feel of my performance in my imagination. 1 2 3 4 5

35. I practice a way to energize myself. 1 2 3 4 5

36. I manage my self-talk effectively during competition. 1 2 3 4 5

37. I set goals to help me use practice time effectively. 1 2 3 4 5

38. I have trouble energizing myself if I feel sluggish during practice. 1 2 3 4 5

39. When things are going poorly in practice, I stay in control of myself emotionally. 1 2 3 4 5

40. I do what needs to be done to get psyched up for competitions. 1 2 3 4 5

41. During competition, I don't think about performing much - I just let it happen. 1 2 3 4 5

42. At practice, when I visualize my performance, I imagine what it will feel like. 1 2 3 4 5

43. I find it difficult to relax when I am too tense at competitions. 1 2 3 4 5

44. I have difficulty increasing my energy level during workouts. 1 2 3 4 5

45. During practice, I focus my attention effectively. 1 2 3 4 5

46. I set personal performance goals for a competition. 1 2 3 4 5

47. I motivate myself to train through positive self-talk. 1 2 3 4 5

48. During practice, sessions I just seem to be in a flow. 1 2 3 4 5

49. I practice energizing myself during training sessions. 1 2 3 4 5

50. I have trouble maintaining my concentration during long practices. 1 2 3 4 5

51. I talk positively to myself to get the most out of practice. 1 2 3 4 5

52. I can increase my energy to just the right level for competitions. 1 2 3 4 5

53. I have very specific goals for practice. 1 2 3 4 5

54. During competition, I play/perform instinctively with little conscious effort. 1 2 3 4 5

55. I imagine my competitive routine before I do it at a competition. 1 2 3 4 5

56. I imagine screwing up during a competition. 1 2 3 4 5

57. I talk positively to myself to get the most out of competitions. 1 2 3 4 5

58. I don't set goals for practices, I just go out and do it. 1 2 3 4 5

59. I rehearse my performance in my mind and at competitions. 1 2 3 4 5

60. I have trouble controlling my emotions when things are not going well at practice. 1 2 3 4 5

61. When I perform poorly in practice, I lose my focus. 1 2 3 4 5

62. My emotions keep me from performing my best at competitions. 1 2 3 4 5

63. My emotions get out of control under the pressure of competition. 1 2 3 4 5

64. At practice, when I visualize my performance, I imagine watching myself as if on a video replay. 1 2 3 4 5

Appendix U: Self-talk Scripts During Intervention Sessions (Study IV)

P1

- Session 1:
    - 0-200M Smooth & Fast
    - 200-400 There you are! (pain welcomed)
    - 400-600 Dad's words
    - 600-800 Countdown and Launch!
- Session 2:
    - 0-200M Smooth & Fast
    - 200-420 Embrace
    - 420-650 Model it for son
    - 650-800 Countdown and Launch!
- Session 3:
    - 0-200M Smooth & Fast
    - 200-420 Embrace
    - 400-600 You got this!
    - 600-800 Countdown and Launch!
- Session 4:
    - 0-300M Smooth & Fast
    - 300-450 Embrace
    - 450-550 You got this!/Dad
    - 550-680 Counting
    - 680-800 You're there - Launch!

P2

- Session 1:

    - 0-200M Smooth & Fast
    - 200-400 Purposefully Uncomfortable
    - 400-600 Get It!
    - 600-800 Countdown and Launch!
- Session 2:
    - 0-200M Smooth & Fast
    - 200-400 Uncomfortably Good
    - 400-600 Get It!
    - 600-800 Countdown from 50 and Launch!
- Session 3:
    - 0-200M Smooth & Fast
    - 200-400 Uncomfortably Good
    - 400-600 Get It!
    - 600-800 Check – Go – Launch!
- Session 4:
    - 0-250M Smooth & Fast
    - 200-500 Purposefully Uncomfortable
    - 500-700 Get It!/ Check-Go
    - 700-800 Launch!

P3

- Session 1:
    - 0-250M Fast & Smooth
    - 250-410 Embrace – “there you are!”
    - 410-500 Open the gift
    - 500-670 Embrace

    - 670-800 Countdown from 50 and Launch!

- Session 2:
    - 0-200M Smooth & Fast (switched order from “Fast & Smooth”)
    - 200-410 Embrace – “there you are!”
    - 410-670 Give yourself a chance
    - 670-800 Countdown and Launch!
- Session 3:
    - 0-200M Smooth & Fast
    - 200-400 Welcome the pain
    - 400-600 Give yourself a chance
    - 600-800 Countdown and Launch!
- Session 4:
    - 0-200M Smooth & Fast
    - 200-400 Embrace/welcome pain
    - 400-600 Now!/Keep going (back and forth)
    - 600-800 Countdown and Launch!

