Skin in the Game: A multimethod exploration of the impact of social support on wound healing rate in sport.

by

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Abstract

Injury occurrence is associated with a range of emotional, performance, and economic costs in sport and understanding how athletes may recover from injury more quickly is of interest to multiple stakeholders. The aim of this thesis was to contribute to what is known about the outcomes of social support on injury-healing in sport, using multiple methods to inform this understanding. Initially, a narrative and scoping review informed the design and execution of 3 empirical studies, namely (1) a cross-sectional study (n=51) exploring the influence of biopsychosocial variables (daily stress, perceived social support, heart rate variability) on would healing (trans-epidermal water loss), (2), an online group intervention (n=65) designed to enhance perceived social support, and (3) a single-subject design with a female CrossFit athlete using a counselling-based intervention to examine the influence of social support on wound healing. These empirical studies are supported by a reflective confessional tale, to shape further study of social support in sport. Broadly, results suggested that (1) social support is associated with beneficial rehabilitation outcomes (chapters 2, 3, 7), (2) social support may have a positive impact on the autonomic nervous system implicated in wound healing (chapters 2, 4, 7), (3) that emotional support (but not informational support, tangible support) could moderate the stress and water loss relationship (chapter 4), (4) that an online psycho-education session could enhance perceived emotional support in the participant population (Chapter 6), (5) that all areas of social support could be improved with a counselling intervention and that healing rate and heart rate variability can be positively increased by increasing social support (chapter 7). Future research could consider the framework of Polyvagal Theory and particularly the social engagement theory, to further generate

experimental research, and develop understanding and application in this domain of inquiry.

Key words: social support, healing, recovery, stress, heart rate variability, psychoeducation, counselling.

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1. Introduction

Sport forms an important part of society and refers to 'all forms of physical activity which, through casual or organised participation, aimed at expressing or improving physical fitness, mental well-being and forming social relationship' (Council of Europe, 2001). Sport is a global social phenomenon (Milanovic et al., 2015) and can be used as a way of solving social issues and to help people meet their social goals or needs (Milanovic et al., 2015). Amateur sport is seen as a lower-level way of meeting fundamental physical and psychological needs whilst professional sport is focussed far more on developing high levels of performance and significant financial profit (Milanovic, 2004). As mentioned, sport is highly social and rarely participated in isolation, and this social engagement has been shown to be beneficial for sport participation (Ingledew & Markland, 2006; Marland & Ingledew, 2007). For example, sport has been shown to increase social capital, (Uslaner, 1999) help with social integration (Bryant, Bradley, & Milbourne, 1994), improve socialisation (Wankel & Berger, 1990), enhance social and emotional development (Astin, 1984), and help in developing teamwork (Barcelona, 2002).

Although there are many social benefits associated with sport participation there are unfortunately some negative experiences. Sport regularly puts individuals under physical and psychological stress, which can amplify the likelihood of a physical injury. Most athletes will experience an injury that will impede sport participation either temporarily or permanently (Ristolainen, 2011; Taylor & Taylor, 1997). To illustrate, research has found that 50% of all athletes examined have experienced a sport-related injury within a 12-month period (Konttinen, Mononen, Pihlaja Sipari, Arvinen-Barrow, & Selanne, 2011).

This prevalence of sport injury can present a significant cost to the health care system. For example, it is estimated that in England alone there are around 3.2 million sport injury related visits to emergency departments, which result in around 0.8 million hospital admissions (NHS information centre, 2012). In a study by Kendrick et al. (2013) which had 638 injured participants (with a variety of minor and moderate injuries), 169 participants between the age of 5 and 65 experienced injury whilst playing sport. Further this study found that of those people that were injured, 27 recovered after 1 month, 51 recovered after 4 months, and 57 took up to 12 months to recover, (it is not known what the recovery outcome was for the rest of the 169 participants). In addition to the prevalence of the injury, there is a level of cost associated with the length of recovery time. Overall, sport injuries are pervasive, and are impactful at individual and societal levels. Accordingly, one avenue for exploration could be how sports medicine professionals enhance the speed of recovery in sport injury.

To help sports medicine professionals understand how the speed of recovery can be enhanced, the biopsychosocial model of sport injury offers one framework to explain the psychosocial and physiological processes in sport injury (Brewer et al., 2002). The model states that there are psychological factors (e.g., personality, cognition, emotion, and behaviour), social factors (e.g., social networks, social support, life stress, cultural), and biological factors (e.g., endocrine system, neurochemistry, circulatory system, tissue repair, and immune system functioning) that can impact the biopsychological outcomes and in turn rehabilitation outcomes. Heart rate variability offers a potential way of exploring this link as it is a physiological process that has also been linked to the psychosocial processes in injury (Appelhans & Luecken, 2006). Those with low heart rate variability have been shown

to indicate early signs of tissue overload (Gisselman et al., 2016) and HRV plays a role in how the body responds to physical injury (Rio et al., 2014). This heart rate variability may provide an opportunity to more fully explore the link being physiological and psychology in injury rehabilitation. Furthermore, heart rate variability has been linked to social engagements through the social engagement system (Porges, 2007), which suggests that social engagements and social processes can influence physiological states and vice versa (Porges, 2007). Designing and understanding interventions that can enhance perceived social support and also demonstrate effectiveness as an aid to healing would be helpful for improving rehabilitation outcomes.

1.2 Aims of the thesis

The thesis seeks to address the preceding issues through the following aims:

1. To provide clarity on the current state of knowledge of psychophysiological stress (heart rate variability and psychological stress), social support, and the links with healing.
2. To explore links between time domains of heart rate variability, daily life stress, 4 sub-domains of social support (emotional, esteem, informational, and tangible support) and skin barrier disruptions healing.
3. To explore how an online social support psycho-education session impacts perceived social support among adult students.
4. To explore how a counselling-based intervention delivered by a Health Care Professions Council registered psychologist will impact time domains of heart

rate variability, daily life stress, 4 sub-domains of social support and healing from skin barrier disruption.

1.3 Thesis structure

Chapter 2 seeks to address objective 1 by reviewing the concepts of social support in relation to sporting injury. This will be achieved firstly by exploring sporting injury and identifying where social support fits into models of sport injury. Once the scene of sport injury has been set, chapter 2 seeks to address whether social support can buffer stress, and to identify the types, sources, and mechanisms of social support. Once the psychological approach has been considered, a psychophysiological standpoint is then taken to explore how stress impacts the body, exploring heart rate variability and how it can be affected by stress. The body's healing systems are briefly described and a discussion around how stress, social support and healing aids to conclude this second chapter. Chapter 4 aims to provide some context to the following 3 chapters by exploring key methodological and philosophical standpoints that are used to guide decision making through this program of work. The chapter explores the researcher's philosophical paradigm, where this program of work fits in the performance and well-being continuums and gives a rationale for the sample and sampling methodology used throughout the research. Chapter 2 provides a systematic and critical narrative review of the stress, healing, and social support literature seeking to understand how social support has been shown to improve recovery outcomes and reduce recovery time in athletes and the medical fields. Using an empirical cross-sectional design, Chapter 5 seeks to explore how social support may have a moderating effect on the stress and healing relationship aiming to address objective 2. Chapters 6 and 7 seek to address objective 4. Chapter 6 uses an online

group-based, pre-recorded psycho-education session aimed at increasing perceived emotional, esteem, tangible, and informational support in university sport science students. Chapter 7 aims to further explore interventions aimed at increasing social support by providing a 4-session counselling-based intervention designed to increase perceived emotional, esteem, tangible, and informational support to a single CrossFit athlete. Chapter 8 provides a confessional tale of the lessons learned throughout the PhD and examines the developments in learning that occurred. Finally, chapter 9 reviews the thesis as a whole and addresses the key results and discussions, the strengths and limitations of the thesis, the applied implications that have arisen from the program and finally some suggestions for further exploration of the impact of social support on the stress and healing relationship. This is illustrated in figure 1 below.

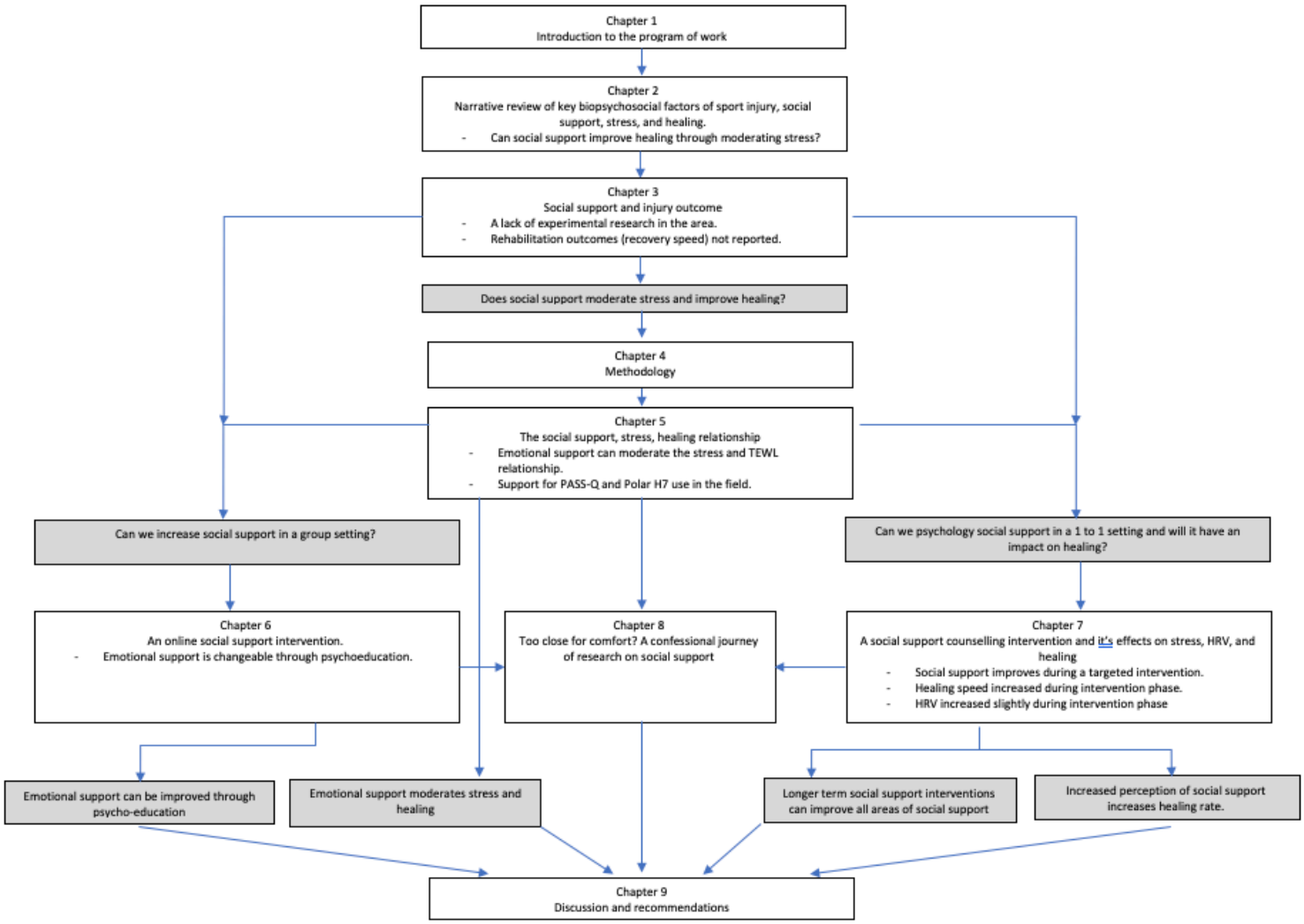

Figure 1: Thesis flow diagram. An overview of the thesis structure, arrows show how chapters build on previous conclusions, shaded boxes are questions arising from chapters and conclusions drawn from previous chapters.

2. A narrative review of psychophysiological stress, healing, and social support

2.1 Chapter introduction

Given the aims identified in chapter 1, this chapter presents a narrative view of psychophysiological stress, healing and social support. To do this, the chapter is organised in the following way. First, an examination of the sport injury models and specifically the biopsychosocial models of sport injury. Second, a review of physiological processes of the autonomic nervous system, it's uses in social interaction, health and well-being, and the physiological components of healing. Third the chapter examines the psychological components of healing and rehabilitation, specifically stress. Fourth an exploration of the uses of social support as an intervention to moderate the stress and healing relationship is done, and finally links between these variables are presented.

2.2 Defining Injury

This section provides an overview of different types of injury, and their classification gestures toward an operational definition for this thesis. There is limited agreement as to what may define an injury (Arvinen Barrow & Walker, 2013), and injuries can be classified in a number of ways. Typically, injuries are discussed in terms of their theoretical and operational terms (Verhagen & Van Melchelen, 2010). The international Olympic Committee manual of sport injury (2012) defines an injury as '*damage to the tissue of the body that occurs as a result of sport or exercise'*. However, this definition does not provide much in the way of information when it comes to what an injury is and thus it is useful to understand how injuries are

classified before studying them in more detail. Classification of injuries can be based on the length of onset time it takes for a specific tissue to become injured, the tissue type (skin, bone, muscle tissue etc.) that is affected, how severe the injury is, and which kind of injury (burn, laceration, graze, fracture) the person presents with (Verhagen & Van Melchelen, 2010). Sport injuries can be broken down into acute injuries (e.g. lacerations, abrasions, fractures etc.) and overuse injuries (e.g. blisters, callus, delayed onset muscle soreness etc.) (Brukner & Kahn, 2012).

In addition to the type of injury, the mechanism of injury can be broken down into direct or contact injury where there is an external force (such as a collision in rugby) that causes the injury, or an indirect or non-contact injury where there is no object or other person who has played a part in the injury (such as an injury as a result of poor technique). A meta-analysis by Williams et al. (2013) analysed the types of injury found in professional rugby and showed that muscle and tendon injury were most prevalent at 40 per 1000 player hours, joint and ligament injuries at 34 per 1000 player hours, followed by central or peripheral nervous system injuries at 8 per 1000 player hours, and fractures and bone stress injury at 4 per 1000 hours. Furthermore, laceration and skin related injuries at 1 per 1000 player hours. Like wounds, muscles go through a similar process of repair. Once injury has happened degeneration and inflammation occur at the muscle injury site. Lymphocytes then release growth factor, which triggers muscle regeneration, remodelling of the muscle fibres and connective tissue matures and finally thickening or scarring of the muscle tissues ensues depending on the severity of the injury (Huard et al., 2002). (see section 2.7 for elaboration)

2.3 Models of sport injury

Of the ways in which we can understand how psychosocial processes influence the injury process, various models have historically been proposed, including the stress-injury model (Williams & Anderson, 1998), the integrated model of sport injury (Wiese-Bjornstal et al., 1998), and the biopsychosocial model (Brewer et al., 2002).[1]

The stress-injury model (Williams & Anderson, 1998) states that there are various factors associated with predicting and preventing sport injury. Specifically, sport injury is posited to be influenced directly by the stress response (comprised of cognitive appraisals and attentional change) with the stress response being shaped by the history of stressors, coping resources, personality characteristics and psychological interventions that are available to an athlete. This model is a good example of the buffering hypothesis whereby psychosocial characteristics (e.g. personality, coping resources, and interventions) buffer against the stress response (e.g. cognitive appraisals and attentional changes). The model suggests that interventions and coping resources are buffers of the cognitive appraisal which in turn decrease the risk of an injury occurring.

On the one hand there is some support for the Williams & Anderson (1998) model. Specifically, both Albinson & Petrie (2003) and Daly, Brewer, Van Taalte, Petipas, & Sklar (1995) have shown that negative appraisal has been associated with emotional disturbance and in turn with low adherence to rehabilitation plans. On the other hand, criticism exists around these models. For example, most practitioners believe appraisal to be far more complex than these models suggest (Johnston& Carroll, 1998). To illustrate, Walker (2006) found additional appraisals include 'god's

[1] It is acknowledged that since the inception of the PhD the Multilevel Model of Sport Injury has been developed by Wadey et al. (2018). The strength of this model appears to be it's connection of injury to broader society and political levels however, similar to the stress-injury model and integrated-models the influence of the biological factors associated with sport injury are largely overlooked.

plan', coaching perspectives, as well as appraisals about causes and implications of injury.

Based largely on these limitations, Weise-Bjornstal *et al.* (1998) proposed an integrated model of the psychological response to sport injury and rehabilitation process. This model also addresses the whole psychological process from pre-injury, appraisal through to post injury recovery outcomes. The model can be divided into three sections: (1) the stress response section (pre-injury), (2) the appraisal and response section (post injury), and (3) the recovery outcome section (also known as the cyclical core) of the model.

With regards to (1), the pre-injury factors of the stress response are those proposed by Anderson & Williams' (1988). The middle section of the model, (2) aims to develop the appraisal and stress response theme further by elaborating on the personal factors (e.g. family, history of injury and individual differences), the situation factors (e.g. the sport, social influences including social support and environmental factors), behavioural responses and emotional responses to injury. The relationship between these areas of the model is known as the cyclical core (3), resulting in an outcome either being positive (effective return to sport) or negative (longer rehabilitation, re-injury or retirement from sport).

Several studies provide support for the Wiese-Bjornsal (1998) model. Support has been found for the personal and situational factors, the injury history, severity, type, perceived cause, a recovery status, all of the sport characteristics except scholarship status, the cognitive appraisal, emotions and behavioural responses involved in the response to sport injury (Walker, 2006: Grindstaff, Wrisberg, & Ross, 2010). In addition, Arvinen-Barrow, Hemmings, Weigand, Becker, & Booth (2007)

found support for the dynamic core of the model which suggests a positive outlook has a positive outcome.

Alongside this empirical support some limitations have been identified. Specifically, Walker, *et al*. (2007) critiqued the dynamic core, suggesting the relationship is more complicated than the model suggests. This complexity is borne out by research suggesting that (1) behaviours directly influence emotional responses, (2) the emotion responses influence appraisals, (3) emotion responses require a further reappraisal before having an impact on psychosocial outcomes and (4) these emotional response appear to have no direct effect on recovery (Walker et al., 2007). Thus, a cyclical approach to the relationship between appraisal, emotion, behaviour and outcome posited in the model is more complicated than proposed.

Weise-Bjornstal (2010) more recently developed the biopsychosocial sport injury risk profile focussed specifically on risk factors for sport injury. The model suggests that internal, personal, and environmental variables can impact upon an athlete's risk of injury. These factors include biological factors (e.g., nutrition, fatigue and body composition), psychological factors (e.g., perfectionism, stress, coping, and risk behaviour), environmental factors (e.g., weather, medical support, sport type), and socio-cultural factors (e.g., social support, coaching quality, and organisational stress) can influence an athletes' risk of injury (Weise-Bjornstal, 2010). Johnson (2021) further reviews the current state of the psychosocial risk factors in sport injury, suggesting that personality factors including the relationship between trait anxiety (Sibold et al., 2011), trait irritability (Ivarsson & Johnson, 2010) and stress susceptibility (Ivarsson & Johnson, 2010) had a significate relationship with injury outcome. Finally, history of stressors such as high life stress (Steffen et al., 2009), daily hassles (Ivarsson et al., 2013), coping resources and social networks such as

social competence, environment, friends, family (Johnson, 2021) also have an impact on sport injury.

2.4 The Biopsychosocial approach to sport injury

Although there is a growing body of research directed towards the integrated model of sport-injury, arguably the main limitation is the lack of consideration given to the biological and physiological influences in injury rehabilitation and outcome.

Brewer *et al.* (2002) proposed the biopsychosocial model as a more parsimonious and comprehensive model of sport injury rehabilitation. This model draws upon similar approaches used by other healthcare professionals (physiotherapists); and suggests that all health and injuries are explained by the interaction between the biological, psychological and social factors that contribute towards them. This model posits that injury characteristics (e.g. type, cause, and location of injury, etc.) and the sociodemographic factors (age and gender, etc.) influence the biological (sleep, circulation, and respiration, etc.), psychological (personality, cognition, affect, etc.) and the social factors interact to predict injury, and influence the rehabilitation outcomes. The strengths of this model show that the recovery from injury is a complex process involving biological, psychological and social aspects that are often dynamic (Anderson, 2007). Much of the research directly examining this model is limited, however support has been found for elements of it. Specifically, Brewer et al. (2002) found a relationship between the emotional reactions to injury and the outcomes of the rehabilitation. Anderson (2007) has examined the collaborative relationships in rehabilitation using the social/ contextual elements of the model, and finally Weise-Bjornstal (2009) advocated the use of a biopsychosocial approach to sport injury however did not explicitly reference the

biopsychosocial model in their original model. Both the cognitive appraisal models and the biopsychosocial models of sport injury described above have certain commonalities. One such commonality is the link between emotion and injury, specifically the link between life stress and emotion in both the integrated model (Weise-bjornstal, 1998) and the biopsychosocial model. In addition to the emotion and injury link, both models also specifically state the usefulness and importance of social relations when rehabilitating from sport injury.

There is currently a significant lack of experimental research in sport injury and much of the previous research has been qualitative or correlational in nature (Leadingham et al., 2020). Leadingham et al., (2020) has suggested there are a number of challenges that come with experimental research in injury specifically; 1) the use and identification of large sample sizes, 2) getting a solid baseline to allow for good comparisons to be made, and 3) the detail of the treatment protocols that are presented needs to be far greater than what is currently available in the literature.

2.5 Polyvagal Theory

This section draws upon Porges (1995, 2001, 2003, 2007, 2015, 2018, 2021) polyvagal theory, as a theoretical account which builds an understanding of *how* the bio-, psycho-, and social- facets described in the biopsychosocial model above may interlink to improve injury rehabilitation. Porges' (2018, 2021) polyvagal theory is an approach that has received a growing body of empirical work across a range of domains including, counselling psychology, clinical psychology, and trauma, and applications such as PTSD treatment, and yoga therapy. To review this work is beyond the boundaries of this thesis. Rather, the aim in this section is more modest, which is to (a) outline the central tenets of polyvagal theory, and (b) establish that one

regulatory mechanism (namely the autonomic system) is (i) associated with key psychological and social variables known to impact the injury process, and (ii) gestures towards a biomarker (heart rate variability) that is (theoretically, at least) associated with the speed of wound healing. The human nervous system is a fascinating and complex network of cells and transmitters that consist of the central nervous system, comprising of the spinal cord, brain stem, and brain, and a number of other major systems that control vision, hearing, touch, smell, and movement (Kiernan & Barr, 2009). The theory concerns one of the major regulatory systems, the autonomic nervous system (ANS). The ANS is composed of two distinctive divisions, the sympathetic and parasympathetic nervous system. Each of the systems are continuously active and to some degree input into body tissue at all times (McCorry, 2007). Each of these systems can either increase or decrease in activity depending on the frequency that neurons are discharged, thus activity can be either enhanced or inhibited (McCorry, 2007). These two systems have opposing effects on the body tissues whilst simultaneously decreasing the activity of the other system. For example, if the sympathetic nervous system is highly active firing neurons at a high frequency, then the parasympathetic nervous will be inhibited and show low levels of activity.

The sympathetic nervous system activity will prepare the body for physical activity by increasing blood flow, heart rate, and nutrient availability for muscle activation. Conversely the parasympathetic nervous system dominates during quiet rest aiming to conserve energy and regulate basic functions such as digestion and urination (McCorry, 2007). The ANS has evolved as social behaviours became more important to everyday life and is a major distinction from the more primitive reptilian behaviours (Porges, 2018). As mammals became more social and cooperative the

defensive mechanisms typically used by solitary reptiles needed to be down regulated to allow for a more meaningful social interaction.

2.5.1 Central tenets of Polyvagal theory.

Porges (2018) posits that there is a relationship between the autonomic state a person is in and defensive behaviours that they display. This idea is the basis for the fight or flight reaction in which either a fight or flight defensive response is chosen when there is a need to mobilise resources to evade a danger. The sympathetic nervous system is required to promote the activation of the fight or flight responses. There is however another more ancient defence system known as immobilisation adding the freeze element to the fight, flight, freeze response (Porges, 2018). This shutting down is a response from the parasympathetic nervous system and is completely in contrast to the activation of the sympathetic nervous system. The fight, flight, and freeze responses are extremely effective as a form of defense in all animals including humans, however as mammals became more sociable, cooperative, and began to rely on others, these responses became far less useful. Appraising a social interaction as a threat has a negative effect on the quality of the interaction. To deal with this problem a second vagal pathway evolved in the parasympathetic nervous system known as the social engagement system. This system allows mammals to regulate and co-regulate their psychological state, helps us to care for others, reproduce, and engage in cooperative behaviour.

Over the course of evolution, the cardiac vagal pathways integrated with the neural regulation of the face and head which allowed for the social engagement system to emerge (Porges, 2018). This neural pathway provides a functional system of engagement that co-ordinates regulation of the heart with the muscles in the face

and head. This neural system co-ordinates basic functions like sucking, swallowing, and breathing, and more complex functions like factual expression, tone of voice, and hearing frequency, all of which have been shown as useful for social communication (Porges, 2018: Kolacz, Lewis, & Porges, 2018). This system also has an influence on the facial nerves and is related to expression and experience of emotion (Porges, 2007). Activation in this instance would trigger changes to support social interaction such as listening, vocalization, and facial gestures, whereas inhibition may work to impede social engagement behaviour; for example, behaviour associated with the fight or flight response (Porges, 2007). Taking this one stage further the heart and face connection allows us to also detect physiological states in other people (Porges, 2018). For example, someone in a calm physiological state may be safe to approach, whereas someone in a highly active or mobilized state may be more dangerous to approach. One can signal safety through facial pattern and vocal tones, thus having better social interactions. The bi-directional nature of the heart-face connection where social interaction positively influence the ventral vagus, and the ventral vagus will influence social interaction. The sense of connectedness that is available due to the connection between the ventral vagus, para-sympathetic nervous system, and through the heart-face connection allows for social communication, co-regulation of interaction via reciprocal social engagement systems (e.g., I can help regulate someone else's ANS, and someone else can help me regulate my ANS).

There are 3 key organising principles of the polyvagal theory that can make the theory useful for the psychologist studying neuropsychology. This can offer an opportunity to understand the moment-to-moment need for safety and connectedness (Dana, 2020). The principles are the 1) autonomic hierarchy, 2) neuroception, and 3) co-regulation. The autonomic hierarchy describes how the ANS responds to the

moment-to-moment changes and needs to survive or be social. When a person is in a state of protection they are closed off to connection and change, and thus survival is the only goal, conversely when a person is in a state of connection via the social engagement system then health, growth, and restoration are possible. As previously discussed, the ANS is made up of two competing systems, 1) the parasympathetic and 2) sympathetic nervous system, with the parasympathetic nervous system being broken down further into the dorsal vagal (immobilization system) and the ventral vagal (the social engagement system). The autonomic hierarchy suggests that these systems are nested based upon the development through evolution with the dorsal vagal evolving first, then the sympathetic nervous system, and finally the ventral vagal on top. This meant that a hierarchy evolved with social engagement at the top and the more primitive freeze response or immobilisation at the bottom (Dana, 2020). When a person feels a sense of safety, the ventral vagus will be active and thus a person will be open to social engagement. The polyvagal theory goes further and suggests that the vagus nerve provides a link between the heart, face, and head allowing for regulation of hearing, speaking, eye contact, emotional expression, and connection with others. At times a person may experience stressful situations such as illness, injury, trauma, or psychological stress. These experiences would be beyond the capability of the ventral vagus (social engagement) and thus a person will move down the hierarchy (Dana, 2020). This downward trajectory would initiate a fight or flight response where the survival response is the primary goal. A person would experience either adrenaline and motion (fight/flight), or activity shutdown, disconnection, numbing, and dissociation from others and the environment (freeze).

The second organising principle is the idea of neuroception, or the ability to listen inside the body to what is happening with your nervous system. The polyvagal

theory proposed that humans can evaluate risk and safety without conscious awareness and this neural process is distinct from perception (Porges, 2021). The cues of threat and safety that are available in the environment allows us to down or upregulate defensive strategies without conscious thought and thus promote social interaction. The ability to use neuroception allows people to decode and interpret the goal of others, animals, or objects. The response is both top down (the brain interpreting cues of threat) and bottom up (bodily feelings, sensory information is interpreted). As with the hierarchy above, a neuroception of safety is completely incompatible with a neuroception of danger thus a person is either open to connection or locked in a survival strategy. A person would need to down-regulate their defense systems in order to activate the social engagement system (Porges, 2015).

The final organizing principle of the polyvagal theory is co-regulation. This term and the possibilities have been touched on before in terms of the social engagement system. Our ANS feels the need for connection with others and will send out signals through the face and voice or search for signals from others (Dana, 2020). Cacioppo & Cacioppo (2014) state that humans are social beings and that it is part of human nature of interact with, recognize, and develop relationships with other people. This sense of belonging is found in multiple psychological theories beyond the polyvagal theory (e.g., self-determination theory) which are beyond the scope of this review and the social support literature which will be discussed later in this chapter. When we attune to other people, we create what is known as an attuned dyad (relationship) which allows for a level of ANS synchrony. This synchrony allows for regulation of the autonomic nervous response. Within our parent-child relationships we experience these kinds of safe relationships and develop a capacity to self-regulate the ANS but also to co-regulate that will remain for our whole lifetime (Porges &

Furman, 2011). Our ANS is designed to help us navigate challenges in the daily life, we will search for cues of safety and danger, which will translate into patterns of protection of connection.

2.5.2 The autonomic system is associated with psychological and social variables impacting injury.

Of the psychological and social variables impacting sport injury, stress and social support are two of the most widely researched areas respectively (see sections 2.8 and 2.9 below for further elaborations on stress and social support). The aim here is to illustrate the evidence supporting polyvagal theory's contention that they each impact the autonomic system.

Polyvagal theory proposed that stress is due to the removal of the safety state and not a default state in itself. Stress is reflected in two specific defensive states that would aim to balance out the system and recreate safety (Porges, 2022). When defined through the lens of polyvagal theory, stress therefore is a measurable state that occurs when homeostatic neurophysiological states are disrupted. The onset of a stressor would trigger a threat state in the body and cause the autonomic nervous system to promote survival (Porges, 2022). The dorsal motor nucleus subsystem of the parasympathetic nervous system is an avoidance system, which usually results in behavioural immobilization in response to a stressor. The sympathetic nervous system is the mobilisation system that would be primarily responsible for fighting or action, thus safety seeking behaviours, and the ventral vagal is the social engagement system that creates a sense of connectedness to reduce the stress response (Doussard-rosevalt & Porges, 1999). The polyvagal theory like most theories of stress and coping distinguishes between acute and chronic stress. Short or acute stress followed by rapid

recovery is seen as a neural exercise that promotes resilience, meaning that exposure to stressors followed by recovery, strengthens the nervous system and leads to a greater ability to deal with stress in the future (possibly offering a neurophysiological justification for systematic desensitization and pressure training). Longer term, chronic stress without periods of recovery can lead to disease, tissue damage, and illness (McEwan, 2013). Therefore, coping with stress is the recruiting of strategies that are designed to return the body to a homeostatic state (Porges, 2022). The autonomic nervous system is designed then to support defence by disrupting optimal bodily processes that will then motivate us to do something to manage stress (a stress response). As mentioned previously, the primary goal of the autonomic nervous system would be to develop feelings of safety and connectedness, and thus a feeling of safety would be the retuning of optimal body processes and a recovery from stress. The evolution of the autonomic nervous system can determine the emotional expression, the communication, and the ability to regulate physiology and behavior in order to recover from the response to a stressor.

The social engagement system is a fundamental concept within the polyvagal theory and thus social behaviour and connectedness is implicated in the regulation of autonomic function. The ventral vagus of the parasympathetic nervous system is evolutionarily designed for social communication, and inhibition of avoidance (Porges, 2003). The differing physiological states created by the autonomic nervous system can facilitate or inhibit a range of emotional expression, communication, and bodily states that are fundamental to social communication. The idea of co-regulation that has been previously mentioned as a major structure of the polyvagal theory is a biological imperative that all humans share. The idea of co-regulation is that belonging is a survival mechanism and allows us to meet our safety and

connectedness needs (Dana, 2020). The need to co-regulate with other people is something that we require throughout our lifetime even after we learn to self-regulate our own emotions (Porges & Furman, 2011). Porges (2003) states that social support may influence the ANS, through promotion of safety and allowing the body to respond to stressors in an adaptive manner. Whilst the polyvagal theory doesn't explicitly state the term social support, several key parallels can be drawn. Firstly, the polyvagal theory posits that the autonomic nervous system promotes or inhibits pro-social behaviour. Secondly, the idea of co-regulation is very similar to that of social support: we regulate our autonomic function through social interactions with others, and there is plenty of research stating that perceived social support is beneficial to managing heart rate variability (a key biomarker of the ANS). Finally, the polyvagal theory states that social connectedness can be used to manage the stress response and allow for feelings of safety thus ensuring coping behaviour. We can draw parallels to the stress-buffering model here in that social support is a buffer against stress freeing people up to cope more effectively with the stress response. It might be possible to suggest therefore that the polyvagal theory gives us a neurophysiological explanation for why social support is effective, however more work may be needed in this area.

2.5.3 Heart rate variability as a biomarker of injury recovery.

The selection of biomarkers that are indicative of the interaction between social, psychological and biological processes implicated in healing is a complex and ambitious aim (cf. Zender & Olshansky, 2012). Thayer & Lane (2007) have noted that lower HRV has been associated with increased risk of all causes of mortality and has been proposed as a marker for disease. In addition, HRV has been linked to environmental factors such as exercise (Gutin et al., 1997), diet (Bouchard, et al.,

1990), and chronic stress (Vrikkotte, Van Doornen, & de Geus, 2000), and individual factors such as work stress and cardiovascular disease. This relationship could be determined by the effects of stress on blood pressure (Vrikkotte, Van Doornen, & de Geus, 2000), and emotion regulation (Appelhans & Luecken, 2006). Greater ability to regulate emotions has been shown to be linked with higher heart rate variability and is linked to increases in successful performance in emotion regulation tasks (Appelhans & Luecken, 2006), and muscular skeletal overuse injury Gisselman et al. (2016),

HRV is an indirect measure of the homeostasis of the ANS and might be able to indicate early signs of tissue overload, even before the onset of pain (Gesselman et al., 2015). The ANS has been shown to play a role centrally and peripherally in responses to tissue disturbance (Rio et al, 2014; Bialosky et al., 2009). As previously mentioned, the ANS plays a large role in the regulation of pain, inflammation, and injury repair (Ackerman et al., 2016), thus HRV may be useful for identifying overuse or overload prior to the onset of pain and injury (Gisselman et al., 2016). Williams et al. (2017) conducted a study looking to identify whether heart rate variability could be used as a moderator of the workload injury relationship in CrossFit athletes. They used key time domain measures of heart rate variability and an overuse injury questionnaire to identify an interaction. The study found that RMSSD was seen in combination with high acute to chronic workload ratio, which has been associated with 5-7 times greater injury rate in a separate study of football players over a 3-year period (Bowen et al., 2019). Williams et al. (2017) found support for Gisselman et al. (2016) that overuse injury may modulate ANS activity at the heart rate variability level. Further, they found that an increase in reported workload was associated with reduction in heart rate variability. Williams et al. (2017) concluded that monitoring heart rate variability is useful in identifying early onset overuse injuries.

There is increased interest in the link between HRV and emotional stress (Solan et al., 1994). In laboratory experiments heart rate variability has been associated with psychological stress (Myrtek et al., 1996), and emotion regulation (Appelhans & Leucken, 2006). A number of studies have been conducted on both clinical and non-clinical participants. Specifically, HRV was found to be lower among female graduates who have high trait anxiety prior to an exam (Fuller, 1992). Limited support was found by Dishman et al. (2000) who suggest that HRV among fit and healthy individuals decreased in participants who reported increases in emotional stress over a 1- week period. Horsten et al. (1999) attempted to explain this relationship by suggesting that decreased HRV could be a sign of a person's psychological inflexibility and vulnerability to stress. Hjortskov et al. (2004) found further evidence that HRV is a sensitive indicator of mental stress during work in 12 participants, they correlated heart rate variability with subjective stress, once again. However, this study was conducted in a controlled laboratory environment which makes it difficult to extrapolate into real world settings. Thayer et al. (2012, p.751) viewed heart rate variability as a marker of the 'dynamic regulation of autonomic activity' suggesting that high HRV is indicative of context and goal-based emotion control. They go on to report that individuals with higher HRV have been associated with appropriate emotional responses to situations. Finally, Theyer et al. (2012) suggest that those with low HRV show a delay in recovery from psychological stress, cardiovascular, endocrine, and immune responses to stress, thus linking the psychological and physiological responses to stressors.

Whilst there are some benefits, and clearly there is support for the use of heart rate variability when examining stress and autonomic function, there are several challenges that one is faced with when using HRV. Firstly, to glean useful HRV data

great care is required to reduce external influences on the measurement (Kleiger, Stein, & Bigger, 2005). Secondly, the best predictors of HRV require extended periods of recording to gain a good average and whilst shorter periods may be useful, long data recording sessions are preferred (Kleiger, Stein, & Bigger, 2005). Usually longer-term measurement (e.g., over 24 hours) is better used to consider the environment, whereas in shorter term measurements of HRV more control is needed over the environment (Hayano & Yuda, 2019). Thirdly, given the number of different variables within HRV, the researcher has a choice of which one to use. It is unclear which of the domains is best as they have all been associated with outcomes and no clear superiority for any domain exists (Kleiger, Stein, & Bigger, 2005). Fourthly, HRV reflects the autonomic state of the whole body and thus it is difficult to separate the effect of autonomic function of other organs on HRV. For example, if someone has recently eaten the autonomic function of the digestive system will impact heart rate variability (Hayano & Yuda, 2019).

2.6 Heart Rate variability

Porges' (2007) polyvagal theory describes the relationship between HRV and emotion regulation. It describes the neural pathways that originate in the cranial nerve. This innervates and regulates the facial muscles, myelinated vagus, the heart, and the bronchi. This myelinated vagus also influences the sinoatrial node, which can positively or negatively impact upon social and emotional behaviours. Porges (2007) goes on to state that this reaction plays a 'major role in the experience, expression and response to emotion' (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013 pg,387). In practice this means that those with low HRV tend to have more difficulty in regulating their emotions and those with higher HRV would be more effective at

controlling situation specific emotions (Porges, 2007). This is support by Mankus, Aldao, Kerns, Mayville, & Mennin (2013) who found that individuals with higher levels of general anxiety had significantly lower HRV and that mindfulness exercises were able to moderate HRV and therefore general anxiety.

Heart rate variability (HRV) is a simple and non-invasive measurement of autonomic cardiac function (Camm et al., 1996). The critical idea is that HRV may be more than just an index of health; cardiac function is key. HRV may provide an insight to the degree to which the integrative system for regulation in the brain provides control over the body (Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). Put simply, HRV may be an easily measured indicator of the neural network which may provide indications of how effective a person can function in a stressful environment. HRV represents the degree of which the parasympathetic and sympathetic nervous system influences heart rate. With higher levels of HRV indicating an increased parasympathetic and reduced sympathetic influence (Appelhans & Luecken, 2006).

To measure HRV, a variety of tools have been reported to be useful. There are roughly 31 different products on the market that are said to measure heart rate variability (Georgiou et al., 2018) and they fall into one of 3 categories; 1) ECG monitors, 2) finger monitors, and 3) wearable chest straps, watches, hand straps. Traditionally HRV has been measured using a electrocardiogram (ECG) which has been identified as the 'gold standard' in heart rate variability measurement (Camm et al., 1996), in which a participant is asked to sit in a reclined position with 12 ECG leads attached to their chest, measuring ECG trace over a set period of time decided by the research question. However, Plew et al. (2017) states that enhancements in photoplethysmography (PPG) technology may allow for heart rate variability to be

measured by a smartphone device. PPG is measured through reflecting light through a participant's skin and detecting the amount of reflected light by a photodetector or camera, in a similar set up that is found on many up-to-date smartphone devices. This approach is seen as more user-friendly than an ECG as no additional equipment is required to measure HRV by athletes and is likely to improve compliance to measurement. A final method of measuring heart rate variability is by using a heart rate chest strap that is connected to a smartphone application. Specifically, Polar heart rate monitors have been relatively well validated in the literature. The Polar s810 (Gamelin et al. 2006, 2008) the Polar V800 (Neil, Giles, & Draper, 2016) and the Polar H7 (Plews et al., 2017). Plews et al. (2017) compared three tools used to measure heart rate variability, a PPG measure using a smartphone device, the Polar H7 and the ECG method. The main finding of their study is that the PPG smartphone recording and the Polar H7 heart rate monitor had acceptable levels of agreement with the ECG recording for the RMSSD index of HRV. Whilst these results are promising for the use of simpler methods of measuring HRV it is worth nothing that the PPG method yielded the lowest technical error of estimate (TEE) (CV%= 3.8(3.1;5.0). When comparing the Polar H7 to ECG correlations of 0.97 and 0.99 were found when looking at RMSSD. Indicating that the Polar H7 is as good as an ECG to assess HRV. In terms of practicality the use of PPG methods and the Polar H7 may provide methods that have fairly strong validity and ability to measure heart rate variability outside of the laboratory environment.

Regardless of the tool used to measure heart rate variability, there are two linear approaches to measurement based on the inter-beat interval, these are the time domain and frequency domain (Stein et al., 1994). The time domain approach answers the question 'how much variability is there in the heart beats?'(Stein et al.,

1994). Measures that are based on the difference between inter-beat R-R intervals include the SDNN (the standard deviation of all normal R-R intervals) (Stein et al., 1994). These inter-beat interval measures are influenced by a number of short-term factors (e.g., breathing rate) and long-term factors (e.g., circadian rhythms). Other approaches to time domain HRV analysis look at comparing the adjacent heart rate cycles such at the PNN50 (the proportion of adjacent cycles that are greater than 50 milliseconds apart displayed in percentage), and the RMSSD (the room mean square of successive differences), which is the sum of squared differences in the length between adjacent N-N cycles. The benefit of measuring these domains is that they are independent of long-term trends suggesting they are less impacted by external factors.

The frequency domain approach answers the question 'what are the underlying rhythms in the heartbeat?' (Stein et al.,1994). This approach is able to show the heart rate variability contributions to the sympathetic and para-sympathetic nervous system (Acharya et al., 2007). These measures are seen in high frequency power (where power equals variance) and low frequency power. High frequency (HF) measures of heart rate variability are mediated by the para-sympathetic nervous system this usually seen at the 0.15-0.4Hz band (Berger et al., 1986). Low frequency (LF) measures of HRV are affected by both the sympathetic and para-sympathetic nervous system is seen at 0.04 to 0.15 Hz band (Stein et al., 1994). In addition, there are ultra-high frequency and ultra-low frequency domains.

2.7 Wound Healing

Healing is a dynamic and interactive process that involves blood cells, soluble mediators, and other cells in the body (Velnar, Bailey, & Smrkolj, 2009). It can also be noted as an extraordinarily complicated process, that takes place in all tissues and organs of the body (Velnar, Bailey, & Smrkolj, 2009). A wound is defined as a disruption to the normal structure and function of tissue (Cherry, 1995), and can be characterised by its cause, location, and duration (Walburn et al., 2009). There can be a considerable number of causes including planned causes (i.e. surgery), trauma, pressure, or pathological changes (e.g., ulcers) (Walburn et al., 2009). We can classify wounds into their duration as either acute (e.g., wounds that progress through the stages of healing in a good time) and chronic (e.g., where healing is delayed or does not occur as expected) (Menke et al, 2007). The consensus is that wound healing typically has three phases, which overlap in time (Singer & Clark, 1999) an inflammation phase, a tissue formation phase, and a tissue remodelling phase. The inflammation phase in which a blood clot re-establishes haemostasis, platelets facilitate the formation of the haemostatic plus, and secrete soluble mediators of wound healing. To make this happen a number of vasoactive mediators and chemotactic factors are generated by the coagulation of blood. These substances recruit inflammatory leukocytes at the site of the skin break (Clarke 1996). The most active phase of tissue formation phase is characterised by fibroblast migration and deposition of newly synthesised extracellular matrix (colloquially known in skin disruption as a scab), put simply lots of granulated tissue is formed (Glat & Longaker, 1997). The final phase of a healing wound is the remodelling phase in which new scar tissue is formed. This remodelling is tightly controlled by regulatory mechanisms, which aim to maintain a balance of degradation and synthesis. This is especially true for simple or acute wounds (Baum, & Arpey, 2005). Successful wound healing

therefore depends on optimal functioning of complex systems, a large number of pathophysiological and metabolic factors can influence would healing, these include oedema, ischaemia, tissue hypoxia, infection, necrosis, and other pre-existing illness (Velner, Bailey, & Smrkolj, 2009). Support has been found for the suggestion that psychological processes have an adverse impact on the immune system and in turn healing (Kiecolt-Glaser, Marucha, Malarkey, Mercase, & Glaser, 1995). For example, Personality variables (such as optimism) have been shown to moderate surgical outcomes (Keicolt-Glaser et al., 1995), self-reported anxiety and stress have been related to more severe post-operative pain (Johnston 1988), and finally stress has been shown to have both psychological and physiological effects (Bomholt et al., 2004) and has been shown to disrupt and supress the immune system responses and inflammation (Bomholt et al., 2004).

2.8 Stress

Stress is a bodily response to any demand placed upon it from the external environment and could be caused by either positive or negative experiences (Kumari et al., 2019). When under threat from physical injury, exertion, or psychological threat the body activates the sympathetic-adreno-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes to restore homeostasis (Russell & Lightman, 2019). This stress response is designed to provide the best chance of survival during times of heightened threat (Bass & Lazar, (2016)). In addition, cognitive, cardiovascular, immunological and metabolic resources and functions are also enhanced when the stress response is activated (Russell & Lightman, 2019). As previously discussed, the HPA in relation to the polyvagal theory is critical for life and is a major regulatory system within the body (Smarr & Schirmer, 2018). The specific details of how the

HPA system work is beyond the scope of this review, however it is worth mentioning the impact of various hormones including cortisol to help to regulate the physiological stress response.

The stress response can be broken down into two domains, acute stress and chronic stress and the body responds slightly differently to each of the two types of stress presented to it. The acute stress response is more dynamic and typically changes over time. This response starts with engaging stereotypic behaviours (e.g., the fight, flight, or freeze response) and then changed to goal directed behaviour to the specific stressor that is presented (Russell &Lightman, 2019). After this, the SAM and HPA begin to work and cortisol is peaked at around 20 minutes after presentation of the stressor (Lightman, 2008). However, within chronic stress there is a numbing of the sensitivity to cortisol feedback (Dallman, 1993) thus increasing the chance of negative effects that the stress response mitigates (e.g., a reduction in the effectiveness of the immune system).

Probably the most prominent psychological theory of stress and coping in the literature is Lazarus & Folkmas's (1984) transactional theory of stress and coping which suggests that people are constantly appraising environmental events, which then generates an emotion depending on the perceived ability to cope with the stressor presented. If an appraisal is seen as threatening or harmful, distress ensues, and coping strategies are needed to overcome and address the stressor. A cognitive appraisal is a process by which meaning is assigned to an external event (Boyd, Lewin & Sager, 2009). Lazarus (1991) suggests that two pathways integrate to help people make an appraisal of a situation, firstly, an individual's agenda specifically their beliefs and values, and secondly, the environmental factors, demands and resources that a person has available to them (Lazarus, 1991). This obviously means

that there is quite often a wide variation in the appraisals between and within people when exposed to a stressor.

At this point it is important to discuss the concept of primary and secondary appraisal. A primary appraisal will determine the meaning and significance of the event and the secondary appraisal will involve the identification of coping resources and ability to cope with the situation variables that are presented in the environment (Dewe & Cooper, 2007). The associations between appraisals and unpleasant emotions are found throughout the literature and the associations between them impact upon coping and performance in the outcome (Nicholls, Polman, & Levy, 2012), furthermore research agrees that appraisals greatly influence coping strategies and outcomes (Brough et al., 2009).