Appendix V: 800 Meter Runner Study Data (Study IV)

	Session	Type	Perceived Performance	Urge to slow	RPE	MTI	Finish time in seconds	200/400/600/800 splits in seconds
P1	1	Baseline	16	55	19	18	271.80	57.68/67.77/72.86/73.48
	2	Baseline	21	55	18	21	262.66	57.19/66.61/68.88/69.93
	3	Baseline	25	65	18	19	263.06	60/66.6/68.81/67.63
	4	Baseline	5	66	18	19	255.30	57.31/65.56/67.53/64.91
	5	Intervent	28	45	18	36	235.50	50.07/59.26/63.34/62.81
	6	Intervent	58	64	17	37	233.50	52.45/58.30/62.02/60.69
	7	Intervent	74	112	17	40	231.10	52.02/56.31/60.85/61.87
	8	Intervent	76	130	18	47	230.00	52.27/56.87/60.86/59.97
	9	Follow	76	175	17	47	226.52	51.62/55.64/61.13/58.13
	10	Follow	92	179	19	50	229.79	52.35/56.95/61.84/58.69
	11	Follow	83	75	20	55	229.07	49.77/55.47/62.86/60.96
P2	1	Baseline	31	27	16	37	196.30	42.91/48.12/52.15/53.12
	2	Baseline	63	37	15	37	198.90	45.02/50.52/50.55/52.78
	3	Baseline	43	39	17	38	202.40	45.88/50.17/51.97/54.35
	4	Baseline	61	35	16	37	202.60	48.05/50.79/51.24/52.50
	5	Baseline	57	27	18	42	203.40	48.39/49.44/52.14/53.39
	6	Intervent	83	42	19	49	188.90	45.22/44.12/53.05/46.46
	7	Intervent	80	43	20	53	183.96	40.94/44.63/48.99/49.38
	8	Intervent	86	135	20	54	180.97	39.31/44.57/48.69/48.40
	9	Intervent	79	179	19	54	178.51	39.94/43.24/48.61/46.70
	10	Follow	82	179	19	56	179.28	40.08/44.32/47.24/47.63
	11	Follow	85	179	20	56	179.10	41.98/44.42/46.50/46.19
	12	Follow	85	182	19	53	182.76	42.03/45.67/47.56/47.48
P3	1	Baseline	41	58	14	39	200.40	43/48/55/54
	2	Baseline	32	69	14	25	203.80	45.4/50.1/52.75/55.52
	3	Baseline	49	87	14	33	201.70	45.53/49.59/52.57/53.96
	4	Baseline	11	57	14	19	209.70	47.50/50.29/53.25/58.88
	5	Baseline	52	102	14	29	205.50	50/52/53/50.5
	6	Baseline	23	111	13	30	207.80	49.08/51.25/54.34/53.09
	7	Intervent	58	67	15	40	190.70	40.41/46.24/51.97/52.04
	8	Intervent	59	70	15	32	194.00	42.85/47.88/50.99/52.81
	9	Intervent	70	120	17	40	193.00	45.89/44.42/54.15/48.50
	10	Intervent	84	110	18	49	189.45	43.37/47.32/49.69/49.05
	11	Follow	72	91	15	44	193.74	44.38/47.88/51.24/50.32
	12	Follow	71	92	17	42	194.70	43.06/47.65/52.08/51.90
	13	Follow	83	67	18	51	193.50	45.8/47.7/51.29/48.72

Appendix W: Ethics Approval Certificates

Study II Certificate

College of Life and Environmental Sciences
SPORT AND HEALTH SCIENCES

St. Luke's Campus
University of Exeter
Heavitree Road
Exeter
EX1 2LU
United Kingdom

Certificate of Ethical Approval

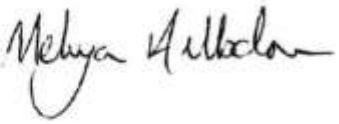
Proposal Ref No: 171206/A/02

Title: An exploration of the within-person variability of mental toughness across a 30-day training cycle within masters level runners

Applicants: Brad Cooper (PhD Student), Dr Martin Jones, Professor Mark Wilson

The proposal was reviewed by a Representative on the Committee.

Decision: This proposal has been approved until March 2018

Signature:  Date: 22/11/2017

Name/Title of Ethics Committee Reviewer: Dr Melvyn Hillsdon

Your attention is drawn to the attached paper which reminds the researcher of information that needs to be observed when Ethics Committee approval is given.

Study III Certificate

College of Life and Environmental Sciences
SPORT AND HEALTH SCIENCES

St. Luke's Campus
University of Exeter
Heavitree Road
Exeter
EX1 2LU
United Kingdom

Certificate of Ethical Approval

Proposal Ref No: 180910/A/01

Title: An exploration of the association between sleep and mental toughness

Applicants: Bradley Cooper, Martin Jones, Mark Wilson

The proposal was reviewed by a Representative on the Committee.

Decision: This proposal has been approved until 25-12-18

Signature:  Date: 20-9-18

Name/Title of Ethics Committee Reviewer: Dr Melvyn Hillsdon

Your attention is drawn to the attached paper which reminds the researcher of information that needs to be observed when Ethics Committee approval is given.

Study IV Certificate

College of Life and Environmental Sciences
SPORT AND HEALTH SCIENCES

St. Luke's Campus
University of Exeter
Heavitree Road
Exeter
EX1 2LU
United Kingdom

Certificate of Ethical Approval

Proposal Ref No: 190506/A/01

Title: Does a self-talk intervention influence mental toughness and endurance performance?

Applicants: Brad Cooper, Martin Jones, Mark Wilson

The proposal was reviewed by a Representative on the Committee.

Decision: This proposal has been approved until 15/04/2020

Signature:  Date: 17/04/2019

Name/Title of Ethics Committee Reviewer: Dr Melvyn Hillsdon

Your attention is drawn to the attached paper which reminds the researcher of information that needs to be observed when Ethics Committee approval is given.