2.8.1 Measuring physiological markers of stress

As discussed, stress has both a psychological element, in terms of primary and secondary appraisals, and a physiological element in terms of the polyvagal theory, SAM, and HPA axis. This means that there is an opportunity to observe the stress response physiologically. Bigazzi et al. (2022) conducted a brief review of the physiological markers of stress during active travel such as cycling and walking and found a number of key markers that are used to assess physiological stress during activity. The main types of marker are Heart Rate Variability, Heart Rate, Electrodermal activity, and skin temperature. Most often used is electrodermal activity and skin temperature, with the least used being heart rate and heart rate variability (Bigazzi et al., 2022). Giannakakis et al. (2019) did a more detailed review on the bio-signals used for detecting stress. They suggest that there is a lack of comprehensive guidelines on using biomarkers of stress and there is a need

to establish reliable indices to examine the stress response. However, Giannakakis et al (2019) identify a vast number of biological measures of stress. A short review of each is presented here. Electroencephalography which identifies the decrease in alpha waves and decrease in beta activity could be used to estimate stress. Pupil diameter which assumes that the muscles that constrict and dilate the pupils are governed by the sympathetic and parasympathetic nervous system thus reflecting an autonomic involuntary action associated with emotional and cognitive arousal. Skin temperature being associated with stress conditions (Mcfarland, 1985) and suggest that high temperature is a key marker for acute stress by using skin conductance sensors placed on the surface of the skin. Thermal infrared imaging works in the same way as skin temperature and records the levels of oxygen in the skin tissue in which increased arousal is associated with increase in blood flow to the vessels just below the skin (Nahn & Chau, 2010). Respiration rate measured in terms of rate and volume of the exchange of air in the lungs. Where an increase in breathing rate represents an increase in the perception of stress conditions (Engert et al., 2014). Heart rate, which Bigazzi et al. (2022) suggests is probably the most widely used and straight forward biological marker of stress looks at the mean RR interval, nearly every study conducted in this area suggests an increased heart rate is associate with increased stress (Bigazzi et al., 2022). Heart rate variability which is the distribution of RR intervals within a minimum measurement time of 5 minutes with an inverse relationship suggesting low heart rate variability is seen in situations where there is a high perception of stress. There are a considerable number of choices that could be made to recognise the underlying mechanisms of the stress response which can be manifested in the physiological bio-signals given off by the body, can offer a good

option for examining the multifaceted and often difficult to measure perception of stressful situations.

2.8.2 Stress and injury/healing

The relationship between stress and healing is relatively complex; there is research suggesting the various physiological processes (e.g., the immune system responses) that are impacted by stress. There is plenty of interest in the medical field on the impact of stress on healing post-surgery. However, this interest however has not yet peaked within the psychology of sport injury literature. Mild stress impairs healing (Christian et al., 2006). In a study by Marucha et al. (1998) biopsy wounds healed 40% more slowly in an exam period as opposed to a holiday period. Further to this (Kiecolt-glaser et al, 2005) found that even a short conflict, which produced a small stress response in a laboratory setting, produced a decrease in cytokines (substances which are secreted by cells in the immune system in order to effect cell function and growth) at a wound site suggesting slowing healing rate. There are a multitude of physiological reasons and behavioural mechanisms that describe why stress impacts upon wound healing, these are detailed in a paper by Gouin & Kiecolt-Glaser (2011) and are summarised here. 'Psychological stress leads to activation of the hypothalamic-pituitary-adrenal (HPA) and sympathetic-adrenal-medullary axes' (Gouin & Keicolt-Glaser, 2011. pp87). The HPA is the endocrine system's response to stressors, which produces changes in cortisol levels in the body, the sympathetic adrenal medullary system produces increases in epinephrine and norepinephrine which in turn produce increases in heart rate when stressors are encountered (Smith, 2006).

There are biological and behavioural reactions that link psychological stress to wound healing. Psychological stress increases the production of glucocorticoids,

increases catecholamine production, reduces oxytocin and vasopressin, reducec cytokine production, and reduces cell infiltration at wound sites, all impacting the healing and recovery process (Gouin & Keicolt-Glaser, 2011). Due to the reduction in immune system and healing system function there is often an increased risk of infection and reduced oxygen availability at wound sites both impacted upon healing (Rojas et al., 2002). The behavioural mechanisms that link stress to wound healing including the promotion of health damaging behaviours such as alcohol and tobacco use, decrease in physical activity, and sleep disturbance (Steptoe et al., 1996). These mechanisms increase inflammation, reduce wound healing enzymes, decrease oxygen at the wound site, and offer the opportunity for bacterial and microbial infection which in turn lead to decreased or impaired wound healing (Gouin & Keicolt-Glaser, 2011). Keicolt- Glaser et al. (2005) considered other stressful situations that may impact upon wound healing and found that blister wounds healed more slowly after couples had conflicts. They found that during supportive interactions between couples, wounds began to heal more quickly and during conflict situations healing was only around 60% of that of the supportive conversation group suggesting a link between supportive conversations (e.g., social support), stress, and healing rate.

2.8.3 Mediators and moderators of stress.

The typical life events that we experience on a day-to-day basis influence psychological and physical health (Dekkers et al., 2001). Daily hassles are one such way of exploring and understanding the typical day-to-day stressors that occur in one's life (Weineberger et al., 1987). Daily hassles are characterised by the small, frustrating, irritating, demands that are put on us during our day-to-day interactions (Kanner et al., 1981). These daily hassles are often considered to be not very intense

or long lasting but often more frequent (Arnold & Fletcher, 2021). Characterised by the environmental demands that are encountered by a person (Fletcher et al., 2008), these hassles can also include things such as social conflict, insufficient time at work, or a lack of money. There is often considerable variability in the interpretation of life events and thus the measurement of such hassles can be quite difficult (Dohrenwend, 2006). Arnold & Fletcher (2021) posit that numerous stressors and hassles are encountered during sport and exercise. They conceptualise these in terms of competitive stress such as pre-performance stressors or the competitive anxiety response, and organisational stressors comprising of anything that is associated with the organisation or environment that a person is operating (Arnold & Fletcher, 2021). The stressors mentioned above can be broken down into 4 key dimensions, frequency, intensity, duration, and severity. Frequency refers to the occurrence of the stressor in relation to time (Arnold et al., 2013), intensity is the level of felt strength of the stressor (Arnold & Fletcher, 2012), duration is the distinction between acute or chronic stressor, and the severity is the degree to which there is a negative impact upon one's life (Monroe & Anne 1991).

Coping is seen to be a mediator of the stress response (Mahat, 1997). Coping is an action orientated effort to deal with stressful events or stressful environments (Taylor & Stanton 2007). Coping responses are complex and can be either problem focussed, emotion focussed, adaptive, or maladaptive (Meyer, 2001). Behaviours in the maladaptive coping strategies may include things like drug use, alcohol use, self-blame or denial, and adaptive coping strategies are planning and the use of social support (Ventura et al., 2004). In their book, Arnold & Fletcher (2021) suggest 3 major mediators of the stress response. They suggest that these mediators can have a powerful impact on the stress process by buffering or exacerbating the relationship

between a person and their environment. These mediators are stress-related growth, personality, and social support. A brief overview of the stress-related growth and personality will be presented for completeness, however the focus of the rest of this section will be dedicated to social support.

Stress-related growth is the positive psychological changes that occur as a result of experiencing a stressful situation (Park, Cohen & Murch, 1996). There are several theoretical models that explain the growth process such as the functional descriptive model of post-traumatic growth (Triplett et al., 2012) and the affective-cognitive processing model of posttraumatic growth (Jospeh, Murphey, & Regel, 2012), a review of which is beyond the scope of this chapter. Extreme events in early life, adversity, and effective learned responses to these events may be beneficial to develop resilience that helps when dealing with life stress (Fletcher, 2021). Personality is linked to the patterns of thinking, feeling, and acting (Pervin & Cervone, 2010) and it's likely that these can impact upon stress responses, and resilience. The personality of a person may predict behaviour under stressful situation (Laborde et al., 2019) and that a stressful situation may act as trait activation thus under pressure specific personality traits may be activated. The research in this area suggest that a number of specific personality traits can be activated under pressure. Athletic identity (Geukes et al., 2017), dispositional reinvestment (Geukes et al., 2017), fear of negative evaluation (Mesagno, Harvey, & Jenelle, 2012), narcissism (Wallace, Baumeister, & Vohs, 2005), and private self-consciousness (Geukes et al., 2013) have all been related to stress and performance.

Social support is seen as a typical moderator of stress that buffers against the negative effects of daily hassles (Zautra et al., 1998). The impact of others upon health, performance, and well-being is widely documented within the literature

(Freeman, 2021). The perception of social support is seen to be an important factor in improving a persons' relationship with negative life events (Evers et al., 1998) and has been shown to have a moderating effect on quality of life, ill-health and depression (Utsey et al., 2006; Yue-Juan et al., 2005; Frese, 1999). There has been quite good support for the direct effects and stress buffering models that are discussed later in this chapter and the health benefits associated with social support (Cohen & Wills, 1985). Social support is seen as an important resource that is linked with stress, coping, and well-being in multiple contexts, with different types of support being moderately correlated and having unique effects on stress (Freeman, 2021).

2.9 Social support

Sociality is embedded in our neurobiology and supports optimized health, growth, and restoration (Porges, 2021). Humans are defined by and within their social environment and social interactions play a key role in our cognitive abilities (Heyes, 2020). Social support is a resource that is available to us coming from our close social connections (Wiate, 2018), it is the perception of, or availability of support through our social ties, whether that be in a group, individual, or the wider community (Ozbey et al., 2008). There are still some difficulties in defining social support and there is limited availability of a good operational definition of social support. Che et al. (2018) suggests that social support can be thought of in terms of the number of social roles a person holds, the frequency of the interaction they have with their social network and the interconnectedness of the relationships within the network. Rees (2007) defines social support as a multifaceted process where a person is aided by the existence of a caring and supportive network and their perception of availability to provide help when it is required.

Social support can be described in terms of structure and functionality, and formal or informal systems. The structure of social support is the existence and size of social network and the extent to which a person is connected to their social network, whereas the functionality is considered the persons appraisal of the social support that they may experience. In this sense social support is the cognitive and functional aspect of human relationships, availability of relationships with others, and the content of those relationships (Drageset, 2021).

Commonly within the literature there is a distinction between perceived and received social support (Kent de Grey et al., 2018). Perceived social support is the perception that supportive resources would be available if they are needed (Dunkel-schetter, 1990). Often the perception of social support is subject to individual difference, personal judgement and memory which can impact upon the accurate perception of supportive events (Lakey & Drew, 1997). It is also a measure of global satisfaction of social support that could be provided (Sarason, Sarason, & Pierce, 1990). There is consistent support for the notion that perceived social support is associated with reduced stress and improved physical and mental health (Haber et al., 2007) and is often more essential when adjusting to life stress (Wethington & Kessler, 1986). Social support has been shown to facilitate adaptive coping and reduce maladaptive coping strategies (Fleishman et al., 2000).

Received social support is the reported exchanges of social support that actually occur when they are required. It is the actual support given to a person when it is needed (Kent de Grey et al, 2018). Received support often looks to examine the specific support behaviours that are provided by a person's support network (Haber, et al., 2007) and in some studies has been positively linked with negative emotions (Peeters & Le Blank, 2001), and mental health challenges (Iwata & Suzuki, 1997).

This may be explained by the fact that those people with the highest levels of stress may also be subject to the most amount of received social support. For example, when people are experiencing stressful situations their friends and family may gather around and provide more support (Lakey & Orehek, 2011). There are further inconclusive results associated with received social support specifically in men, received social support may be associated with increased strain but in women it has no effect (Lindorff, 2000). Nurullah (2012) concluded that there are mixed effects on the effectiveness of received social support and there was quite limited understanding of the understanding of how received social support works and is a much more complex phenomena than thought in earlier studies (Shrout et al., 2010).

2.9.1. How social support works

There are two key theories as to why social support has positive effects on biopsychosocial well-being. These are known as the stress buffering and main effects models. The buffering hypothesis suggests an increase in health and well-being by decreasing and reducing the influence of stress by re-evaluating the level of threat posed by stress or positively increasing someone's perceived ability to cope (Che et al., 2018). Social support can be seen as additive in the sense that low social support adds to the sense of stress and multiplicative where social support and stress act independently of each other on a disorder (e.g., injury). Alternatively, social support can be seen as both additive and multiplicative in that low social support adds to the effect of adversity. Finally, social support can be seen as a restricted concept as suggested by Brown (2008) where social support has no effect on the rate of the problem (e.g., injury) unless the participant is exposed to stress. Alloway and Bebbington (1986) argue that the distinction between multiplicative and additive approaches to the buffering model is not important as neither can be the correct

definition but both offer some use in understanding how buffering works to positively impact stress. These ideas do not take into account the possibility that stress may in fact have a role in the elicitation of social support, and during a crisis people may seek out more social support.

There is considerable support for the stress-buffering hypothesis of social support which makes logical sense. In Che et al's (2018) paper they found confirmation that social support interacted with physical suffering and predicted a decrease in depression (Park et al., 2017), increase in emotional well-being (Holtzman & DeLongis (2007) and in turn physical pain. They also found support for a mediating role of social support on quality of life (Morgan et al., 2011), an influence on the perception of perceived pain and related stress, which increased participants confidence in their ability to cope. These results suggest a direct interaction between social support and stress appraisal (Che et al., 2018).

The main effect hypothesis suggests that social support has an over-all benefit on well-being and injury (Che et al., 2018). The model suggests that having a large supportive network offers increased positive emotions, and thus improving health outcomes (Arvinen Barrow & Pack, 2013). In their paper Che et al. (2018) found support for the main effect model where social support is directly linked to reducing depression and greater psychological functioning. Thoits (1984) argues that social support or the lack of can be seen as a stressor itself and have a direct impact on the psychological symptoms regardless of whether stressful situations occur, which is the primary critique of the buffering model in which social support is only important when stressful events occur. Thoits (1982) found a lack of data to support the idea that social support exists only when stressful events occurred and posits a significant negative main effect of emotional support on psychological distress, instead of what

the buffering hypothesis would suggest whereby support would interact with an event. This would mean that social support plays a primary role in stress responses and not a moderating or buffering role. A person would become vulnerable to emotional disturbance due to their lack of social support thus offering a main effect approach instead of a buffering approach. Modern conceptualisations of the main effect hypothesis can be seen in the social constructionist perspective where social cognition and symbolic interactionism are seen as important in the understanding of how social support works (Lakey & Cohen, 2000). The social constructionist approach to social support refers to the primary perception of support. If a person has stable beliefs about the supportiveness of others, day to day positive thoughts about available social support then this will have a positive impact upon psychological well-being and health. In this view, negative thoughts about social relations overlap with negative thoughts about self and therefore stimulate emotion distress. Positive perceptions of social support led to higher self-esteem and therefore improved health outcomes (Barrera & Li, 1996). The notion of symbolic interactionism is the premise that regular social interaction rather than the provision of support is useful in the maintenance of well-being (Thoits, 1985). Social environments directly promote health and well-being and assist in making sense of the world, essentially friends, family, and interaction sustains identity and promotes self-esteem (Stryker, 1980).

Whilst not a focus of the program of work, in the interest of fullness and completeness it is important to note the effect of attachment style on social support. Adult attachment has been reported to mediate the effect of social support and stress (Ditzen et al., 2006) and can potentially explain why not all people benefit from social support during stressful life periods (Coyne et al., 2001). Bowlby describes attachment as the supportive interactions between a child and primary caregiver

during periods of stress (Bowlby, 1969). There is a good amount of research to suggest that secure attachment is positively associated with perception of social support and social support seeking (Sarason et al., 1990; Vogel &Wei, 2005) and insecure attachment interferes with social support use even when it is available (Coble et al., 1996). Milkulincer et al. (2000) suggests that people engage in social support to modulate physiological reactivity to stress and those who are deemed insecurely attached show high reactivity to hypothalamic-pituitary-adrenal axis and decreases in autonomic nervous system reactivity during times of stress. Each of these systems are directly related to the polyvagal theory (Liu et al., 1997; Reite & Boccia, 1994). Ditzen et al., (2008) concluded that adult attachment anxiety and avoidance are both negatively associated with perceived support. They confirm that buffering effect of social support on endocrine stress responses but suggest that attachment does not directly modulate the effect and calls for more research to explore this idea. Further studies have found similar patterns relating to attachment style and social support seeking, availability, and interactions. In their review Mcleod et al. (2020) found 5 studies that examined associations between attachment and support seeking. Those who have a secure attachment style report seeking more support on a day-to-day basis. However, this is shown to be gender specific (Feeney et al., 2003), which alludes to one of the major problems with support seeking research and attachment. There is ambiguity in the results when comparing men and women, with some studies finding no association between men's attachment style and support seeking (Simpson et al. 2002). There are a number of key critiques of the association between attachment and social support, specifically when support provision is observed and not measured through the use of questionnaires the number of null findings increased

dramatically suggesting that the association between attachment and observed support is not as robust as one would assume (Mcleod et al., 2020).

2.9.2 Types of social support

This section will aim to give an overview of the different types of social support available to people. As previously mentioned, social support is widely accepted as a meta-construct (Barrera 1986) consisting of social embeddedness, supportive transactions, and subjective appraisal of the support (Furukawa et al., 1998). Documented throughout the literature is the notion of received versus perceived social support. Received social support is defined as the supportive behaviours that are provided by other people in their social networks these are often measured by self-report questionnaire measures. Perceived support relates to the individuals' perception of the availability and satisfaction of support from their social network, also often measured by self-report measure (Haber, Cohen, Lucas, & Baltes, 2007).

Nurullah (2012) suggest the research on received social support is inconclusive, stating that supportive behaviours have no positive effect on well-being (Bolger, Foster, Vinokur & Kg, 1996), furthermore when people are faced with stressful situations, support behaviours are linked to negative affect (Peeters & Le Blanc, 2001), depression (Frese, 1999), and other mental health problems (Iwata & Suziki, 1997). This link however has been shown to be confounded by the fact that those who receive the most amount of support is often more prone to worse well-being (Lakey & Orehek, 2011). Received support have been shown to increase emotional strain on men, Deelstra et al. (2003) suggested that received support can be invasive or often demanding. Despite the negative effects of received social support

Nurullah (2012) suggests that received social support can have some positive effects and should be considered in improving health and well-being, however this provision should be considered in the context of culture, gender, and the need of the individual receiving support.

Much of the research on social support however focuses on the perceived nature of social support. Perceived social support can be defined as the perception or belief that support is available to people when it is needed. Usually, the perception of social support is measured subjectively and often is seen as more determinative than overt or received social support (Stokes, 1985). The perceived availability of friends, family, coaches, teammates, and support staff has been shown to have positive impacts on individuals (Freeman et al., 2011) and their well-being (Dunkel-Schetter & Bennett, 1990). Further, perceived social support has been shown to improve a variety of outcome measures consistently over time (Barrera, 1986, Sarason et al., 1990). Specifically, positive outcomes on psychological health (Dunkel-Schetter & Bennett, 1990), subjective well-being (Gulacti 2009) depressive symptoms (Eagle et al., 2019), and mental well-being (Roohafza et al., 2014). Roohafza et al. (2014) suggests that perceived social support is a protective factor in relation to depression and anxiety. Finally, Viswesvaran et al. (1999) found in a meta-analysis that perceived social support had a threefold effect on stress, it reduced the strains experienced by people, social support mitigated perceived stressors, and social support moderated the stressor-strain relationships experience by participants.

To extend the benefits of perceived social support, Freebourne et al. (2019) found that higher levels of perceived social support are associated with a slightly lower risk of all causes of mortality. When considering the usefulness of perceived social support in sport, the research has found that perceived social support has

positive effects on self-confidence (Rees & Freeman, 2007), performance (Rees, Ingledew, & Hardy, 1999), susceptibility to injury (Smith, Smol, & Ptacek, 1990), to have direct positive effects on physical and mental health and can be seen as a buffer to the damaging effects of mental and physical health problems (Thoits, 1995). More specifically, Carson & Polman (2008) and Yang et al. (2010) find that emotional support appears to be the most important type of social support in assisting returning to sport and enhancing well-being.

People are motivated to connect with other people, and their emotions are often precursors and consequences of social interactions (Niendenthal & Brauer, 2012). Social interaction may be useful in regulating emotions. This process of social emotion regulation is referred to as interpersonal emotion regulation (Gross & Thompason, 2007). One of the most widely researched and used areas of interpersonal emotion regulation is social support. Social support has been shown to be one of the most important environmental resources in stress buffering (Suls & Wallston, 2003). It is also one of the most rigorously researched psychosocial resource (Thoits, 1995). Social support has also been shown to enhance the functioning of the immune system (Baron et al., 1990). Those with higher levels of social support are more disease resistant when put under stress. It is thought that social support facilitates rehabilitation in two ways; the first being buffering athletes from the harmful effects of injury related stress and secondly by directly influencing the rehabilitation process (Rees, 2007). It is also thought that social support can directly influence a person's response to the injury process. Having a support network can increase positive emotion, thus decreasing frustration, stress and increasing positive rehabilitation behaviours (Rees, 2007).

To date approximately 10 different types of social support have been identified, namely: Esteem support (Freeman & Rees, 2009), listening support (Taylor & Taylor, 1997), emotional support (Freeman & Rees, 2009), emotional challenge support (Taylor & Taylor, 1997), shared social reality (Taylor & Taylor, 1997), technical appreciation support (Taylor & Taylor, 1997), technical challenge (1997), personal assistance (Rees et al., 2010), material assistance (Rees et al., 2010), and motivational support (Udry, 2001). These can be summarised by 5 overarching themes. These themes are; (1) Emotional social support (including esteem support, listening, emotional support, emotional challenge and shared social reality) (Freeman & Rees, 2009; Rees, 2007' Taylor & Taylor, 1997; Rees, Mitchell, Evans, & Hardy, 2010); (2) Technical support (including technical appreciation and technical challenge) (Taylor & Taylor, 1997), (3) Information social support (including personal assistance and technical assistance)(Rees et al., 2010; Rees, 2007), (4) Tangible social support (including material assistance and technical challenge) (Taylor & Taylor, 1997; Rees et al., 2010), and finally (5) Motivational social support (Udry, 2001).

Rees & Hardy (2004) suggests that social support should be seen as multi-dimensional when considering its effects on stress. Social support works by offering 5 significant effects. This suggests a protective effect of high social support when there is a high level of stress, supporting the buffering hypothesis. Rees & Hardy (2004) found emotional support had associations with high levels of flow, suggesting that emotional support specifically has significant stress buffering effects. Taking this idea further, high levels of emotional support was seen to 'hold' emotions in their place whereas low levels of social support increased the intensity or emotions suggesting that emotional support is an effective emotional buffer (Rees & Hardy, 2004).

Positive results were also found for esteem support, tangible support, and informational support. However, it is worth noting that only two stressors were measured during this study and measures chosen specifically for those stressors, they suggest that more general measures would perhaps not find such strong effects of stress buffering (Rees, Ingledew, & Hardy, 1999; Cohen & Wills, 1995, Veiel, 1992).

Earlier research also by Rees & Hardy (2000) found that there were 4 primary dimensions of social support and that specific types of social support were used to deal with specific types of stressor. For example, emotional support was found to be useful in helping with deselection, with pressure, with life direction or future planning, and help with injury. Esteem support was found to help with competition nerves, help with injury and dealing with fitness concern, informational support was useful in dealing with low confidence, performance concerns, performance catastrophe, fitness concerns and help with interpersonal problems, and finally tangible support was found to be useful in helping with injury, worries about practical matters (e.g., travel), and reducing pressure which may allow athletes to concentrate on performance (Rees & Hardy, 2000). They concluded that different stressors require different types of social support and these types have been elicited by previous research into the area.

When individuals perceive a high level of social support there is evidence to suggest that ambulatory blood pressure and attenuated cardiovascular responses are lower (Bowen, et al., 2014). Gerteis & Schwerdtfeger (2016) have found a significant interaction between rumination, social support and ambulatory HRV. When participants in their study experience a strong sense of social support, HRV (as measured by Electrocardiogram, ECG, quantified by the root mean squared successive differences (RMSSD)) significantly increased. Cosley, McCoy, Saslow &

Epel (2010) supports these findings and suggest that high levels of social support, result in lower cortisol, lower blood pressure and higher HRV. Westmaas & Jamner (2006) also found that social support lowered blood pressure. To summarise we know that types of social support are useful in improving perceptions of injury and the above discussion suggests that social support can have a positive effect on heart rate variability. Currently it appears that the research doesn't take into account whether we can manipulate the amount of social support that someone perceives, and whether this manipulation will have a positive effect on heart rate variability. Furthermore, we are unsure whether social support, stress, and heart rate variability has an effect on injury rehabilitation time.

2.9.3 Social support, health, and injury

Longitudinal studies find that perceived social support has a positive effect on reducing the risk of heart disease and cardiovascular problems (Gintin et al, 2016), respiratory diseases (Janicki Deverts et al., 2017), and even impacts mortality rates enhancing longevity and overall life satisfaction (Holt-Lunstad et al., 2015), social support has analgesic effects (Goldstien et al., 2018), modulates physiological responses (Bowen et al., 2014), and has positive effects on the stress response (Ditzen et al,. 2006). The importance of social support on the cardiovascular system cannot be over-looked. Lett et al. (2014) supports the notion that a good social network has positive effects on cardiovascular reactivity and hypothalamic- pituitary-adrenocortical axis (Hostinar et al., 2014) which has direct links to the polyvagal theory and vagus nerve discussed earlier in this section. In their work Teoh & Hilmert (2018) found a positive effect of social support that reduced cardiovascular reactivity, and that those receiving social support have less reactivity to stress and felt more supported than those without social support. Furthermore, Teoh & Hilmert (2018)

also found a buffering effect of social support, decreasing the cardiovascular response in a stress condition.

Adaptive physiological responses suggested by the polyvagal theory can help mitigate the effects of the stress response in the body. In their review Goodyke et al., (2021) explore the research on heart rate variability as a physiological marker of stress and perceived social support. They found only 8 studies that examined social support and heart rate variability. There was varied reporting of the relationship between social support and heart rate variability throughout the research. Three of the studies reported that those who perceived less social support had decreased levels of heart rate variability. Of the remaining 5 studies, 1 found no significant relationship between social support and HRV at rest. The final 4 studies found greater levels of perceived social support associated with high level of HRV, even when presented with an induced stressor. These varied findings suggest that HRV may be useful in studying the links between social support and the stress response, however more research would be needed to draw any strong conclusions about the relationships between social support and HRV (Goodyke et al., 2021).

2.10 Stress and social support

The evidence and models reviewed above suggests that social support influences the manner in which injuries heal. The integrated model (Wiese-Bjornstal et al., 1998) and the biopsychosocial model (Brewer, 2002) reference social mechanisms in the rehabilitation of injury. The relationships between social support, stress and health have been extensively researched in a wide variety of contexts (e.g., sport, business, and primary and secondary health care settings). In addition, a number of models have been presented to explain why social support may have an

effect on stress. The stress buffering models have been used to describe the moderating effects social support has on stress. These models assume that social support 'buffers' the individuals' responses to the stressor (in this case injury), essentially providing a filter to the stressful event. This interaction affects the strains that a person has placed upon them. Those with higher levels of social support will have a weaker stressor/strain relationship (Viswesvaran et al., 1999) and thus will be less affected by stress. The direct effect models assume that social support independently acts upon the individuals' responses to the injury and that social support increases the general level of positive affect a person experiences thus helping an athlete to be more realistic about their injury (Viswesvaram et al., 1999). Beyond these models, social support can be seen as a starting point for many health-related outcomes (Heaney & Israel, 2008). This occurs initially by meeting the basic human need for connection, a sense of belonging, and reassurance of worth (Berkman & Glass, 2000). Social support has also been shown to increase coping resources, community resources (that enable people to more effectively problem solve), and access key information (Heaney & Israel, 2008). The individual and community resources that become available for those with high levels of social support and social interaction may have direct health enhancing effects and reduce exposure to stressors. In addition to this Heaney & Israel (2008) further suggest that having good social networks can impact the frequency and duration of a person's exposure to stressors. For example, a supportive parent may give words of encouragement, wisdom, or ideas to a child in order to help them solve a problem they are faced with. Heaney & Israel (2008) go on to state that social support has a positive impact on health-related behaviours, specifically help-seeking behaviours (McKinlay, 2012) and other health promoting behaviours.

2.11 Stress, healing, social support, heart rate variability

In 2007, Robles conducted a study examining the relationships between stress, social support, and delayed skin barrier recovery. The study used 99 healthy people aged between 18 and 44, combining both males and females. During the study, participants took part in a 3.5-hour session of data collection where baseline blood pressure, baseline skin measurements, saliva samples were taken, and the skin barrier was disrupted. Once baseline measurements were taken participants were assigned to one of three groups where they experienced a no stress condition, a stress condition (consisting of a trier social stress test) and a stress and support condition (where participants were offered a level of social support from a confederate during the trier social stress test). The social support was manipulated during this study by an offer of support to prepare for the presentation part of the trier social stress test. Once the initial offer was presented the confederate sat quietly as a passive support provider during the test. The confederate also offered emotional support by asking about feelings, instrumental support by asking if the participant would like to rehearse their speech, informational support by giving tips and ideas about how to cope, and validation support by validating the participants emotions. Psychological measures taken included the Speilberger State and Trait Anxiety Inventory (Speilberger et al., 1983), and the Positive and Negative Affect Schedule (Watson et al., 1988), physiological measures taken included heart rate, systolic and diastolic blood pressure, and mean arterial pressure taken by an automated monitor, salivary cortisol, and skin barrier disruption measured by trans-epidermal water loss.

Findings of this study found that acute stress manipulated by the trier social stress test delayed skin barrier recovery. During the stress condition findings report a

10% and 15% delay in skin barrier recovery. In addition to this the study found that confederate support did not reduce any psychological responses, nor did it increase the speed of skin barrier recovery. This is in contrast to previous research suggesting that social support does impact upon skin barrier recover (Heinrichs et al., 2003). In addition, the findings support that social support did not affect self-reported anxiety, positive or negative affect, or the cognitive appraisal of the task. It is worth noting that this study was conducted in a laboratory where conditions could be controlled, thus questions about the ecological validity of the study could be raised. Further, the use of a confederate to provide social support is a significant weakness during this study. Given that we know social support is based upon relationships with others it is likely that people did not use the support as much as possible during the test, using an actual support provider from the persons own network or providing someone who had a better relationship with the participant may have increased the impact of the social support within this study. Furthermore, the researchers did not control for approach or avoidance attachment patterns which could have influenced use of social support and the physiological responses to stress (Maunder et al., 2006).

2.12 Chapter summary

Sporting injury is a costly experience on teams, the individual and the health service providing rehabilitation and medical care. This review has explored healing processes in relation to stress and social support and has shown support for the link between healing and stress. That healing can be influenced by the stress response, through physiological processes by influencing the hypothalamic-pituitary-adrenal and sympathetic-adrenal-medullary systems, which can increase epinephrine and norepinephrine in the body. Further the review has identified the link between social

support and stress. Previous research has found that through a stress buffering approach, social support has been shown to reduce stress. Given this idea that social support can influence stress, and that stress has a relationship to healing this link between social support, stress, and healing is worth exploring in more depth. Robles (2006) began to explore this link through the research using confederates in a lab study, however this study has several limitations that were explored above, further limitations identified that there is lack of research on enhancing social support through psychological intervention. Whilst narrative reviews help illuminate the landscape of research broadly, they do have their limitations. For example, they do not allow for direct comparisons between studies and typically describe but not analyse the results of the research in each area. For this reason, and because there is seemingly little research directed towards the influence of social support on rehabilitation outcomes in sport, the following chapter "narrows" the focus by using a scoping review to examine whether social support can have an impact on healing rate and injury recovery.

3. Systematic scoping review of social support and injury rehabilitation.

3.1 Chapter introduction

Chapter 2 concluded stating that healing theoretically is a process that is related to stress and social support. This process is influenced by the HPA axis, and the sympathetic-adrenal-medullary process, and finally that social support may have a direct or indirect effect on healing due to the ideas presented by the polyvagal theory. Although, the narrative review suggested that social support is associated with injury rehabilitation and recovery speed, one limitation of narrative reviews is that they are not replicable, they are prone to selection bias, and do not offer direct comparisons between studies.

To address this limitation, this chapter reports a scoping review that specifically examines the literature assessing the influence of social support on injury recovery. Scoping reviews are considered advantageous when there is a need to map the concepts that underpin a specific research area (Arksey & O'Malley 2005). They have a number of functions in the research space. Firstly, scoping reviews are used for synthesizing research evidence and aim to map the existing literature in a specific field (Arksey & O'Malley, 2005), they aim to map the current lay of the land within an area. Secondly, whilst scoping reviews are used to determine the scope of a larger systematic review or meta-analysis, they are often used to identify research gaps, and make recommendations on their own (Arksey & O'Malley, 2005). Thirdly, scoping reviews use a broader approach with a less specific research question. Finally, they are designed to provide an overview of the evidence base rather than assess the quality of that evidence.

Psychosocial interventions have been shown to reduce an athletes' susceptibility to injury (Williams & Anderson, 1998), facilitate recovery (Levleva & Orlick, 1991), help to improve a sense of control over the rehabilitation process (Flint, 1998), and help to improve communication between athletes, coaches, and sports medicine professionals (Ray & Weise-Bjornstal, 1999). In addition to typical psychological skills training such as goal setting, imagery, and relaxation, social support has been shown to be important and beneficial for injured athletes (Brown, 2005).

Of the varying psychosocial interventions available (e.g., relaxation, cognitive restructuring etc.; see Fletcher for review), social support is considered one of the most rigorously and frequently researched psychosocial resources (Thoits, 1995) and is a buffer against the effects of stress (Rees, 2007). Many types of social support exist in the literature (see section 2.8.2).

There are several reviews in the extant literature that have been directed to social support. Similar to the previous chapter, Taylor (2011), provided a comprehensive narrative review regarding antecedents, characteristics, and outcomes of social support. Sheridan et al. (2014) who reviewed social support in youth sport, Dimatteo, (2004) who reviews social support and adherence to treatment, Davidson (1987) who reviewed social support and cardiac rehabilitation, and Williams & Anderson (1998) who reviewed the psychosocial antecedents to injury, there appears to be only one review (Chronister et al., 2008) that aimed to summarise the impact of social support on injury related outcomes. This review found that perceived satisfaction (effect size 0.28), perceived availability (effect size 0.32), and perceived social support (effect size 0.21) have small effect sizes on psychological and physiological outcome related measure (e.g., The Beck Depression Inventory, life

satisfaction, diabetes control, and functional disability). This review had a number of limitations, specifically it focussed on the non-experimental, correlational studies, and not on the intervention studies and intervention outcomes, nor did it investigate the type of functional support in relation to rehabilitation outcomes, which would be of interest in the applied practice setting. Finally, this review found only 8 studies that reported physical rehabilitation outcome measures (Chronister et al., 2008) and concluded that more intervention-based studies needed to occur.

Because the previous chapter suggested that little research had investigated the impact of social support on healing among athletes, this scoping review was designed to capture literature that was connected to the healing of wounds among athletes, but also to be inclusive enough to draw on applicable literature that may facilitate understanding of the impact of social support on healing among adults more broadly. Accordingly, the objectives of this study were:

(1) To identify the impact, if any, of social support on rehabilitation outcomes.

(2) To identify the influence of the types of social support on specific rehabilitation outcomes.

(3) To consider the typical types of studies that are used when examining social support.

(4) To identify the social support providers and their impact upon rehabilitation outcomes.

(5) To propose ideas for further study around social support interventions and their effects on soft tissue rehabilitation outcomes.

3.3 Method

To explore these aims, a scoping study was undertaken. Scoping studies provide a less restrictive alternative to the normal systematic reviews of literature (Arskey & O'Malley, 2005). Arskey & O'Malley (2005) suggest four uses for scoping studies; (1) to examine the extent of the research activity, (2) to determine the value of a full review, (3) to summarise research findings, and (4) to identify gaps in existing literature. The proposed study was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews (Peters et al., 2017). The review had 5 key phases proposed by Arksey & O'Malley (2005): (1) to identify the research question, (2) to identify relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarising, and reporting the results.

3.3.1 Eligibility criteria/ types of sources.

This review considers both quantitative and qualitative studies including but not limited to, experimental, or quasi-experimental trials, cohort studies, uncontrolled trials, systematic reviews, and meta-analyses. Grey literature such as text and opinion papers would not be considered for inclusion. Media articles were also excluded. Inclusion and exclusion criteria were developed using the 'population, intervention, control, and outcome' (PICO: da Costa Santos, de Mattos Pimenta, & Nobre. 2007) acronym as a framework for sorting and structuring the search. This methodology is beneficial for developing search terms that are deemed relevant to the research question (Considine et al., 2017). Key strengths of this methodology are (1) it's ability to help researchers find information for specific populations and interventions, (2) it can increase sensitivity and precision of searches (Argoritsas et al., 2012), and

(3) it has a high sensitivity to retrieving relevant information (Eriksen & Frandsen, 2018). The PICO tool is a widely used tool to ensure an exhaustive list of information being investigated relates to the outcomes of the study (Brown, 2020).

Criteria drawing on the PICO tool, are detailed here and summarised in table 1. Specifically, in terms of *population*, the review focussed on (1) including only studies from countries with developed psychological associations (to increase the robustness of the review and studies contained within it), (2) amateur and elite athlete participants, medical patients, injured people, and all age groups. In terms of interventions, criteria included any social support intervention to keep a wide range of studies involved during the initial search strategy, with no necessary control group. As with previous literature there is a wide range of qualitative and quantitative research in the injury and social support sphere, therefore not including a control group would allow for a wider range of studies to be identified. Finally, any performance and physical rehabilitation *outcomes* were identified and recorded as per the aims of the review. Focus was on research that is written in the English language due to a lack of translations facilities, thus reducing the feasibility of effectively including the data in this review.

With regards to exclusion criteria, (1) mental health problems were excluded (as the focus of the review and wider project is on physiological healing from injury), (2) self-injury was also excluded as it is beyond the scope of the project and social support in this area has different uses (Christoffersen et al., 2015). Traumatic Brain Injury and Spinal Cord Injury were also excluded due to their complex and often longer-term recovery process. In addition to the type of injury, studies that were associated with war and natural disaster were excluded because social support in this domain is used to help people adjust to the stresses of the environment and adjust to

life post the disaster (Fontana et al., 1997). Finally, studies that had only physical intervention, studies from the developing world, non-English, non-empirical studies, and books were also excluded.

3.3.2 Search strategy

The search strategy was designed to locate published studies related to the research question. An initial search of the following databases was completed PsychINFO, EbscoHost, SportDiscuss, and Medline, to identify articles related to the subject area. The databases were chosen because of their comprehensive nature and ability to cover a broad range of sport and health related disciplines. Searches were performed in each database individually and each search term (summarised in table 2) was entered individually to allow for each of the criteria to meet the databases specifications. For example, using the PsychINFO database, search 1 'social support and injury' was completed, then search 2 'social support and injury recovery' was completed and so on until each search term had be covered. To some extent, the date range for the inclusion of research is somewhat arbitrary and subjective. However, based on the inception of the first sport psychology specific periodicals (Journal of Sport Psychology, 1979; The Sport Psychologist, 1986; Journal of Applied Sport Psychology, 1989) signalling a proliferation of research in this field, a reasonable and pragmatic approach was to include research from the 1980's onwards. Grey literature was not included in this study due to the large number of studies identified in the initial search. No limits on study type or subject were placed on the database search. The same search strategy was used for each database where a search of each of the main key terms was done, and references were downloaded to an excel database. Further, once the abstract review had been completed, the reference lists of relevant

papers were scanned for any other relevant papers that may have been missed in the initial search strategy.

Table 1 Inclusion and exclusion criteria for the scoping review

Inclusion criteria	Exclusion criteria
Population: Western/developed countries Amateur and elite athletes Medical patients Injured people All age groups	Population: Mental health Self-injury Sexual abuse War/disaster Disability (Physical/ mental) Carer Infants Traumatic Brain Injury (TBI) Spinal cord injury (SCI)
Intervention: Psychosocial interventions	Intervention: Physical intervention only
Control: Control group not necessary	Control: Studies from the developing world
Outcome: Performance outcomes (e.g., increases or decreases in athletic performance.) Physical rehabilitation outcomes (e.g., time to recovery, positive or negative recovery outcomes, leaving or returning to sport or work, return to normal daily life.)	Limits: Non-English language papers Non-empirical papers Book chapters Review papers

Table 2 Search terms entered in databases for the scoping review

Search Terms
Social support and injury
Social support and injury recovery
Social support and injury rehabilitation
Social support and healing
Social support and wound healing

3.3.3 – Study/source of evidence selection

Following the search, all identified citations were collated in an excel spreadsheet and duplicates were removed. Titles and abstracts of each identified study was screened against the inclusion and exclusion criteria described in the PICO approach above. Relevant sources were retrieved in full and their details were collated on a separate spreadsheet. Once the initial review of titles and abstracts was complete, a full text review was done. This more rigorous approach continued to identify those studies that did not meet the inclusion criteria for the review and reasons for excluding were recorded. Common reasons for articles being rejected were duplication of articles, articles that were relevant to mental health related recovery (e.g., self-harm and depression), articles not examining social support specifically, and articles related to traumatic experiences (e.g., social support in warzones, or social support after natural disaster). Finally, papers that were included were reviewed with a member of the supervisory team to gain agreement that each of the papers met the inclusion criteria for the review. Any disagreements were resolved through discussion between the two reviewers and papers were included or excluded on the basis of this discussion. All decisions are presented in the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping reviews (PRISMA-ScR) flow diagram (Tricco et al., 2018) presented below (Figure 2).

3.3.4 Inter-rater reliability

During the full text review the lead author and one other researcher screened all articles. Where there were differences in agreement (n=3) then these differences were resolved using discussion and a consensus between both researchers.

3.3.5 Data extraction

Data was extracted from the papers for inclusion in the scoping review by the lead researcher. The data was extracted and entered into an excel spreadsheet that was developed by the lead author to synthesise the data. For the included articles data was extracted on the following key areas; (a) the year of publication, (b) the number of participants, (c) the methodological design (qualitative or quantitative), (d) the methods of data collection, (e) the key findings and conclusions of each study (f) any reported injury related outcomes (e.g., decreased rehabilitation time and effective or ineffective recovery). There were no modifications to the data extraction process, or the data extracted from the selected studies during the scoping review as this was deemed not necessary. As recommended by the Joanna Briggs Institute protocol for scoping reviews (Peters et al., 2017) there was no requirement for a detailed critical appraisal of each of the sources of evidence.

3.3.6 Synthesis

The synthesis of the data extracted included quantitative analysis (e.g., frequency analysis) of the participants and methodology and qualitative analysis (e.g., content analysis) of the key findings of each of the studies. Each of the studies was analysed independently and then compared with each other. One author completed this analysis; the information was then coded and charted with key units of text identified to support the charting process.

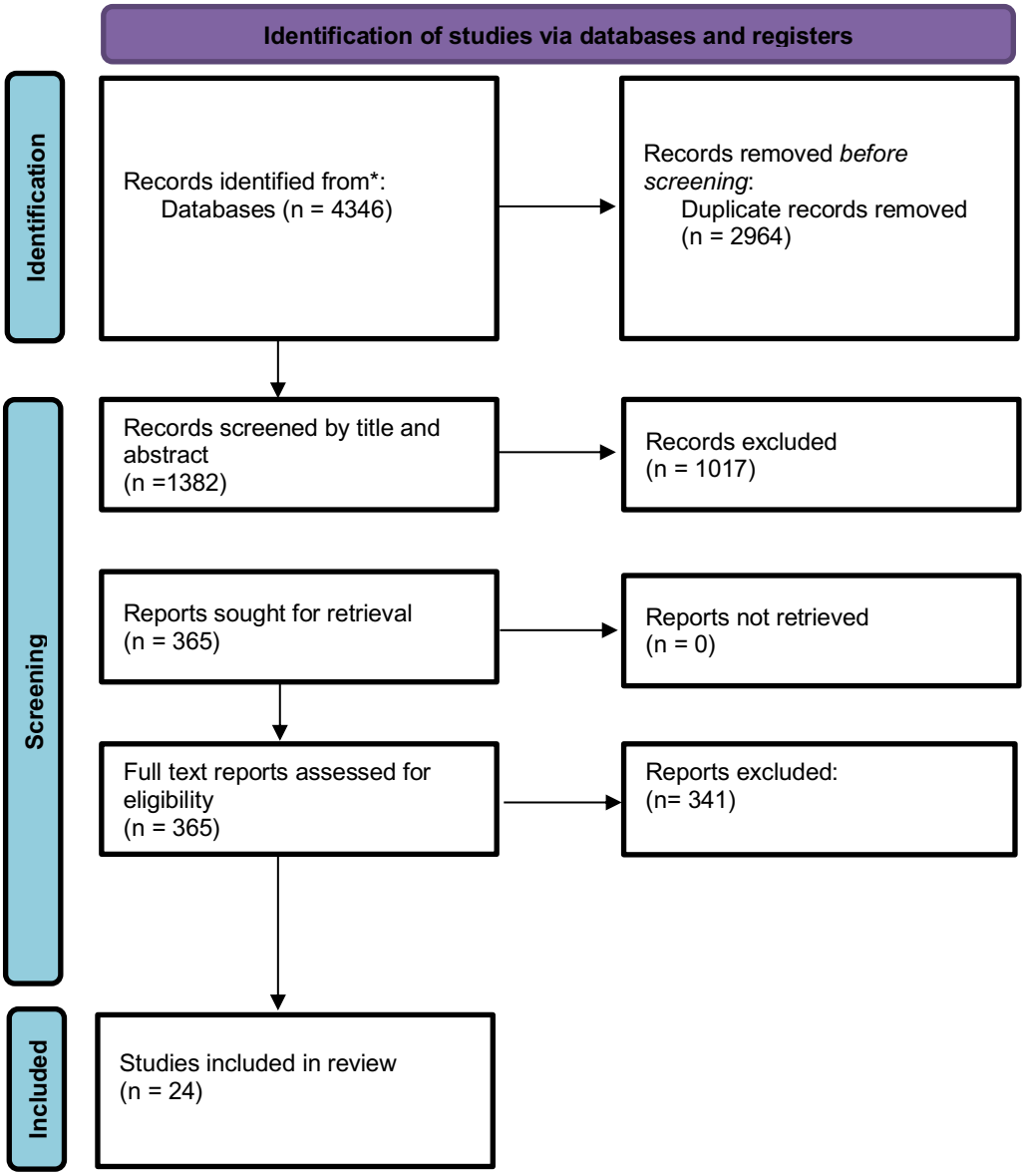

Figure 2: Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping reveiw (PRISMA-ScR) flow diagram for all screening stages.

3.4 Results

The search strategy yielded 4346 results, after screening for the inclusion and exclusion criteria 24 published articles were included in the review. Relevant data was extracted from each article and summarised in table 1. Articles were published between 1981 and 2015, specifically articles were published in 1981 (n=1), 1998 (n=1), 2000 (n=1), 2001 (n=2), 2003 (n=1), 2004 (n=1), 2005 (n=1), 2006 (n=1), 2007 (n=1), 2008 (n=2), 2010 (n=1), 2011 (n=2), 2012 (n=2), 2013 (n=2), 2015

(n=15). The total number of participants included in all studies was 2625, drawn from a range of samples including males and females, athletes, non-athletes, clinical populations, and non-clinical populations. 13 studies used a quantitative methodology, 7 studies used a qualitative methodology, and 2 studies used a mixed methods approach. The articles included in the review have used a wide range of measures to explore social support and injury including demographic information, life event stress questionnaires, social support inventories, mood state questionnaires, coping method questionnaires, life satisfaction questionnaires, rehabilitation beliefs questionnaires, diaries, semi-structured interviews, and qualitative questionnaires. For a full review of the research methods included in the articles see table 3.

Overwhelmingly the studies reviewed used a cross-sectional approach (n=20) taking data from one or two time points using both qualitative and quantitative approaches, 3 studies use a longitudinal approach, one lasted 11 years (Avlund et al., 1998), one followed an athlete over an 11-month injury (Carson & Polman, 2008), and one followed several athletes for between 6 to 11 months (Carson & Polman, 2008).

4.4.1 Overview of themes identified

The review identified 5 key themes: (1) usefulness of social support in rehabilitation outcomes (2) impact on recovery, (3) social support as a beneficial resource in injury, (4) types of social support, and (5) providers of social support. These themes were identified through an analysis of the results and discussions in each of the articles. Firstly, the usefulness of social support, all studies identified that social support had been seen as useful in producing a positive impact on recovery. Further, some studies found that social support is useful pre-surgery, during injury

recovery, and when working through a return to play protocol. One study (Robles, 2007) however did find that support from a confederate did not reduce psychological responses to an induced skin barrier injury, nor did it impact upon the speed of recovery. Secondly, social support has an impact on well-being during injury. Seven studies identified that social support from family, friends, peers, and athletic trainers had an impact on perceived well-being during injury recovery. Athletes report that social support may impact upon both psychological and physical well-being, and in one study social companionship has been shown to impact upon quality of life during recovery. Thirdly, social support is reported in almost all qualitative studies as a beneficial resource during injury rehabilitation. Eight qualitative studies summarised that perceived social support was beneficial during the rehabilitation phase, however there are very few experimental studies identified that directly aimed to improve social support markers to test the outcome. One non-experimental study found no relationship between perception of social support and the effectiveness of a rehabilitation programme. Fourth, 12 different types of support were reported through 13 of the studies examined, specifically emotional support (n=9), emotional challenge support (n=5), reality support (n=5), informational support (n=5), task challenge (n=4), task appreciation (n-4), listening support (n=3), tangible support (n=2), personal assistance (n=2), validation support (n=2), esteem support (n=1), and instrumental support (n=1). Finally, studies identified a number of providers of social support, specifically coaches (n=7), athletic trainers (n=6), family (n=6), teammates (n=5), medical staff (n=5), significant others (n=3), sport psychologists (n=1), and other providers (n=1). The below table (table 3) summarises articles that mention social support and injury rehabilitation.

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Table 3: Summary of the data extracted from included journal articles

Study number and author	Year	Study design,	Measure	Participants	Conclusions summary	Types of social support and social support interventions	Length of recovery
(1) Adam, Brassington, Steiner, Matheson	2004	Multi-method questionnaire plus structured interview about injuries in the past 10 months season.	(1) Demographic info, (2) Life event stress for college athletes, (3) the Social support Inventory, (4) life optimism test, (5) short POMS, (6) cognitive appraisals, (7) billings and moos coping responses inventory (8) sports injury rehabilitation adherence scale.	N=54 Mean age 26.59 Professional dancers. Males and females	(1) Life event stress, social support, disposition optimism did not significantly predict primary or secondary appraisal. (2) Correlations between negative life event stress and secondary appraisal, and dispositional optimism and primary appraisal were large. (3) Suggests the need for longitudinal interventions to address social support, sleep, and psychological distress	Nonexperimental study Types of support- Focus on subjective appraisal that one is loved, respected, and involved. Sources of support – none reported.	Length of recovery results not compared to social support
(2) Albinson, & Petrie	2003	Quantitative methods. Data collection completed by athletic trainer. Questionnaires given post injury and complete at 7, 14, 28 days post-injury.	(1) demographic information, (2) life event stress (3) Social support (4) Dispositional optimism (5) Mood state (6) Cognitive appraisals	N=84 17 people with injuries. Division 1 American football players. Mean age= 19.59	(1) life event stress, social support, dispositional optimism did not significantly predict primary or secondary appraisal of injury. (2) Correlations between negative life stress and secondary appraisals, and between dispositional optimism and primary	Nonexperimental study Types of support- Not reported. Only reported overall perceived social support. Sources of support- none reported.	Length of recovery results not compared to social support

			(7) Coping methods (8) Rehabilitation adherence		appraisals were large. (3) athletes who experience negative life stress perceived themselves as having greater difficulty coping with injury.		
(3) Avlund, Damsgaard, & Holstein	1998	Longitudinal study from the 1914 birth cohort. Qualitative design	(1) mortality, (2) structure of social relations, (2) function of social relations, (3) functional ability (Mob-T scale) associated with social relationship, (4) socio-demographic factors, (5)	N=1119 in 1914 total in this study 734 completed all phases. Mean age=70 Males only	(1) There is an association between social relations and mortality, (two aspects of social relations matter (a) to receive support for small or large tasks, (b) to help others with different tasks, those who engage in social relations had a decreased risk of dying at follow up. (3) social relations may serve different functions for men and women.	Nonexperimental study Types of support - Focussed on the structure of social relations e.g., the composition of the household (living alone, with children etc). and the function of the social relations (e.g., social support for activities of daily living, task support, and help given to others). Sources of support – none reported.	Length of recovery results not compared to social support
(4) Badger & Royse	2010	Quantitative study. Questionnaire based	(1) demographic and service use. (2) Perceived value of peer support (3) Social comfort (4) Quality of life (5) Life satisfaction	N=95 Burn survivors. Mean age 47 (sd 14.9).	1) Informal and formal peer support was seen as moderately positive. 2) Burn survivors positively regard peer support 3) Peer support has positive associations with outcome variables. New survivors can have their feelings and experience validated by others.	Non-experimental study Types of support- Focus on social comfort (e.g., the degree of social inclusion in social situations), and the degree of social integration (e.g. how much one is integrated within their community).	Length of recovery results not compared to social support

			(6) Social integration and productivity		4) webchat seen as lowest rate peer resource.	Sources of support – none reported	
(5) Bianco	2001	Qualitative design Semi structured interviews.	Hierarchical content data analysis. Idiographic interpretation and nomothetic description.	N= 10 Ages 19-45 Males and females	(1) The injury experience spanned three separate phases, injury phase, rehabilitation phase, return to competition. (2) there were distinct social support needs associated with each phase, (3) the skiers support networks varied across phases.	Non-experimental study No mention of social support interventions	Length of recovery results compared to social support.
(6) Bone & Fry	2006	Quantitative design	(1) Social support survey (SSS), (2) sport injury rehabilitation beliefs survey (SIRBS)	N=57 Mean age 20.13 Males and females	(1) Support found that when severely injured athletes perceive that their trainers provide strong social support, they are more likely to believe in their rehab program. (2) When severity of injury was accounted for stronger relationships emerged. (3) however, no support found for the relationship between social support and belief in rehabilitation program across the full sample size.	Non-experimental study Types of support - Focussed on examining listening support, task appreciation, task challenge, emotional support, emotional challenge, reality confirmation, tangible assistance and personal assistance. Listening support most important type of support. Followed by task appreciation, task challenge, emotional support, emotional challenge, reality confirmation, tangible	Length of recovery results not compared to social support

						assistance and finally personal assistance. Sources of support – none reported.	
(7) Carson & Polman	2008	Longitudinal quantitative design. Semi-structured interviews, and diaries	Hierarchal content analysis	N=5 Age = Male Rugby players with ACL injury	Split into phases with general dimensions (1) influential emotions or coping strategies, (2) initial injury phase - shock, helplessness, depression, frustration, anger, information gathering (3) pre-surgery phase - apprehension, anger depression, frustration, problem focussed coping, emotion focussed coping, avoidance coping, social support, (4) post-surgery phase- relief, anxiousness, problem focussed coping and avoidance coping, (5) limited participation phase - encouragement and apprehension, goal setting, avoidance coping, influence of previous injury knowledge (6) late limited participation - encouragement, apprehension, depression frustration, benefits of goal	Non –experimental study Types of support - Communication between player and medical staff, Motivation, Encouragement, positive reinforcement, Sources of support - medical staff, coaches, team, or family	Length of recovery results not compared to social support.

					setting, social support, problem-focussed coping, avoidance coping, (7) return to play phase - confidence building, apprehension, relief, goal setting, problem focussed coping, social support.		
(8) Carson & Polman	2012	Case study. Longitudinal investigation. Quantitative and qualitative. Diaries, interviews, questionnaires.	Emotional responses of athletes to injury questionnaire Sports inventory for pain Coping with health injuries and problems inventory MOS social support survey Adapted sport climate questionnaire Injury rehabilitation questionnaire Hierarchical content analysis	N=1 Age not reported Males	(1) physical competence important when dealing with fear of re-injury. (2) need for self-confidence high when returning to competition, (3) psych skills can aid return to competition, (4) problem focussed coping may be better used to facilitate return to play, (5) social support is influential to successful return to play.	Non – experimental study Types of support - emotional support, tangible support, affectionate support, and positive social interaction. Sources of support - Identified participants report perceived benefit from received support from medial staff, support from coaches, speaking with teammates, spending time with family, reassurance from medical staff, encouragement, and good communication.	Length of recovery results not compared to social support.
(9) Clement, Arvinen-Barrow, & Fetty	2015	Qualitative study Semi-structured interviews	Directed content analysis.	N=8 Age = 18-22 Male and female	(1) commonalities in psychosocial responses to injury across 3 phases of	Non-experimental study	Length of recovery not compared to social support

					injury. (2) athletes' appraisals, emotional, and behavioural responses evolve in a cyclical manner at each stage of recovery.	Types of support - Assessed listening support, emotional support, emotional challenge support, reality confirmation, task appreciation, task challenge, tangible support, and personal assistance. Support found for all types of social support. However, listening support seen as most important. No differences were found in the availability of different types of social support. Sources of support - Found that athletes currently more satisfied by support provided by their athletic trainers than that provided by coaches or teammates.	
(10) Clement & Shannon	2011	Descriptive, quantitative design.	Demographic information Social support satisfaction modified for athletes	49 injured athletes. Mean age 20.1 years Males and females.	(1) Injured athletes significantly more satisfied with social support by athletic trainers. (2) Injured athletes reported social support provided by athletic trainers contributed to their well-being.	Non-experimental design Types of support – non reported. Sources of support - Athletic trainers, or significant others.	Perceived length of time to return to sport considered.

(11) Clement, Granquist, & Arvinen-Barrow Athletic trainers.	2013	Mixed methods Online survery with qualitative and quantitative items		N=215 Mean age – not reported Males and females	(1) Athletic trainers perceive athlete to experience a number of psychological responses to injury (stress/anxiety, anger, adherence problems. (2) AT's use short term goals, keeping athlete involved in the team, and creates variety in rehabilitation. (3) increased levels of stress suggested to negatively affect well-being and self-worth.	Non- experimental study Types of support - emotional control strategies, enhance self-confidence, encourage positive self-talk, encourage effective communication. Sources of support - Athletic trainers	Length of recovery not compared to social support
(12) Davidson, Bowden, Tholen, James, & Feller	1981			N=314 Males and female No age reported	(1) social support directly and indirectly associated with post burn adjustment. (2) social support form family friends and peers for subjectively related to life satisfaction, self-esteem, and participation in social and recreational activities. (3) social support moderates the rehabilitation process independent of the severity of the burn injury.	Non-experimental study Types of support – esteems support, informational support. Sources of support - family, friends, and peers.	
(13) Evans, Hardy, & Fleming	2000	Action research study Consults with participants and	Reflexive narrative.	N=3 Males	(1) emotional support perceived as important when rehabilitation progress was slow, set-backs were	Non-experimental study. Types of support- Emotional support	

		physiotherapists. Face to face and telephone. Diaries, case notes, interviews.			experiences, and life demands added pressure, (2) task support took the form of goal setting, used to enhance motivation and adherence in early and mid-phase rehabilitation	(listening, and emotional challenge support). task support, task challenge support (goal setting), Sources of support- physiotherapist, sport psychologist.	
(14) Inigo, Podlog, & Hall	2015	Scanlan Collaborative Interview method (mixed method approach)	Intra-textual deductive analysis Inter-textual analysis over 4 stages.	N=10 No ages reported Males and female	(1) 7 participants included social support in the commitment picture. (2) family and teammates represent significant support networks. (3) social support, sport enjoyment, valuable opportunities, personal investment, and social constraints are salient in energising participants to return to sport after injury.	Non- experimental study Types of support-. Not reported Sources of support- family, teammates. Coaches,	Length of recovery not compared to social support
(15) Kempen et al.	2001			N=171 No ages reported Males and females	(1) recovery was significantly associated with social support (2) high levels of support showed better recovery (3) recovery is not associated with education level (4)	Non- experimental study Types of support- not reported, only overall social support reported. Sources of support- not reported	
(16) Lu & Hsu	2013	Cross-sectional study. Quantitative.	Trait hope scales Sport injury rehabilitation beliefs survey	N=224 Males and females	(1) low hope = social support was associated with high levels of subjective well-being (2) high hope =	Non-experimental study. Types of social support- emotional support,	Length of recovery not compared to social support

			Satisfaction with life scale Positive affect and negative affect scale Multidimensional scale of perceived social support.		social support has low association with subjective well-being.	informational support, tangible support, and esteem support. Sources of social support- family, significant other, peers, teammates, coaches, and athletic trainers.	
(17) Malinauskas	2008	Quantitative design	Social support survey	N=29 Males and females	(1) social support given by coaches is important for athletes (2) social support is a contributor to physical well-being (3) Perception of social support buffers against impact of stress, (4) Social support may help counteract two of the causal mechanisms (self-preoccupations, chronic muscular tension.	Non-experimental study Types of support-task appreciation support, task challenge, emotional support, emotional challenge, reality confirmation Sources of support- coaches,	Length of recovery not compared to social support
(18) Muangman, Sullivan et al.	2005	Quantitative	Demographic, Therapeutic and outcome data collected	N=36 Males and females	(1) The presences of social support and the size of the burn are the only differences when considering risk of death. (2) survivors of severe burns may benefit from increased presence of friends and family.	Non-experimental design Types of support- not reported Sources of support- family and friends	Social support proposed as a moderator to lengthen life span.

(19) Nijis, Ingbelbrecht, daenen et al.	2011	Quantitative study	Neck disability index Medical outcome study short form Anamnestic comparative self-assessment measure of overall well-being. Symptom checklist 90 Dutch personality questionnaire Social support list	N=143 Males and females	(1) personality traits and social support have a role in long term functioning following whiplash injury (2) inadequacy, self-satisfaction and resentment associates of long term functioning (3) the discrepancies dimension of social support identified as more important for long term functioning following whiplash (4) everyday emotional support, emotional support during problems, appreciative support, and informative support identified as correlates of long term functioning following whiplash. (5) social companionship and informative support play some role in recovery. (6) social companionship is related to quality of life.	Nonexperimental design Types of support- emotional support, information support, appreciation support Sources of support- not reported	Length of recovery not compared to social support
(20) Podlog, Wadey et al.	2013	Qualitative design	Semi-structure interviews over 2-3 occasions over 11 months Intra-textual and inter-textual analysis using	N=11 M and F	(1) social support was seen as a benefit and relevant to relatedness need satisfaction (2) This impacted upon injury related growth and experiences of success	Nonexperimental design Types of support- emotional support, informational support	Length of recovery not compared to social support

			constant comparative method.			Sources of support- physiotherapist, coaches, peers,	
(21) Robles	2007	Quantitative laboratory study	Delayed skin barrier response (trans-epidermal water loss). Cardiovascular activity Salivary cortisol Health related behaviours Spielberger state trait anxiety inventory Positive and negative affect schedule	N=85 M/F	(1) acute stress in the lab delays skin barrier recovery (2) confederate support did not reduce psychological responses of speed skin barrier recovery (3) social support manipulation did not affect self-reported anxiety, positive or negative affect, or cognitive appraisal of the task.	Experimental study Types of support- information support, emotional support, instrumental support, validation support. Sources of support- confederate.	Social support did not reduce physiological response to skin barrier disruption.
(23) Ruddock-Hudson, O'Halloran, & Murphe	2012	Qualitative	Semi-structured interview Thematic analysis	N=43 Males only 18-36 years	(1) Social support from staff, players, and family provide informational and emotional support throughout the injury period (2) Continued support from family and partners reported as a major contributor to successful rehabilitation (3) Positive feedback from coaches may have assisted their recovery following serious injury.	Non-experimental study Types of support- emotional support, validation support, information support Sources of support- family, sport staff, teammates,	Length of recovery not compared to social support

(24) Watt, Ford, Doley, Ong, Hicks, Fritzon, & Cacciola	2015	Quantitative	Demographic Experience and evaluation of work Multi-dimensional scale of perceived social support	N=110 M/F	(1) Participants with durable return to work outcomes report significantly better relationships with superiors and colleagues	Non-experimental study Types of support- not reported, overall support studied. Sources of support- family, friends, significant others.	No significant differences were found between social support and return to work and non-return to work groups. All groups reported similar levels of social support.

3.5 Discussion

The aims of the study were, (1) to identify the impact of social support on rehabilitation outcomes, (2) to identify the types of social support on rehabilitation outcomes, (3) to consider the types of studies that are typically used to examine social support, (4) to explore the social support providers and their impact upon rehabilitation outcomes, and (5) to propose ideas for further study around social support interventions and their effects on soft tissue rehabilitation outcomes. Through the scoping review, 24 articles were identified that reported links between social support and healing measures. These papers have been published from 1981 through the present day with half (11 studies) published since 2010, suggesting a rise in interest in this area of research. This review catalogued and synthesised the literature in the area of social support, stress and healing with a view to exploring the specific links with the variables but also identifying specific gaps for further research in this area.

Within the studies reviewed 15 presented as quantitative, examining a mix of relationships between social support, rehabilitation, and recovery. This mix varied across studies, overwhelmingly there is a reliance on cross-sectional research in this area, and it is possible that social support is a variable that is typically observed rather than manipulated by researchers. Six studies were qualitative in nature, often examining three key themes, these are 1) the perceptions of the use social support, 2) the amount of social support available, and 3) the satisfaction of this support during the injury rehabilitation process. It appears that less importance is placed on the lived experiences of participants using and experiencing social support, and that once again

social support is something that is typically observed and explored rather than manipulated and enhanced. Finally, 3 studies used a mixed methods approach.

Social support has been found to be beneficial to rehabilitation-related outcomes. In 14 studies it was shown to improve emotional control, rehabilitation adherence, psychological responses to injury (e.g., stress) and rehabilitation success. There appears to be a strong relationship between positive social support and positive injury rehabilitation experiences. Malinauskas (2008) found that perceptions of social support buffers against stress, and that it is a contributor to physical well-being, Evans, Hardy, & Fleming (2000) suggests that emotional support is important in improving the speed of rehabilitation, and task or tangible support is useful when improving adherence, Damsgaard & Holstein (1998) found that social support was significantly beneficial in reducing mortality rates in a longitudinal study, and Badger & Royse (2010) found that peer support had a positive relationship with outcomes in burn survivors, specifically they found that emotional support was most useful, and validation of emotions improved outcome variables.

In addition to social support being beneficial for rehabilitation experiences, 9 studies found social support to be useful in buffering life stress. This finding supports the stress buffering models proposed by Rees (2007). Bone & Fry (2006) found that social support was more useful with a severe injury and that it has a positive impact on successful return to sport (Carson & Polman, 2012; Kempan et al., 2001). Outside of an athlete population social support has been found to moderate the rehabilitation process in burn patients (Davidson et al., 1981). This evidence suggests a fairly strong link between social support and the recovery process. However, in most of the studies reviewed the mechanisms that increase success of the recovery process is not known,

and the specific types of social support that impact outcome variables again are yet to be explored fully.

In 4 of the studies reviewed life stress had been associated with injury. Specifically, life stress has a negative impact on an athlete's ability to cope with injury rehabilitation (Albinson & Petrie, 2003) and has a negative impact on the primary and secondary appraisals of injury (Adam et al., 2004). Life demands have an impact on injury by adding pressure to the experience, which can potentially be mediated by social support (Adam et al., 2004). Therefore, the amount of stress can have a negative impact on injury outcome through the appraisal process, but no studies were found that fully explained why life stress impacts upon the injury rehabilitation process or whether it has an impact on the length of recovery. Whilst in this review there were few studies that suggested life stress has an impact on injury, the specific underlying mechanisms would be worthy of further exploration.

In fulfilling one of the aims of this review types of social support were extracted from the literature. It is clear that athletes report certain types of social support more often than others (e.g., emotional support). Emotional support is reported in more studies reviewed than any other type of social support. The reasons for this are unclear, however it could be because of the mix of emotions that people go through when they suffer from an injury. Clement et al., (2015) state that there are a number of changes that happen during the rehabilitation process and therefore the need for emotional support may be higher during this phase. Interestingly the next most reported types of support are emotional challenge support where people are using support providers to challenge their emotions and improve their realism, and informational support. Given that during rehabilitation individuals have a range of appraisals associated with the rehabilitation process, thoughts around re-injury, and

thoughts around injury severity (Clement et al., 2015), it is un-surprising that emotional support is reported more frequently. Conversely a number of types of support are reported less frequently throughout the literature reviewed; specifically esteem support, tangible support, and instrumental support. This is quite surprising as it is often reported or thought that during times of injury, injured persons require significant assistance in facing life challenges related to their injury (Lu & Hsu, 2013). Further, Bone & Fry (2006) state that tangible assistance support was significant and had an influence on treatment efficacy, however as previously stated this has not been repeated through the rest of the literature. Very few details are given within the studies of how these types of social support are provided, for example what is it that a social support provider does that enables and athlete to feel that they have been given emotional or informational support. This may be due to the way in which the data on social support is collected, in this review we identified that the most common way of investigating social support is using social support questionnaires these assess the amount of perceived social support one received but miss the opportunity to explore how a provider goes about providing a specific type of support.

When reviewing the studies, 8 different sources of social support were identified. Specifically, coaches and athletic trainers were reported in the greatest number of studies. There could be several reasons for this, specifically athletes tend to spend most of their time with their technical coaches, therefore it makes sense that they would be seen as the most likely and most available source of support. Given that the primary relationship in sport is that of a coach and athlete, these relationships often have the strongest bonds and therefore may offer the primary source of social support for an injured athlete. In addition, one of the primary rehabilitation professionals involved with an injured athlete is the athletic trainer and secondary to

the technical coach, athletes often spend a large amount of time with their athletic trainers compared to say a performance nutritionist. Further to this, athletic trainers are one of the primary professionals involved in developing and delivering rehabilitation plans, so it makes sense that athletes perceive these individuals as good social support sources. Outside of these two sources, teammates, family, and medical staff are also reported in several studies as social support sources, again this makes logical sense, as these are people that are in the secondary performance circle outside of the coach athlete relationship. Surprisingly, only one study reported the use of a sport psychologist as a social support provider, this opens the question as to the role of a sport psychologist in the injury rehabilitation process and whether they have a role in helping to rehabilitate athletes.

Only one study (Robles, 2007) attempted to increase social support under laboratory conditions by using a confederate to provide social support prior to a stress-inducing task. This confederate was provided to help the participant prepare for the stress-inducing task, they offered verbal comments, instrumental support to help the participant prepare for their speech, information support to help calm the participant down and some validation of the participants emotions. This study found that the attempts to increase social support 10 minutes prior to a stress-inducing task had no effect on wound healing, they state that the use of a confederate instead of using the participants own social network is a limitation of this study. No other study screened mentioned an intervention designed to increase actual or perceived social support. It may be that the relationship with the person giving the social support is a key characteristic in how it is received.

One of the most surprising outcomes of this review is the lack of attention that has been paid to the length of recovery outcomes. The reduction in recovery time post

injury has an important impact to health services, sport science and medicine services, and to sports teams, athletes, and their coaches. Anecdotally, one of the most asked questions athletes have when they are injured is 'when can I return to play?'. Of the studies reviewed, only four studies considered or reported any information relating to length of rehabilitation time. In addition to that only two of those studies considered that social support might impact rehabilitation length. The results of those studies are also surprising in that they report that social support has no impact on physiological recovery.

The studies reviewed have a number of note-worthy limitations. Firstly, overwhelmingly the studies are cross-sectional by design, which can create a number of problems for interpreting the impact and usefulness of the results. These designs make it difficult to make any causal inferences and we cannot fully explain what impact social support has on stress and recovery outcomes, only that it does have some positive effect. Secondly, these studies offer only a small snapshot of the whole process that participants go through when using social support during rehabilitation (Levin, 2006). The longitudinal studies that were included in this review were mainly quantitative in design thus again making it difficult to identify causal links and full explanations of why social support has a positive impact on stress and healing. Further limitations of the studies reviewed include sample size (n=4), the use of self-report measures of stress, social support, and other variables (n=24) with no correlations with objective measures, and many of the studies reviewed relied heavily on retrospective recall to assess variables and to glean information through interview.

All but one study (Robles, 2007) failed to look at the physiological markers of injury, stress, or healing. The study reported having more participants than previous research however still had a low to moderate power to test small effect sizes and the

study used confederates to provide the social support. It was however the only study reviewed to consider using someone to increase the level of social support. This is a big limitation as the previous research has identified that people known to the injured person are reported as good sources of social support, none of the studies reviewed here mentioned that strangers were used as source of social support. All of the studies reviewed including the Robles (2007) study used a self-report approach to social support, rehabilitation length, and perception of stress during injury rehabilitation, in addition most of the studies reviewed use a retrospective recall approach, sampling athletes that had been through injury and completed the rehabilitation process. There are a number of significant limitations to the use of self-report data within psychology, specifically, 1) the level of honesty and accuracy of the reported information, 2) the potential lack of introspective ability that some participants have, meaning that they may not be able to assess themselves accurately, 3) the potential for participants to interpret the questions incorrectly or some questionnaires having a restrictive rating scale meaning that the data collected is limited and does not answer the question fully, and 4) there is an issue related to response bias, specifically each of the questions is biased by the previous responses. There is a need to validate participants' responses to stress questionnaires, and injury/healing markers with more accurate physiological markers. There is potential within this research to use an interdisciplinary psychophysiological approach in order to reduce some of the limitations of the non-experimental questionnaire designs that have come previously.

Despite the findings that social support is useful in life stress and injury rehabilitation few studies have attempted to explore the links between stress, social support, and injury recovery. Even less studies have attempted to manipulate social support in order to improve recovery outcomes. Once again this is an interesting yet

concerning finding. We know the types and sources of social support that are reported to be beneficial but there has been no experimental research that points to the increasing or decreasing of actual provided social support to injured athletes in order to examine the likelihood of reduced recovery or rehabilitation time. Future research should aim to fill this gap and explore experimentally the impact of provided social support on rehabilitation outcomes, not just self-reported, retrospectively recalled data.

Further, future research could look to more fully explore the links between key variables like stress, social support, and injury recovery. In addition, future research could look to explore ways to manipulate and improve social support and therefore theoretically improving recovery outcomes. Furthermore, there is very little research that uses heart rate variability or any physiological marker of stress as a way of exploring the effect of social support on stress, as much of the research that has been done has used self-report measures of stress. In line with recommendations from Chronister et al. (2008) there is a need to do more experimental research manipulating the levels of social support people receive to explore if this has an impact on rehabilitation outcomes.

3.6 Chapter summary

This chapter identified 3 key findings. Firstly, it found that none of the studies included in this review reported rehabilitation outcome measures (e.g., speed of recovery), secondly, the review proposes that the question of whether social support impacts upon rehabilitation outcome remains unanswered, and finally, there are methodological limitations of the current research specifically the use of cross-sectional designs which aimed to explore perceptions of social support via

questionnaires or through qualitative interviews, these were usually focused on the process of rehabilitation (e.g., whether rehabilitation was less distressing or completed) rather than the outcome of rehabilitation. Future work should firstly consider the use of experimental designs, intervention-based research, and consider whether the sport psychology professionals can be an effective support provider in order to close the gap in understanding whether social support can be an active ingredient within rehabilitation outcome.

3A. Summary of Reviews

The reviews presented at the beginning of this programme of research aimed to examine the sport injury and social support literature. Chapter 2 explored the biopsychosocial model of sport injury and then aimed to summarise relevant theory related to the physiological processes of the autonomic nervous system and its impact on bodily healing (the biological), then explore the links between stress and social support on health outcomes (the psychosocial). Chapter 3 aimed to build on the key findings from chapter 2 and explore more specifically the research relating to social support and injury. Specifically, the chapter aimed to identify whether social support can be an 'active ingredient' in the rehabilitation process.

Chapter 2 set out to present a narrative of the psychophysiological mechanisms of stress (the polyvagal theory), healing, and social support. The chapter found that healing has a stress related component. Stress can influence the effectiveness or efficiency of the physiological process of bodily healing through the hypothalamic-pituitary-adrenal axis. The review identified that there is a link between the HPA axis and the autonomic nervous system. Given this idea the polyvagal theory, developed by Stephan Porges, was proposed as a theoretical explanation for the link between psychological stress and the autonomic nervous system. Suggesting that autonomic regulation can be achieved through the use of psychological techniques and strategies. One particular technique suggested by Deb Dana (2020) is that of co-regulation. Co-regulation has significant similarities to social support suggesting that human being's co-regulation in their social circles and that social support can influence autonomic regulation through a social engagement system. This can have a positive effect on the fight, flight, or freeze system, the stress response, and threat awareness. Theoretically then, social support should have a positive impact

upon autonomic nervous function, the stress response, and in turn healing effectiveness and efficiency.

Chapter 3 then built on the limitations of a narrative review, with the aim to explore whether social support can have a positive impact on healing rate. The scoping review found that no studies included in the review examined the actual rate of healing, they did not include any measure of successful recovery, or any outcome related measures. Secondly, the scoping review found that there are number of methodological problems related to the sport injury and social support research. Specifically, there is an over reliance of cross-sectional, correlational, or quantitative design studies. This is problematic as whilst social support is seen as a moderating or mediating factor in sport injury, and even as a predictive or preventative factor in sport injury, very little research has been conducted to explore whether social support can be increased or improved for injured athletes and what effect this might have on their rehabilitation outcome.

The reviews above conclude that an examination of the social engagement system, social support, stress, and healing would be worthwhile. To extend the previous literature some experimental research into social support as an active ingredient of the injury healing process would also progress the literature forward. The next steps in this programme of research would be to clarify the mind-body connection in terms of heart rate variability, polyvagal theory, the social engagement system, and healing rate, consider how perceived social support may be increased or improved upon in group and individual settings, and explore what effect increases in social support have on the stress and healing relationship. The next chapter sets out the methodological approaches used to examine these aims.

4. Methodology

4.1 Chapter Introduction

Given (a) the operational definitions of social support and injury outlined in chapter 2 (see sections 2.9 and 2.3 respectively), and (b) the identified research questions guiding this program of research (section 1.2), this chapter provides an explanation of the process that informed *how* to address these research questions. This programme of research, like any other is an act that takes place among a community of scholars, who share similar ideas about the appropriate ways of asking questions, going about research, and interpreting data (cf. Sparkes, 1992). Indeed, the research term, that is often employed to describe these research communities is "paradigm" (Schulman, 1987).

Broadly speaking, one metaphor that has been used to describe paradigms is that of lenses through which we experience and enact with the world, and that shape our methodological decisions (see Sparkes, 1992). As someone who is already variably entangled within this community as a research consumer, producer, practitioner and learner, it is fair to suggest that I am already wearing some lenses; as author, I do not enter this programme of research as a tabula rasa.

Accordingly, given the heterogeneity of how both social support and injury *could* be understood (discussed in chapter 2), this chapter (a) provides a consideration of paradigmatic assumptions associated with research, (b) articulates the author's positionality (cf. Holmes, 2020) in relation to these assumptions, and (c) operationalises these parameters for the methodological decisions underpinning this programme of research.

4.2 Paradigms

Based on the work of Kuhn (1970), a paradigm comprises basic ideas, methods, language, and theories that are accepted by the members of a scientific community (cf. Anand, Larson, & Mahoney, 2020). Anand et al. (2020), further contend that "a paradigm creates clear boundaries for what makes up a given field or defines which theory is relevant. These boundaries enable scientists to harmonize the choice of research questions, methods, and ultimately, the direction of inquiry in their fields" (p. 1651). For Kuhn, this shared constellation of ideas and practices leads to normal science, which can be defined as "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice" (Kuhn, 1970, p.10).

Kuhn (2012) states that science does not usually go through uniform development but has an alternating development going through slower (normal) and revolutionary (extraordinary) phases. Normal science on a day-to-day basis represents a cumulative approach to the development of knowledge, where today's knowledge builds upon what was found yesterday, in essence the puzzle is more solved now than it was before, thus a cumulation of knowledge occurs over time (Kuhn, 1962).

The question of whether science proceeds as Kuhn (1970, 2012) contended has been problematized. Indeed, whether psychology as a discipline has attained a period of "normal science" has also been challenged (Passer & Smith, 2004). Illustrative of the latter claim, Driver-Lynn (2003), has presented the discipline of psychology as fragmented and that although psychologists want to understand, predict, and intervene in relation to a particular phenomenon, their approaches are characterized and rooted in two traditions (i.e., natural and social sciences)

characterized by different assumptions about what is "real" and how knowledge of what is real is acquired.

With regards to these basic beliefs, Sparkes (2015) cites Denzin & Lincoln's (2005) proposition that paradigms are generated and characterized by how researchers respond to the following questions: What kind of being is the human being? What is the nature of reality? (ontological questions); How do we know the world? and what is the relationship between the knower (the inquirer) and the known (or knowable)? (epistemological questions). In particular, how these philosophical questions are answered informs a theory of how inquiry should proceed in practice, how researchers might go about gaining access to, and acquiring knowledge of the world, and what comprises legitimate research. For Whaley & Krane (2011), philosophy is inseparable from research practices; methodology is the bridge between epistemology and methods. In the following section, I explore the different ways in which the natural and social sciences broadly address ontological and epistemological assumptions, before positioning myself and contextualising this research in these debates more precisely.

4.2.1 Philosophical Assumptions

As alluded to above, a number of philosophical assumptions are embedded within the research process, whether one conceives of this research being conducted within a paradigm or not. Here, I consider three broad assumptions that have been suggested to characterize different paradigmatic positions associated with the natural and social sciences, namely ontology, epistemology, and axiology.

Ontological assumptions are associated with beliefs about the nature of existence (Sparkes, 1992), that is, the subject matter of research. Burrell & Morgan

(1979) succinctly suggest that researchers are confronted with the question of, "whether the 'reality to be investigated is external to the individual – imposing itself on the individual consciousness from without – or the product of individual consciousness; whether reality is of an 'objective' nature, or the product of individual cognition; whether 'reality' is a given 'out there' in the world or the product of one's mind" (p.1).

Sparkes (ibid) highlights that the former is indicative of an external-realist conception of reality, whereas the latter is associated with an internal-idealist position. The ontological assumptions are intimately related to questions of epistemology, that is questions of knowing, in particular, how we come to know reality. Epistemological assumptions then, are beliefs about the grounds of knowledge. As Burrell & Morgan (1979) suggest, epistemological assumptions are,

> "about how one might begin to understand the world and communicate this as knowledge to fellow human beings. These assumptions entail beliefs, for example, about the forms of knowledge that can be obtained, and how one can sort out what is regarded to be 'true' from what is regarded to be 'false'. Indeed, this dichotomy of 'true' and 'false' itself presupposes am epistemological stance. It is predicated upon a view of the nature of knowledge itself: whether, for example, it is possible to identify and communicate the nature of knowledge as being hard, real, and capable of being transmitted I tangible form, or whether 'knowledge' is of a softer more subjective, spiritual or even transcendental kind, based on insight of a unique and essentially personal nature. The epistemological assumptions in these instances determine extreme positions on the issue of whether

knowledge is something that can be acquired on the one hand, or something which has to be personally experienced on the other" (ibid, p.2).

The former, is classed as an objectivist epistemology, whereas the latter is associated with a subjectivist epistemology.

Axiology refers to a set of assumptions regarding the place of researcher values in the research process (Ponterotto, 2005). On the one hand, a strong positivist position would present the research process as value free (see table 4 for a summary of assumptions associated with positivist and constructionist paradigms); that the research process is devoid of values in terms of the questions that are asked, and that researcher values and biases can be eliminated via rigorous objective protocols. On the other hand, is an argument that values are enmeshed throughout the research process, from the research questions that are contemplated, through to the manner in which results are presented and disseminated.

Admittedly, although somewhat of a caricature, the positivist position is indicative of a set of assumptions more aligned to the natural sciences, whereas the constructionist position is more aligned with that of the social sciences (see Driver-Lynn, 2003).

Table 4: A summary of assumptions associated with the positivist and constructionist views

	Positivist	Constructionist
Ontology	External-realist	Internal-idealist
Epistemology	Objectivist	Subjectivist
Axiology	Value-free	Value-laden

3.3 Researcher Positionality

Alongside these philosophical assumptions, it has been argued that consideration of the researcher's positionality in relation to these assumptions is associated with researcher development (Holmes, 2020). As Holmes attests, although a statement of positionality is not fixed, and does not *guarantee* better quality research, it has been associated with more credible and ethical research.

As a researcher I am not a tabula rasa: arguably I have "skin in the game" (pun intended!) As a Health and Care Professions Council practitioner psychologist, there are several facets of my personal experiences and development that shape the relationship I have with these ontological, epistemological and axiological assumptions. I am a HCPC accredited sport and exercise psychologist who has worked as an applied practitioner in private practice, for a national team, and within professional sport since 2012. This focus on applied work has shaped a number of values about the nature of science and research. A shared understanding of phenomena (e.g., social support) provides a platform for research and practice. However, it is also important to be able to quantify, control and predict as far as possible. This is typically quite important in elite sport where providing data and evidence of impact is arguably important to professional success. Further, science should aim to reduce the research-practice gap, aiming (at least in part) to solve applied problems and provide evidence to support applied practitioners in their work. To further enhance the translation of research and practice, the use of techniques and methodologies that are attainable and available to practitioners can be helpful. Beyond recent experiences of research and practice in sport psychology, there are residues of earlier experiences that impact the translation of philosophy to practice. After leaving university with an MSc in Sport and Exercise Psychology, I worked as

an Ambulance Technician with another technician or Paramedic responding to 999 calls across London. I worked 12-hour shifts responding to medical emergencies ranging from common falls to cardiac arrests and major trauma incidents. In this role, I developed a good knowledge of applied emergency medicine to treat people on the frontline of the NHS. This medical knowledge included detailed understanding of the musculoskeletal system, cardiac and respiratory system, digest system, neurological system, their functions, what can go wrong, and how to provide emergency treatment prior to more specialist treatment in a hospital. This experience helped me appreciate the interplay of the physiological systems influencing recovery, and also the interpersonal factors shaping patients' responses. Similarly, my experience of using portable and effective measures of bodily systems, and my applied practice experience when trying to measure intervention effectiveness in the real world influenced how I considered the usefulness of different measures.

For example, the use of HRV and the Polar H7 (see section 2.6) as a data collection method was influenced not only by the validation research but also a pragmatic mindset of wanting to use a methodological approach that was applicable "in the field by many" as opposed to "in the laboratory by the few".

Threads of literature relating to the characteristics of doctoral study (Zier et al., 2012), evidence-based practice (Sackett, 1996; Winder & Collins, 2014), the knowledge-practice gap (Vealey, 2006) weaved themselves alongside literature on philosophical assumptions and "doing research that is useful" surfaced as a personally orienting value.

4.4 Operationalising the methodological approach

On the one hand "paradigm talk" can be considered a "good thing to think with", yet on the other, there invariably remains questions about how these philosophical questions translate to practical methodological choices. In this section, I endeavor to distill a sense of the debate about the paradigmatic philosophical assumptions, alongside my own positionality, to operationalize a "way of doing" this research.

Where paradigmatic assumptions and researcher positionality coalesce is in what has been described as the "middle ground" (Driver-Linn, 2003). Although a pragmatic philosophy has been described as a third paradigm, I want to de-emphasise (rather than eschew) the philosophical implications and elucidate a *pragmatic methodology*. Specifically, there are no correct answers to these philosophical positions and sooner, or later, we have to get on with the doing of research. Thus, this pragmatic methodology, as Whaley & Krane (2011) suggest, bridges the epistemological and practical choices that researchers make.

Briefly, recognising these assumptions as continua, it seems as though healing (at least in part) is a phenomenon that occurs somewhat independently of our ability to conceive of it. This is not to say that our ability to conceive of it does not impact the healing process, but rather healing occurs across a range of biological organisms independent of conception of healing. Invariably, the apparatus we use to assess healing is not distinct from the conclusions we can make about the healing process, but it is proposed that a material process occurs independently of our ability to conceive of it. Epistemologically (i.e., how we can come to know this process) shifts in this thesis; that is, the 'apparatus' used to assess the impact of social support on the healing process moves from a more objective position to a more subjective place

across successive empirical chapters. That is, I both inquire about the role of perceived social support "from a distance" and also become entrenched in the provision of social support and its perception in a case study and via a confessional tale. Indicative of a pragmatic methodological approach embracing "mixed methods" (see Sparkes, 2005 for example), this framework is intended to reduce the difficulties inherent in any one approach and strengthen the applicability of research to practice "in the field". These considerations are returned to in chapter 9, as I consider the implications for judging the quality of the research programme undertaken.

With regards to axiology, answering research questions that are of "value in practice" pervade this research and are in accord with the current research limitations associated with the biopsychosocial model of sport injury. For example, although chronologically dated, Antonovsky (1989) likened the integration of different facets of the biopsychosocial model to islands, rather than bridgeheads. Specifically, Antonovsky (1989) wrote, "Even at this level [the doctor-patient relationship], no less than on the broader societal level, the biopsychosocial paradigm has made few inroads into western medicine" (p. 246, parentheses mine). With regards to sport injury, it can be argued that the interventions to promote recovery are almost entirely underpinned by a medical approach (Bittencourt et al., 2016). Although, it is clear that research is accumulating regarding the influence of social support on injury recovery, colloquially, "lip service" is paid to the value of social support in impacting recovery in the locations where it matters most.

Accordingly, and indicative of the pragmatic methodology underpinning this research programme, "wound healing" and specifically the trans-epidermal water loss procedure was considered as a pragmatic vehicle with which to travel this "middle ground". In terms of an approach that gestures towards understanding processes in

healing, that enabled “injury” to be ethically “administered” that can and could be used to help understand whether social support impacts healing, this approach ticked a multitude of boxes. Using wound healing as this pragmatic methodological approach, this thesis attempts to place several bricks in this edifice of knowledge of what we know broadly about the impact of social support on healing in athletes and to help translate this knowledge to practice “in the field”. Tying this paragraph to explorations in 3.2 and 3.3 may be strengthened in a subsequent iteration. Specifically, this broad aim is accomplished across the following studies.

4.4.1 Investigating the effects of social support on stress, heart rate variability, and wound healing (Chapter 5).

The central aims of this study are to clarify the mind-body connection that appears to exist within the polyvagal theory. To explore the assumption from the polyvagal theory that the social engagement system can improve autonomic function and healing, thus extending the sport injury literature, specifically the biopsychosocial model (Brewer et al., 2002) by exploring the rate of recovery in relation to social support.

To meet these aims a cross-sectional research design was used, whilst keeping a pragmatic and ecologically valid approach. This inexpensive and straightforward approach enabled preliminary evidence to be established on the efficacy and usability of the measures, and to establish a foundation of evidence that would identify the proposed links mentioned in the literature (found in chapter 2 and 3). There was emphasis given on developing the ecological validity throughout this PhD by removing the lab and conducting the research in naturalistic settings, this study aimed to increase the ecological validity on three dimensions as proposed by Schmuckler

(2001). Firstly, by focussing on the setting in which the data is collected, specifically for this study all data was collected outside of a lab in a naturalistic setting where the participants spent time (e.g. a sport centre, a classroom, or a meeting room). Secondly, the specific stimuli and data that was collected. In this case most of the participants will understand what stress is, and that they will have relationships and connections around them that can be known as social support, many will have measured their heart rate (either through a smartwatch or heart rate strap like the Polar H7), and be aware of their basic physiological processes, whilst the wound healing was perhaps a novel stimuli being observed, to most people it would be reasonable to assume that they have had a graze on their skin at some point in their life thus was a realistic and known stimuli. Finally, through the responses or ways that these stimuli were measured. Specifically, we can assume that all participants will have filled out some kind of questionnaire in their past, most athletes and members of the public will have answered questions in a formal way (if only to give customer satisfaction feedback) therefore the use of questionnaires would not be abnormal or new to most participants. Many of the participants, if not all, would have measured their heart rate before using either a smartwatch or heart rate strap (e.g., the Polar H7) and would be familiar with the process of using these technologies. Whilst the use of a TEWLmeter might be new and novel to most people it is a well-known and well used tool in the health care sphere to measure healing rate of skin barrier disruption.

This study added another brick in the wall (to use Forscher's 1963 metaphor) in two ways, firstly by building on Robles' (2007) work by exploring the variables in a naturalistic setting, using naturalistic and ecologically valid methodologies. The approach adhered to the pragmatic philosophy that underpins this research program, and thus makes is replicable and useable by the sport psychologist, coach, and athlete

in the field. Secondly by mixing both the constructivist and positivist methodologies, exploring both the psychological (questionnaires, stress, social support) and the physiological (HRV, stress, and TEWL). This extends the biopsychosocial approach by exploring the links between the biological, psychological, and social.

4.4.2 Validating an online social support intervention (Chapter 6)

The central aim of this study is to consider whether psychoeducation on social support can improve perception of social support, and to explore the efficiency of how this might be done using a novel (for the time) online delivery method.

To further extend the ecological validity of the programme of research this chapter set out again to control the setting, stimuli, and response in an ecological way. Firstly, the setting, this was the clients' own environment where they could log on to a computer or smartphone in their own time and work through the psychoeducation material prompted when required to do tasks in their own time. The stimuli again was social support and social connectedness, and it can be argued that humans are social beings and sociality is innate in our being, thus is not something that people would not be unaware of. Finally, the responses through the questionnaires would not be something that people would not be unaware of and would not have completed before. Once again, we can assume that many of the participants would have answered questionnaires online throughout their daily life.

As this is a scientifically underpinned PhD where empiricism and pragmatism is at the forefront of the decision making throughout the PhD this leads to a certaintist practitioner philosophy. Whilst the key intervention was underpinned by the social support theory, and the polyvagal theory, the philosophical underpinnings were that of a practitioner led, psychoeducation approach. Where we can test the effectiveness of

the intervention. The approach here attempted to provide confirmatory evidence for the use of an intervention to enhance social support thus proving it not to be just a variable that is observed or recorded but one that we can improve and enhance through the use of techniques prescribed by sport psychology and the polyvagal theory.

This chapter again adds to the bricks in the wall. Firstly, building on the previous study by taking the foundations laid out suggesting some links between the theoretical ideas and providing evidence for the use of emotional support in moderating stress and healing, and extending them to explore whether we can improve emotional support, esteem support, informational support, tangible support, and overall social support. Secondly, it extends the social support literature and the polyvagal theory literature by suggesting that techniques underpinned by the polyvagal theory can improve perceptions of social support. Thus, social support is not just an observable variable but something that we can improve with a good, theoretically thought-out intervention. Finally, this adds one final brick to the wall by suggesting that online psychoeducation has some benefit to the sport psychology practitioner and one that we can maximise and use to improve our engagement with the public increasing our effectiveness.

4.4.3 A single case using counselling methods to improve social support: An investigation of stress, healing, and heart rate variability (chapter 7)

The aims of this chapter are to explore in more detail whether social support, emotional support, esteem support, tangible support, and informational support are moderators of the stress and healing relationship, secondly to identify a possible counselling based social support intervention process that can improve perceived

social support, and finally to understand if improvements in perceived social support can improve healing rate.

As will be discussed at various points throughout this thesis there are methodological issues with the research in sport injury. Most often there is observation and recording of phenomena, there is very little experimental research or intervention research and quite a reliance on cross-sectional design research. One way that this problem can be dealt with is by using single case research. The use of single case research can allow us to reduce the snapshot error that is common with cross-sectional and observational design. By taking data points over a long period, in the case of this study over 12 weeks, we can begin to understand what happens to the variables over time. Furthermore, the single case design will allow us to test an intervention protocol thus dealing with the lack of experimental research in a cost effective and time efficient way.

In keeping with the pragmatic philosophy within the PhD, the ecological validity has been kept throughout this study. Specifically, the setting is represented by the athlete participants own setting. All data collection was done in their own environment, an environment that they were familiar with, where they spent a lot of time and was not representative of a laboratory. The stimuli were the same as was completed in chapter 5, whereby heart rate variability, healing, stress, and social support were examined. All phenomena that the participant would have been aware of and have come across in their life before. However, extended in this study is the intervention, these stimuli would also have been relatively familiar to the participant. They would have engaged in emotional, esteem, informational, and tangible support in their life previously before. It was not a guarantee that they would have explored this through counselling however but the general tenants of the intervention, for

example questioning, validation, and problem solving would have been something that they would be experiencing throughout their life. Finally, the responses involved were also the same as in chapter 5, the participant was familiar with questionnaires and heart rate monitoring but less aware of the novel use of the TEWLmeter.

Extending the wall further this study took 3 novel approaches. Firstly, the single case design in sport injury was a novel option to explore and remove the snapshot error that is present in cross-sectional research. Secondly, this study used a well-defined interdisciplinary methodology that combined the use of physiological methods (heart rate variability and trans-epidermal water loss) and psychological methods (the PASS-Q and daily stress inventory) to fully explore the biopsychosocial approach to wound healing and recovery rate. Thirdly this study looked to improve social support with a counselling-based intervention, this adds a new brick to the wall by promoting the idea that social support is an active variable that can be manipulated and that counselling-based approached can be used as a social support mechanism increasing perceived social support.

4.4.4 Confessional tale

The aim of this study is to report the researcher's "lessons learned" with a view to using this as a stimulus to enhance the understanding of what a researcher does and has learnt about social support, the polyvagal theory, healing, and the research process through the course of completing a PhD in sport psychology.

Ethnographic writing is a complex approach to understand the learnings and situations that a researcher has been put in, allowing for an understanding of the key processes that one goes through when conducting a PhD. The point here is to demystify the process and provide some of the key authenticity of the research

process. In this chapter, vignettes of melodrama, of hardship, an exploration of the background and personal choices of the researcher, and some of the learning that the researcher went through are explored. This approach allows for a level of intimacy to be explored and stand beside the research as an exploration of a practitioner based inside a research process that attempts to provide meaningful and useful research to applied sport psychology practice

Stories are a fundamental way by which we interpret our experience and that tap into patterns, connections of events, and the way we develop meaning in what we learn or do (McNett, 2016). By using stories to explore the learning, development, and experience of the researcher in this chapter we better help the researcher to understand the predicaments, decisions, and key milestones that happened throughout the PhD resulting in completion of the process. The stories can provide an emotional element to an otherwise scientific and 'sanitised' thesis that focusses on enhancing the rigour to conform the scientific norms. Furthermore, stories can play a vital role in bridging the discourse between scientists and the un-initiated (Constant & Roberts, 2017). At parts during this thesis there are some complex ideas presented, specifically in the healing and polyvagal theory discussion and thus the use of stories is a good way to translate these highly complex ideas into a way that is easily digestible to the reader. As a pragmatic researcher and a self-confessed straight forward practitioner, to me it is important to put ideas across in the simplest and most easily understood way. The confessional tale builds upon this idea.

The final brick that this thesis offers is the stories of the researcher going through a process of learning, development, and transformation whilst completing a research process. This study adds some of the key lessons learned, developments

taken, and challenges overcome, whilst remaining true to the practitioner within which one works on a daily basis.

4.5 Summary

The aim of this chapter was to provide the reader with a sense of the process by which methodological decisions regarding the programme of research were taken. By embracing (a) philosophical assumptions associated with paradigmatic stances identified within psychology, and (b) an outline of the researcher's positionality, these two facets of the research process coalesced around a "middle-ground" that gestured toward adopting a pragmatic methodological framework (specifically wound healing and trans-epidermal water loss) that guides the ensuing empirical chapters.

5. Investigating the effects of social support on stress, heart rate variability and wound healing.

5.1 Chapter introduction

As outlined primarily in chapters 2 and 3, there are 3 key limitations within the literature that the present chapter addresses. First, there is little research examining the effect of social support on rate of recovery. Second, it was identified that although the biopsychosocial model has generated a great deal of research on sport injury, there have been limited attempts to "bridge" the bio-, psycho-, and social domains in relation to injury among athletes. Specifically, as outlined more fully in section 2.6, by using heart rate variability as a biomarker of an individuals' autonomic nervous system, this study presents a novel way of integrating the bio-psycho-social to examine the influence of key psychological and social variables on injury. Finally, the use of trans-epidermal water loss as a method for assessing healing among athletes, represents an application of an existing technique to a novel population. Given, the challenges of researching sport injury (cf. Ledingham, 2020), this method appears to offer a solution to some of these challenges. That is, it offers a strategy that is ethical, and by inducing a minor injury (abrasion) in a largely consistent and time-efficient way, allows for many variables to be controlled, and replication studies to be undertaken (Rindfleisch et al., 2008).

Two of the key questions associated with the influence of stress on injury is the extent to which social support provides a direct or moderating effect (see section 2.9), and whether the effect on stress can influence the ANS and wound healing. The regulation of healing is completed by the interplay between the immune system and the nervous system (Pradhan et al., 2011). The sympathetic nervous system is

implicated in the bodies healing response usually through the hypothalamic-pituitary-adrenal and sympathetic-adrenal medullary axis. These systems communicate to the body to release cortisol, prolactin, epinephrine and norepinephrine (Felton et al.,1992). These hormones are known to modulate the immune system by binding to the receptors of cells disrupting the ability of the cells to produce cytokines. Cytokines are proteins that help to control inflammation and allow the immune system to defend against germs and infections (Vileikyte, 2007). Malarkey et al. (1995) showed that even small amounts of exam stress can activate the autonomic nervous system, in turn the HPA and SAM axis, releasing stress hormones, reducing the ability for cytokines to control inflammation and therefore reducing healing effectiveness.

Polyvagal theory (Porges, 1997, 2001) arguably provides an explanation that helps us to understand how experiences of stress may be recorded using physiological measures. Polyvagal theory suggests that physiological state can dictate or influence the behavioural or psychological experience someone has, stressful experiences impact upon the rhythms of autonomic states and in turn behaviours (Ernst, 2017).

Polyvagal theory (Porges, 1997, 2001) states that the autonomic nervous system evolved in three stages (Appelhaus & Luecken, 2006). The first was the dorsal vagal complex, which is a slow responding system that supports the freeze response to threats. The second system to develop was the sympathetic nervous system (SNS) which brought the ability to mobilise effort (fight or flight) when faced with a threat, and finally, and most recently developed is the ventral vagal complex which is a fast-acting system that can withdraw and reinstate the inhibitory influence on the sinoatrial node (SA node, Appelhaus & Luecken, 2006). This final system and the ability to

withdraw influence on the SA node allows us to engage or disengage with the world without the energy cost of activating the SNS.

Porges (2003) states that the environmental context (such as the provision of social support) can influence the neurobiological state and a person's ability to deal with the challenges placed upon them. This theory gives a neurobiological model of how social behaviour is linked, and how it can be used as a regulator of physiological activity. Polyvagal theory suggests that the evolutionary development of the ANS provides underlying neurological systems that account for emotional experience that are vital for social behaviour (Porges, 1995). The theory states that physiology can limit the range of behaviours and coping strategies that are available to a person. Hastings et al., (2008) used the polyvagal theory to explore social interaction. They found that those who have better physiological regulation are found to have less difficulties in adjusting to unfamiliar social interactions. Specifically, pre-school age children were able to socially adjust more effectively than those whose cardiac regulation (HRV) was lower. The findings in this study suggest that the proposal made by the polyvagal theory, that cardiac regulation supports positive social engagement and that decreased parasympathetic influence is related to social threat (Porges, 2007), may be useful in understanding the link between physiology and the social world. However, these cardiac reactions may not indicate dysfunction or maladaptive coping but may be normal in conditions where a person faces challenge (Lovallo, 2005). In addition to this Geisler et al., (2013) found that vagal tone is associated with social engagement and self-regulation of emotion. Specifically, they explore the use of high frequency heart rate variability (measured with an ECG machine) and its links with coping, emotion regulation and social engagement in young adults. Cardiac vagal tone (measured by HRV) was associated with high levels

of coping and social well-being, less use of disengagement strategies, and more use of socially adaptive emotion regulation strategies. Further they found that higher cardiac tone predicted more conflict avoidance related strategies after anger potentially in order to protect social ties. Those individuals that had higher cardiac vagal tone were found as more likely to seek social support and social engagement. This study offers support for the use of polyvagal theory in the study of social interaction and physiological response.

In addition to giving us a basis for understanding how social processes can influence physiological outcomes, the polyvagal theory makes a number of predictions about how the cardiac vagal tone may influence both physiology and social processes. The first and most importantly for this study polyvagal theory makes predictions about the regulation of heart rate and heart rate variability. The development of what Porges (2003) refers to as a vagal break (the vagus influencing heart rate) may help a person to engage or disengage with people or objects, which in turn may promote self-soothing or calming coping behaviours. In addition, Porges (2007) states that components of the autonomic nervous system, (ANS) specifically the myelinated vagus (found near the ventricles of the heart) has behavioural functions, it can impact upon social communication, and help to inhibit arousal. The evolution of the ANS has helped to impact upon the affective or emotional experience, expression of emotion, vocal communication and social behaviour (Porges, 2007).

Porges (2007) goes on to describe a social engagement system which is intertwined with the autonomic nervous system. This system influences the muscles in the face and head that are used within social interaction, the suggestion is that these muscles function as determinants of social engagement and as filters that may limit

social stimuli (Porges, 2007). Finally, Porges (2007) suggests that hypothetically an optimally working social engagement system would enhance social behaviour, emotion regulation, and improve vocal communication, this increases an individual's ability to access specific types of social support. Thus, the polyvagal theory suggests that social processes are associated with physiological states (e.g., heart rate variability) and this may be implicated in the rate of recovery. The sport injury models mentioned above (Weise-Bjornstal et al., 1998, Brewer et al., 2002) also state that social support can have an influence on injury incidence and on rehabilitation outcomes. It is therefore important to consider social support as a social intervention for stress reduction.

5.2.1 Stress and skin barrier function

One way to examine the associations between stress and injury recovery is to look at the measurement of skin barrier function. Stress and dermatology hold an interesting link, with many dermatologists understanding that individuals will present with skin disorders or eruptions that have no physiological mechanism (Woodruff et al., 1997) Stress can offer an interesting explanation for such problems. Stress has been repeatedly shown to influence skin barrier repair and function, this is explored in chapter 2 where we discussed the links between stress and healing. Specifically, Garg et al.'s, (2001) work that found students with increased stress had slower skin barrier recovery. Using a tape stripping procedure (repeated removal of cellophane tape off the forearm) to remove layers of epidermis, the skin will release water through trans-epidermal water loss. Garg et al. (2001) found that students experienced slower skin barrier repair during times of significant stress (e.g., exam periods). Those students with more stress experienced slower skin barrier repair. Further studies have found

that shorter periods of stress such as a Trier Social Stress Test result in slower skin barrier repair. Altemus et al. (2001) suggest that different types of stress can impact skin barrier function. Specifically sleep deprivation and interview stress had adverse effects on skin barrier function, increased plasma, and natural killer cells (cells that kill bacteria and infections) numbers. Interestingly, Altemus et al. (2001) found that exercise related stress did not adversely affect skin barrier function or recovery but did cause an increase in natural killer cell activity. Emery et al. (2005) found that exercise even improved wound healing, however not by altering the levels of perceived stress but by enhancing the neuroendocrine responsiveness releasing hormones that increase blood flow, control the heart rate and blood pressure, and allow for bone and muscle growth by increasing epinephrine. In a meta-analysis by Walburn et al. (2009) findings suggest that greater levels of psychological stress are associated with impaired wound healing with an effect size of r=-0.42 suggesting a medium effect size. This meta-analysis included study with a wide variety of biomarkers associated with wound healing including TEWL, and a variety of chronic and acute wounds. The effect size suggests that this interaction between stress and healing could be clinically as well as statistically significant (Walburn et al., 2009). It is worth noting that a number of studies in this meta-analysis found that stress did not impact wound healing and a number of reasons for this are put forward. In addition, this meta-analysis finds that exercise may have a beneficial impact on the mechanisms that induce healing thus supporting the work by Altemus et al. (2006). Although engagement in physical activity could represent a confound if measuring healing for an extended period of time, it is clear that trans-epidermal water loss can provide a measurement vehicle to examine the theoretical associations between stress and injury recovery over a short period of time (Robles, 2007).

Trans-epidermal water loss (TEWL) is a measurement of healing in even minor skin abrasions. It aims to measure the protective water barrier of the human skin. Measured in grams per square meter per hour (g/m2ph), TEWL can measure healing over time. The more perfect the skin's protective coating is the higher the water content and therefore the lower the TEWL. It is expected that in a less than perfect (wounded) skin layer there would be a higher TEWL. Two approaches to measuring TEWL are proposed in the literature. The first approach is using an open chamber, which measures the water gradient providing an insight into the small alterations of the micro-climates overlying the skin (Da Paepe et al., 2005). This is usually done with a TEWLmeter (Courage+Khazaka Electronic, Koln, Germany). The measurement of TEWL is based upon Fick's Law of diffusion, which describes the relationship between the rate of diffusion and the surface area, concentration difference, and thickness of the membrane. This method of measurement has a number of problems, specifically it is sensitive to room temperature, convection, and humidity due to the open chamber used to measure the differences in TEWL. A further device has been developed to measure TEWL is the VapoMeter (Delfin Technologies, Kuopio, Finland). The VapoMeter uses a closed chamber which negates the issues present with the TEWLmeter and thus not effected by ambient room temperature or airflow (Da Paepe et al., 2005). The VapoMeter is also not affected by increased probe pressure. Good correlations between the two measures have been found (Fluhr et al., 2003).

The mind body impact is receiving greater attention in the health and medical literature (Hussey and Young, 2020), and the link between psychology and wound healing is becoming more and more prevalent (Brown, 2008). Within this literature social support is being explored as having an impact on the healing process.

Typically, there is a reliance on the correlational and qualitative methodologies in sport injury research and these have served the space well in developing knowledge and understanding of the key features of the injury experience (Ledingham et al. 2020). A quick Google Scholar search of the term 'social support and injury cross-sectional' yields 1.74 million results and whilst it is beyond the scope of this research to provide a review of the research in this area, discussion of some key themes will be helpful to give context. Increased perception of social support in people with diabetic ulcers has been found to improve healthy behaviours and outcomes (Laopoulou et al., 2020), social support during rehabilitation has been found to improve subjective well-being in injured athletes (Lu & Hsu, 2013), among women, positive attachment relationships were shown to improve skin barrier recovery, and in men, ineffective attachment strategies were shown to slow skin barrier recovery (Robles et al., 2013) Finally, social closeness has been shown to have a beneficial effect on skin barrier recovery (Robinson et al, 2017). The above studies and the results presented in the earlier scoping review point to the suggestion that cross-sectional research is a key theme throughout the injury and social support literature and often yields interesting and useful results.

The cross-sectional design research has a number of key characteristics that make it beneficial for the use in sport injury research. The single time point allows researchers to compare single, often complex variables across groups with similar characteristics (Allen, 2021). They are best used to identify key patterns, correlations, and incidence rates within a population (Allen, 2021), this makes them a good platform from which to build more complex research that can go on to establish a cause and effect or test out the efficacy of an intervention. These types of research designs are often quite basic, are highly efficient ways of collecting data, they do not

drain on researcher or participant time, and can adequately address many research questions (Spector, 2019). Spector (2019) goes on to explain that cross-section research can be a good starting point for many programs of research and complexity within the program of research can be built as more information becomes available. For example, a cross-sectional correlational study can provide an understanding of the magnitude of the relationships between variables, that can help to inform later studies' estimates of effect size (Spector, 2019). Spector (2019) provides some guidelines on when to use cross-sectional research design, these are; 1) when there is a clear case for determining whether there are relationships between pairs of variables and whether moderators might play a part, 2) exploratory research where there is a need to search for meaningful patterns, before larger scale more expensive research is conducted, 3) there is a time frame effect, where it is unclear over what timeframe might be useful to explore the research, 4) when exploring the effects of a naturally occurring variable such as social support or injury, and 5) the research is trying to rule out covariation or confounding variables.

Brewer (2020) states that it is almost impossible to recreate the temporal variables that relate to injury. It is difficult to reflect and research the dynamic nature of many of the key changes that occur during an injury process (e.g., daily stress), and thus it is likely to be quite different on a day-to-day basis. This often makes it difficult to assess or investigate models of sport injury in much depth. Furthermore, Brewer (2020) goes on to state that this is often the reason why many different investigations are used across models, and it then become necessary to piece together the research to fully and completely understand the process of injury healing. This might point to a reason why cross-sectional research is often a preferred method of exploration in sport injury. This methodology offers the opportunity to gain a 'snapshot' in time

building more ‘bricks in the wall’ as Forscher (1963) stated. Thus, allowing for a fuller picture to be created.

5.2.2 Aims of the chapter

Given the discussions made in chapters 2 and 3 there appears to be value in assessing the associations between a number of key variables, specifically social support and stress which was argued as theoretically linked in chapter 2, social support, stress, and healing which again was discussed in chapter 2, and finally the use of social support as an effective moderator of healing as discussed in chapter 2 and 3. There is value in using a multi-disciplinary approach whereby psychology and physiology is integrated to observe and explore a phenomenon, in this case the study of psychological (Psychometric tests) and physiological (HRV) markers of stress, and physical wound healing. As previously explored in chapter 2 and 3 there are several links made between stress and healing, for example, Kiecolt-Glaser et al. (2005) found that short conflicts between individuals delay healing of a skin wound through the decrease in substances used to effect cell function and growth. These links are noted in the endocrine system response to stress which increase glucocorticoids which supresses the recovery process. Also, in chapter 2 it was suggested that the hypothalamic-pituitary-adrenal axis which is known to activate when under psychological stress is linked through the release of epinephrine which may impact upon the heart rate variability (Smith, 2006). Further to this there is a theoretical discussion that heart rate variability may act as a marker of psychophysiological stress, given this thought investigation in to whether heart rate variability can be used as a maker of stress and whether it’s links to the parasympathetic and sympathetic

nervous system have any effect on healing and recovery can be explored. The aims of this study are:

1. To examine whether emotional support, esteem support, informational support, tangible support and overall support moderates the relationships between daily stress and wound healing.
2. To examine the strength of correlations between the time domains of heart rate variability and social support.
3. To examine if increases in the time domains of heart rate variability are associated with greater healing/recovery in skin barrier disruption as discussed in section 2.6 and 2.7.

5.3 Method

5.3.1 Participants

51 participants age between 18 and 55 (M=24.23, SD = 6.41) were recruited to participate. The sample consisted of both males (n=17) and females (n=34). Participants were either in employment or students at university and were non-sport participators, gym goers, or active participants in sport. Sports included horse riding, running, dance, weightlifting, football, hockey, netball, cycling, volleyball, cricket, wheelchair basketball, badminton, squash, and shooting.

5.3.2 Measurement

5.3.2.1 Heart Rate Variability (HRV)

Physiological arousal is controlled primarily by the autonomic nervous system (ANS). The ANS is then subdivided into two systems the first being the sympathetic nervous system (SNS) which is an excitatory system, the second being the parasympathetic nervous system (PNS) which is the inhibitory system of the ANS. Heart rate variability is a measure of the inter-beat intervals of the heart. It provides information on the constant communication of the parasympathetic and sympathetic nervous systems. This was measured using a Polar Heart Rate Monitor (Polar H7) in combination with an iPhone application called HRV Logger developed by Marco Altini (2013). This method of measuring HRV was chosen due to the underlying applied philosophy considered throughout this PhD, of the 31 products available on the market (Georgiou et al., 2018) the Polar H7 appears to have the most practicability, was cost effective, and has been found to correlate well with the gold standard ECG machine (Plews et al., 2017, for further exploration of the validity of the measure see chapter 2). The use of the HRV Logger iPhone app was chosen again because of the applied focus of the research, the apps ability to link with the Polar H7, and finally it's accessibility for use outside of a lab. Both the Polar H7 and HRV Logger app were chosen because they are fully accessible for coaches, athletes, physiotherapists, and psychologists to use on a day-to-day basis within their practical applied work.

5.3.2.2 Daily stress inventory

The Daily Stress Inventory (Brantley et al., 1987) is a measure of daily hassles and life events that have occurred and caused stress in the past 24 hours. Ivarsson et al. (2013) predicted that daily hassles would mediate the relationship between life

events and injury frequency and found that it had an indirect effect on injury frequency. They also found that daily hassles have a moderate, direct positive relationship with injury occurrence, moreover those that experience chronic or long-term daily hassles may have an increase vulnerability to appraising minor events as more stressful, increasing the risk of injury occurrence (Ivarsson et al. 2013). This highlights the important role that daily hassles and general life stress has on injury risk. The participants were asked to complete a Daily Stress Inventory (DSI) (Brantley et al., 1987). The DSI is a 58 item self-report measure which allows a participant to show which stressful life events they have encountered in the past 24 hours. They rate the level of stress each life event caused them on a Likert scale from 1 to 7 (1 = happened but no stress to 7 = caused me to panic). Three possible scores can be obtained from the DSI, firstly, the total number of events that occurred (the frequency), secondly, the total sum of the impact of these stressful events (the sum), finally, the average impact rating of stressful events (the sum divided by the frequency). For this study the total sum of stressful events was used as the most common and simple approach to understanding stressful events. The Cronbach Alpha coefficients for the total sum of the stressful events approach is 0.87, suggesting that the items are similar and have some construct reliability. The average correlation for the sum method was significant ($r=0.40$, $p<0.01$) suggesting a good level of concurrent validity. In addition to this, the daily stress inventory was also significantly correlated with the hassles scale. Finally, the construct validity of the DSI was correlated with the STAI- X1 where the sum scores were highly related to this measure of anxiety (Brantley et al., 1987).

5.3.2.3 Social support

The participants were taken through the PASS-Q, a 16 item self-report measure of perceived available social support developed by Freeman, Coffee, & Rees (2011). This measure was intended to assess emotional, esteem, informational and tangible support (Rees and Hardy, 2000). Emotional support describes attempts that lead the participant into believing they are cared for. Esteem support involves boosting a person's sense of competence. Informational support describes the provision of advice and guidance, and tangible support is the assistance that the participant receives. Participants respond on a 5-point Likert scale ranging from 0 (not at all) to 5(a lot). This was used to identify the amount of social support that the participant perceived during each of the conditions.

5.3.2.4 Trans-epidermal water loss

In this study trans-epidermal water loss was measured with a Vapometer (Delfin Technologies), which was calibrated until November 2019 with a standard adapter fitted. The Vapometer was placed upon the area of skin that had been disrupted by the tape stripping procedure and held gently against the skin whilst the Vapometer measured the amount of water vapour given off by the disrupted skin.

5.3.3. Procedure

After gaining university ethical approval, participants were approached via the researchers' work network. An opportunity sampling method was used where adverts were made via social media and through professional connections of the researcher. Participants were explained the methodology, and the reasons for the research and were asked for their consent to participant. Once consent was gained participants completed the perceived available social support in sport questionnaire (PASS-Q),

and the daily life stress questionnaire. In addition to this they engaged in the tape stripping procedure (explained below) where trans-epidermal water loss (TEWL) was measured to the level of 24.4 gm/m2 of skin. In addition, participants were asked for a 10-minute heart rate variability measurement measured by Polar Heart Rate Monitor (Polar H7) received via iPhone app (HRV logger). Finally, after 3 hours participants were measured again on the TEWL to gauge the level of healing that has occurred over the 3 hours.

5.3.3.1 Tape stripping procedure

The tape stripping procedure suggest by Lademann, Jacobi, Surber, Weigmann, & Fluhr, (2009) was used in this study. Tape stripping aims to remove the stratum corneum (SC) or the outermost barrier of skin. An adhesive film is applied and removed successively from the same area of treated skin usually on the underside of the arm where hair is limited. The Cellotape is applied in strips to a marked area of skin. The weight of the roller was used to press the tape onto the skin a number of times, with the aim being to reach an optimal level of adhesion. Trans-epidermal water loss was measured from this at 2 points during the study, immediately after stripping and after a 3-hour time period to assess healing.

5.3.4 Data analysis

Data analysis was completed using the Statistical Package for Social Sciences V25. A primary inspection of the data was conducted to identify if there were any missing data points. None were found so no data was removed from the final analysis. Initial analysis involved descriptive statistics and Pearson Product Moment Correlation. A moderated hierarchical regression was conducted examining whether

social support moderated the influence of daily stress on healing and whether social support moderated indices of HRV on healing. A moderator is defined as a variable that affects the relationship between two others (Field, 2018) in this study the moderator is social support and the relationship it is impacting upon is the stress and healing relationship. The moderated hierarchical regression will allow us to understand the conditions which effect the strength and direction of the relationship, furthermore this moderated hierarchical regression will allow us to know the conditions which provide better explanatory power for the theory presented (Aguinis & Gottfredson, 2010). Field (2018) provide further justification for the use of a moderated hierarchical regression in this case. Field (2018) suggests that predictors in the regression are chosen based on the past work done by other authors in this case around social support, stress, and healing. Field (2018) goes on to suggest that all predictors should be put into the model simultaneously to reduce the effects of the possibility of random variations in the data.

Although a mediation analysis was also considered it was considered problematic theoretically. A mediator refers to a specific situation where the relationship between a predictor (stress) and an outcome variable (healing) can be explained by their relationship to another variable (social support). In this type of model, the predictor (stress) may also predict the mediator (social support) which as explored in chapter 2 and 3 is not theoretically the case. Stress does not increase or decrease the level of perceived social support. Most of the theoretical models that are proposed in chapter 2 and 3 suggest that social support has a moderating effect on the stress and injury/healing relationship.

To further fully test the proposed theoretical links that have been described in chapters 2 and 3, it was decided that a moderated hierarchical regression analysis

would be the most appropriate test to determine the effects and relationships between two variables on trans-epidermal water loss. It was decided that only 2 combined variables would be done during any one analysis. This would reduce the likelihood of type 1 error (e.g., finding a false positive) by testing too many variables in one model. The model tested had three layers based on pre-trans-epidermal water loss, the two measures of stress (self-reported stress and heart rate variability), the buffering effects of social support and its sub-components, and the moderated effects these had on trans-epidermal water loss. Relevant statistics are presented in table 5, and a diagrammatic overview of the theorised model is presented in figure 3.

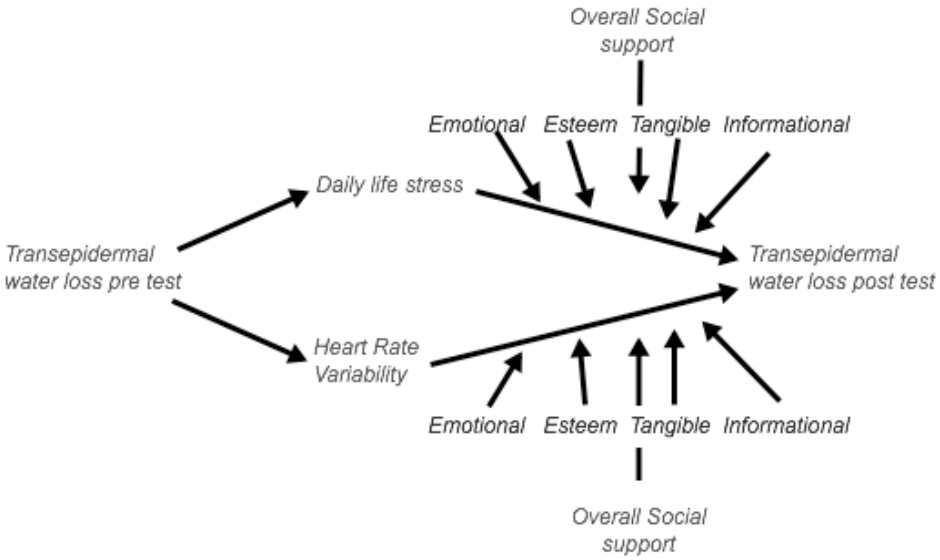

Figure 3 A visual representation of the moderator analysis completed

5.4 Results

The descriptive statistics are summarised in table 4 below.

Table 5 The mean, standard deviations, median, and standard error for heart rate variability (RRAVG, RMSSd, SDNN), stress, social support total, four sub-categories of social support, and trans-epidermal water loss (TEWL).

Variable	Mean	St. Dev.	Median	St.Error	Skewness	Kurtosis
HR	79.5	16.77	79.65	2.326	1.04	2.71
RRAVG	788.56	157.75	760.40	21.87	.416	.199
RMSSD	51.74	29.24	44.30	4.09	.74	-.05
SDNN	80.36	102.35	64.10	14.33	6.45	44.38
Daily Stress	63.84	44.98	54.00	6.24	1.48	2.54
PASS-Q total	41.92	8.67	43.00	1.20	-.42	0.2
Emotional support	3.00	0.669	3.00	0.09	-.223	-.866
Esteem Support	2.70	0.599	2.75	0.83	-.53	1.09
Informational support	2.69	0.767	2.75	0.10	-.99	1.24
Tangible support	2.33	0.91	2.37	0.126	-.13	-.72
TEWL percentage change	57.63	14.04	57.63	1.94	-.00	-1.05

The assumption of normality for heart rate, daily stress, emotional support average, esteem support average, informational support average, and trans-epidermal water loss percentage change was violated as assessed by the Shapiro Wilk's test ($p < 0.05$). The assumption of normality for RRAVG (heart rate variability), PASS-Q (social support), and tangible support was satisfied as assessed by the Shapiro-Wilk's

test (p>0.05). Due to the variation in normality, it is assumed that normality is violated.

Despite the violations in normality, it was decided that parametric tests would be completed. There are several reasons for this decision. It has been argued that this decision is supported in the literature by Ernst & Albers (2017) who stated that violations in normality are not normally problematic provided that the assumptions of linearity and independence are met. Norman (2010) also found no references in the literature to restrictions on sample size.

5.4.1 Perceived social support and wound healing.

There were no statistically significant correlations between perceived social support and would healing the magnitude of the relationships however were highest for (a) emotional support and TEWL percentage change, r(50)=-.-148, p=0.297 and (b) information support and TEWL percentage change r(50) = 0.20, p=0.889 (see table 7) .

5.4.2 Daily stress and wound healing

There was a small non-significant correlation between daily stress and TEWL percentage change, r(50)=.151, p=0.286,

5.4.4 Time domains of heart rate variability and social support.

There was a statistically significant, moderate negative correlation between SDNN average (Heart Rate Variability) and (a) total perceived social support, r(50) = .32, p =0.022, (b) informational support, r(50) = .30, p=0.031, and (c) tangible support, r(50) =. 31, p=0.023. As social support increases so there are increases in

HRV. Further non-statistically significant small correlations were found between heart rate variability and informational support, r(50) = .214, p=0.128, informational support and RRAVG (heart rate variability), r(50)=.210, p=0.135, informational support and daily life stress, r(50)=.210, p=.136, informational support and LFavg (heart rate variability), r(50)= .270, p=0.053, esteem support and heart rate variability, r(50)=.106, p=0.453, esteem support and SDNN, r(50)=.195, p=0.166, tangible support and HFAV (heart rate variability) r(50) ==.172, p=0.221.

5.4.5 Time domains of HRV and healing in skin barrier disruption

Non-statistically significant small correlations were found between RMSSD and TEWL percentage change, r(50)=.181, p=0.200. All other time domains of heart rate variability found very small correlations which were not significant, these are as follows, RRAVG and TEWL percentage change, r(50) =0.057, P=0.687, AVNN and TEWL percentage change, r(50)= 0.053, P=0.709, SDNN and TEWL percentage change, r(50) -0.037, p=0.795.

5.4.6. Correlations of facets of social support

Large positive correlations were found between PASS-Q total and emotional support, r(50) =.617, p=0.001, PASS-Q total and esteem support, r(50) = .692, p=0.001, PASS-Q total and informational support, r(50) =.731, p=0.001, PASS-Q total and tangible support, r(50) = .885, p=0.001. Further statistically significant large positive correlations were found between emotional support and esteem support, r(50)= .519, p=0.001, emotional support and tangible support, r(50)= .509, p=0.001, esteem support and informational support, r(50)=.487, p=0.001, esteem support and tangible support, r(50)= .556, p= 0.001, and informational support and tangible

support, r(50)= .663, p=0.001. In addition a non-significant small correlation between emotional support and informational support, r(50)=.260, p=0.063. A summary of the main relevant correlations is summarised in a correlation matrix below in table 6.

Table 6 :A summary of the Pearson Product Moment Correlations with statistically significant results highlighted.

Variable	Daily stress	Pass-Q tot	EM sup	ES sup	IN sup	TA Sup	TEWL % change
HR	.195	0.66	.083	.098	.174	0.67	.016
RRAVG	-.171	-.112	-.163	-.210	-.210	-.095	.057
SDNN Avg	.064	**-.318***	-.166	-.195	**-.300***	**-.314***	.037
RMSSD	-.214	-.081	.018	-.095	-.098	-.085	.181
Daily Stress	1	-.002	-.222	0.40	.210	-.001	.151
PASS-Q tot	-0.002	1	**.617***	**.692***	**.731***	**.885***	-.067
EM support	-.222	**.617***	1	**.519***	**.260**	**.509***	-.148
ES support	.040	**.692***	**519***	1	**.487***	**.556***	.069
In support	.210	**.731**	**.260**	**.487***	1	**.663***	-.020
TA support	-.001	**.885***	**.509***	**.556***	**.663***	1	-.079
TEWL % change	.151	-.067	-.148	.069	-.020	-.079	1

Note. HR=heart rate, RRAVG=heart rate variability, SDNN avg= heart rate variability, RMSSD= heart rate variability, PASS-Q= perceived social support, EM=emotional, ES=esteem, IN=informational, TA= tangible, TEWL= trans-epidermal water loss, *=statistically significant at =<0.05 level.

Table 7: Moderator analysis results

Dependant variable	Independent variable	^R2	sumR2	P(F)	*b*	SE b
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
	Daily stress PASS-Q	0.006	0.162	0.857	0.20	0.44
	PASSQ Daily stress product	0.024	0.186	0.247	0.33	0.29
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
	Daily stress Emotional Support	0.008	0.164	0.808	0.017	0.044
	Emotional support daily stress product	**0.087**	**0.186**	**0.025***	0.125	0.054
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
	Daily stress Esteem support	0.012	0.169	0.714	0.017	0.043
	Esteem support, daily stress product	0.007	0.176	0.524	0.058	0.090
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
TEWL	Daily stress Informational support	0.004	0.161	0.886	0.017	0.045
TEWL	Informational support, daily stress product	0.001	0.162	0.844	-0.012	0.062
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
	Daily stress Tangible support	0.005	0.162	0.862	0.020	0.044
	Daily stress, tangible support product	0.030	0.192	0.200	-0.071	0.055
TEWL	TEWL Pre	0.157	0.157	0.004	2.240	0.742

	RMSSD (HRV), PASS-Q	0.053	0.210	0.251	0.111	0.063
	RMSSS, PASSQ product	0.008	0.218	0.505	-0.020	0.030
TEWL	TEWL Pre	0.157	0.157	0.004	2.240	0.742
	RMSSD (HRV), Emotional support	0.058	0.214	0.188	0.111	0.063
	RMSSD, Emotional support product	0.011	0.226	0.416	-0.089	0.108
TEWL	TEWL Pre	0.157	0.157	0.004	2.240	0.742
	RMSSD, Esteem support	0.068	0.224	0.140	0.118	0.063
	RMSSD, esteem support product	0.001	0.225	0.913	-0.012	0.106
TEWL	TEWL Pre	0.157	0.157	0.004	2.240	0.742
	RMSSD, informational support	0.058	0.214	0.189	0.116	0.063
	RMSSD, informational support product	0.001	0.215	0.816	0.021	0.090
TEWL	TEWL pre	0.157	0.157	0.004	2.240	0.742
	RMSSD tangible support	0.053	0.210	0.216	0.111	0.063
	RMSSD, tangible support product	0.003	0.213	0.670	-0.033	0.077

5.5 Discussion

This study aimed to examine whether emotional support, esteem support, informational support, tangible support and overall support moderates the relationships between daily stress and wound healing. To examine the strength of correlations between the time domains of heart rate variability and social support. To

examine if higher time domains of heart rate variability are associated with greater healing/recovery in skin barrier disruption.

With regards to the moderating influence of social support it was found that emotional support moderated the influence of daily stress on healing. This suggests that emotional support has a positive impact upon daily stress, which influences healing. This finding supports and extends the previous research around stress-buffering models presented by Rees (2007). In this model, social support is shown to buffer the relationship between stress and response to injury or illness. However, the mechanisms regarding how social support may impact healing are obscured, given the lack of anticipated correlations between (1) social support and HRV, and (2) HRV and wound healing. Interestingly however, no other facets of social support moderated the daily stress-healing relationship. Examination of mean scores in table 5 suggested that of the facets of social support measures in the PASS-Q, emotional support was on average the highest and perhaps it is the amount of support perceived, as much as the type of support received that is important.

In terms of the magnitudes of the correlations between HRV and social support, it was found that there was a moderate negative correlation between SDNN and total perceived social support, informational support, and tangible support. This suggest that these types of support increase heart rate variability as predicted. Further, moderate correlations were found with RMSSD and total perceived social support, emotional support, esteem support, information support, and tangible support, however these were non-significant. It is possible to conclude that there may be a beneficial effect of social support on heart rate variability.

Aim 3 was to examine if the time domain frequency of heart rate variability is associated with great skin barrier healing. The results suggested a non-statistically

significant small correlation between RMSSD and wound healing. It is difficult to draw and strong conclusions from these results as the lack of statistical significance suggests the results could be there by chance. Whilst there is a suggestion that a relationship may exist, this relationship is currently inconclusive based on the results presented in this study. Possible reasons for these results are discussed below.

Similar to previous studies (see section 2.9), the present study found support for the perceived available support in sport questionnaire (PASS-Q, Freeman et al., 2011). Specifically, the present study found support for the correlations of the four factors of social support (emotional, esteem, tangible, and informational support). In addition, this study supported the idea that separate dimensions of social support are not usually independent (Cohen & Wills, 1985). All but one of the correlations were found to be large, with all but one correlation being significant. Interestingly and contrary to previous findings and the validation of the PASS-Q (Freeman et al., 2011), emotional support and informational support were correlated low and not significant. This could be due to the wide range of scores that were collected from the participants. In this study the correlation between emotional support and informational support was 0.260, whereas in the original development study this correlation was reported as 0.40. It is worth noting that the participant numbers in this original development study were 180 thus potential for this low correlation could come from participant numbers.

One of the useful findings in this study is the correlation between the physiological markers of stress and self-report psychological assessment of stress. In the present study Heart Rate Variability as measured by a Polar Heart Rate Monitor (Polar H7) does not significantly correlate with psychological assessments of stress, specifically the daily life stress inventory. Typically, when physiological and

psychological measures of stress are taken the findings suggest very little relationship between then (Mordkoff, 1964). Mordkoff (1964) suggested a number of reasons why this may be the case, this study suggests that verbal reports can be susceptible to distortion from the participant, further physiological measures of stress are often measured continuously for a period of time whilst psychometric measures of stress take a snapshot measurement usually at one time point. Oldehinkel et al. (2011) suggest a limited association between physiological and psychological measures of stress. However, in this study Oldehinkle et al. (2011) suggest there were three interesting findings, firstly, this study found that perceived stress to some extent predicts the activity of the hypothalamic pituitary adrenal system. Secondly, the study found that during a social stress test perceived stress did not predict physiological stress. Finally, the study found that physiological stress did predict post social stress test response. It is worth noting that the physiological measure used in this study was cortisol and not heart rate variability. Further studies into the relationships between psychological and physiological stress find minimal correlations between the variables, for example Ekberg, Kjeldsen, Greenword, & Enger (2009) found no direct relationship between physiological and psychological variables in phobic anxious people, suggesting it is not clear how these variables are linked. Whilst some small negative correlations were found specifically RMSSD and daily life stress (r=-.214), and RRAVG and daily life stress (r=-.171), these were non-significant. This shows that the psychometric measure of stress does not accurately relate to the heart rate variability, which has been shown to be a possible marker of physiological stress. This raises several potential questions, firstly, does heart rate variability accurately measure ‘stress’? Or vice versa does the perception of stress measured by psychometric measures accurately predict the reality of stress that a person may be

suffering. Given the unclear nature of the previous research and the results shown in this study it appears there are limited relationships between psychological and physiological measures of stress. It is worth recognising the power limitations of the present study and this therefore may make interpretation of this result difficult.

The main strength of this study is the naturalist design aimed at being as close to real life as possible. This meant that all measurements were conducted in the participants own setting either in their sporting or work environment. Whilst previous studies (Robles 2007) have explored many of the relationships that this study explored they were often completed in a highly controlled laboratory with temperature, noise, interference all being controlled. Many of those studies therefore fail to consider the full picture when exploring the key variables, as this control impacts upon the ecological validity of the studies being conducted.

The tape-stripping model employed within the present study is a reasonable approach to disrupting the outer layer of the skin. This then increases the trans-epidermal water loss in the air layer adjacent to the disrupted skin. The skin will usually return to baseline within a few hours of skin disruption. Despite this method being a very reasonable way of measuring healing in humans (Robles, 2007; Altemus et al., 2001) has a number of disadvantages, TEWL measurements (including the Vapometer) are extremely sensitive to ambient temperature and relative humidity, and can be affected by air-conditioning, air temperature, and wind (Lautenschlager, 2008). This sensitivity to ambient temperature reduces the reliability and validity of the measurement process in un-controlled temperature environments (Miteva et al., 2006).

There are a number of difficulties when conducting this kind of research that make it challenging to collect large sample sizes, and whilst the importance of having

a sufficient sample size is important these issues cannot easily be overcome. Specifically, the tape stripping procedure and use of injury could be perceived as a concern for participants. Creating a 'wound' on someone's arm can be perceived as a large sacrifice for research in which they are not being reimbursed. Further previous research using similar methodologies albeit in a laboratory environment (e.g., Robles et al., 2007) have used similar sample sizes and reported significant findings when examining the relationship between TEWL and stress. Finally, as mentioned previous the research aims are to explore the possibilities of these findings outside of a lab with more freely available technology, given the exploratory nature of the study and the estimated response rate it was deemed acceptable.

There is a growing body of research looking at the psychological factors in sport injury and as previously mentioned in chapter 3's scoping review there is an overwhelming reliance on cross-sectional and interview research. The benefits of cross-sectional research are clear, it offers a snapshot in time and a clear examination of the relationship of variables. This research allows us to close many gaps and answer many questions in injury and as Forscher (1963) states allows us to put more bricks into the wall. In this programme of research, it has allowed us to tell a story in a coherent and logical way, building on the research questions already proposed. There is growing calls in the literature and a similar conclusion made in Chapter 3's scoping review that the profession and topic area needs to step forward from the correlational and quantitative research into experimental research (Leadingham et al., 2020). It is recognised that there are significant challenges when conducting this kind of research in the sport injury arena, such as recruiting large sample sizes, getting a stable and equivalent baseline, blinding, standardising the treatment protocol, and using valid and reliable measures (Leadingham et al., 2020). Despite these challenges

there appears to be a large lack of the literature in this area with only 14 studies identified in their review exploring interventions in sport injury, and only one of those identified that use any type of social support (Leadingham et al., 2020). The future benefits of this kind of research are, an increased number of protocols available for practitioners to use when working with injured athletes, a bridging of the applied practice and research gap, and a clear understanding of 'what works' in helping athlete to recover or rehabilitate when injured. It is suggested here and supported by Leadingham et al. (2020) that single case designs may be a good option available to 'pracademics' as a way of increasing the amount of experimental research in the sport injury field.

Several studies have begun to utilise the mix of both physiological and psychological markers of stress, and there is an increase in psycho-physiological research into stress. Future research should further look into the correlations between physiological markers of stress and subjective psychological measures of stress. In addition to this future research new psychometric tests that aim to explore and measure psychological stress should aim to correlate their results with physiological markers of stress to explore the relationships between perception and reality. In addition to this further research into the psychophysiological markers of stress and their relationship to healing and social support should be conducted, this research would clarify and more fully explain the moderated relationship between social support, stress, and healing (via trans-epidermal water loss).

5.6 Chapter summary

This chapter set out to explore the links described in Chapter 2 and 3 and understanding whether social support can improve healing through the moderation of

stress through the lens of the polyvagal theory. This study suggests that emotional support can moderate the stress and trans-epidermal water loss relationship, this means that those people with higher levels of emotional support were better able to moderate their stress, which decreased trans-epidermal water loss (healing). Unexpectedly, this study found a secondary finding that physiological measures of stress negatively correlated with psychological measures of stress thus offering an interesting area for discussion and further research beyond the scope of this program of work. Given the positive results presented in terms of the utility of emotional support as a stress moderator and a possibility that it improves healing future research should consider (1) how easily or efficiently we can improve perception of social support and (2) whether an increase in social support through an intervention has any impact on healing rate.

6. Validating an online social support intervention

6.1 Chapter introduction

Thus far this programme of research has considered the possibility that social support can play an active role in improving rate of recovery. Chapter 3 highlighted that there is a significant lack of experimental research in the area of social support and sport injury. Chapter 5 identified that emotional support, one of the 4 key types of social support has a moderating effect on the stress and healing relationship. However, whether it was the type of emotional support or the strength of the support was unclear. Underlying the latter observation is the absence of literature examining the impact of strategies designed to increase social support. Whether it is researchers who may wish to enhance aspects of social support in an experimental type manner, or to examine associations between social support and healing more specifically, strategies to enhance perceived social support are valuable. Accordingly, the aim of this chapter is to examine whether an intervention strategy can enhance the perceptions of social support.

Of the research examining how perceived social support may be enhanced, there is very limited consensus on the most effective way to increase social support (Hogen, Linden, & Najarian, 2002). However, when considering the development of effective social support interventions, House (1981) suggests a single question to help; who should provide what, to who, and when? In essence who should give the social support, what type of social support should they give, and when should this social support be given.

Social support can be given by various types of providers (e.g., parents, coaches, teammates, friends, family, sport science and medicine professionals). These

can be both non-professionals such as friends and family. We know that long standing social connections have unique capabilities when it comes to providing social support (Feeney & Collins, 2003), or can be professionally provided by trained helpers which may be better suited to specific types of support (e.g., informational support, Gottlieb, 2000). The perceptions of the social support rather than the exact behaviours (*what*) of the provider are linked to health and well-being (Wethington & Kessler, 1986), meaning that a specific list of 'effective behaviours' may not be necessary to discuss. It would be more beneficial to consider what behaviours the receiver expects or needs at any given time. So, when specific behaviours are considered, a collaborative effort between the provider and receiver may be best to enhance perceived social support (Palmer, Baucom, & McBride, 2000). Social support interventions can be characterised in a number of ways, and Hogen et al., (2002) provide a scheme to help, they suggest there are 3 sub-types of social support intervention: (1) group vs individual, (2) direct increasing of support vs changing naturally occurring support (e.g., developing social skills vs identifying current support), and (3) the source of support within the intervention.

6.2.1 Group vs individual social support interventions

Group interventions come in two forms (Hogen et al., 2002), firstly when social support is developed using family or friends. In this type of intervention family and friends are part of the treatment group where the clients support is developed through natural systems. Secondly, where social support is developed through the peer group. In this type of interventions people with low support are brought together and peers in the group provide support to each other, these are often known as self-help or support groups. In addition to developing support through naturally occurring

and forced support, group interventions can be used to develop social skills. Individual interventions come in a similar format to the group-based interventions, in that support can be given either via peers, or through naturally occurring support. However, they have the added effect that support is often also given through the supporting professional that the client may be interacting with. Within their review, Hogen et al. (2002) only found three studies that compared the differences between group or individual support interventions, specifically Linehan et al. (1979) found no differences between group or individual social support intervention. This was supported by a second study by Cain et al. (1986) in which no differences were found between group or individual interventions. From this we may be able to infer that group based social support interventions may be equally as beneficial as individual interventions. Finally, Schwartz (1999) found some benefit of peer support interventions suggesting that a group-based intervention increased commitment.

6.2.2. Direct increasing of support vs changing naturally occurring support

Within group and individual interventions, typically we find that the focus is on either directly increasing the amount of support a person received or by changing/developing the naturally occurring support that a person has. When interventions focus on directly increasing the amount of support, they often use the group as a way of increasing social support, in essence using a self-help group to increase social support. This aims to directly increase the individuals social network group and it is hypothesised that these types of peer support groups have had favourable effects on well-being (Maton, 1987). Furthermore, these groups have the benefit of having a professional individual to facilitate the development of new relationships. The results of these types of groups have demonstrated positive effects

on both psychological and physiological measures (Andersson, 1985; Spiegal et al., 1989; and Spiegel et al., 1999). However, it worth noting that these group-based interventions are often long-term which can be costly and time consuming. Network therapy is designed to use the client's family and friends in order to provide social support. It is a cognitive-behaviourally based therapy usually used with substance misuse clients. The aim with this type of therapy is to increase social cohesiveness as a vehicle for engaging the client in treatment outcomes (Galanter, 1993). This kind of therapy comprises of three distinct phases which aim to enhance social networks. Phase 1 is concerned with the identification of a social network, phase 2 is designed to build, engage, and mobilise the social network, and phase 3 is a consolidation phase aimed at relapse prevention (Copello et al., 2002). The main aim of this type of intervention is to promote and develop positive social networks within a clients' life in order to help with behaviour change.

6.2.3. Online psychology psychoeducation

The psychotherapy community has embraced the use online psychoeducation and therapy in order to deliver mental health services to patients via the internet (Ritterband et al., 2003). Furthermore, Alleman (2002) predicts an increase in growth and prevalence of the use of online and technologically enhanced healthcare in the future. Many of the online psycho-education interventions that are reported in the literature are based on the principles of computerised interventions, and often follow the same procedures of face-to-face education (Anderson & Titov, 2014). Further studies have shown that online psychoeducation and peer support has been used to support mental health problems.

There are a number of advantages and disadvantages to this methodology. Disadvantages to using online interventions are the lack of adherence to longer term programs and a systematic review conducted by Melville et al. (2010) found that attrition rated ranged from between 2% and 83%, which has been suggested as a natural and typical feature of many eHealth programs (Nicholas et al, 2010). Melville et al. (2010) suggest a number of reasons why there is such a dropout rate, specifically they suggest participant motivation, impulsivity, distractibility, specific aspects of the targeted psychological problem, and a number of socio-demographic factors including age, gender, and relationship status. In addition to this, most studies of online psychology interventions have shown a benefit of interaction with the therapist provided the quality is appropriate and engaging online interventions can have a positive impact on outcomes (Andersson & Titov, 2014). Further advantages to using online methodology include a far reach to many people with large amounts of information being able to be stored and delivered, significant increase in convenience for service users, significantly reduced costs for services on both the service and service user, and finally the ability to access hard to reach groups of services users (Griffiths et al., 2006).

Although there are many advantages to using this type of service delivery there are very limited reports and evaluation of the use of online psycho-education delivery in sport and exercise psychology generally. Of these reports, it appears that none have been directed to social support. Weinberg, Neff, & Jurica (2012) explored the use of psychological training online, suggesting that prior to 2012 there was very limited online psychological training. Further they suggested that face-to-face sport psychology could cost up £100 an hour or more. This study summarised that whilst online sport psychology would provide training to the masses there are a significant

number of barriers similar to those mentioned by previous studies in psychotherapy in providing online sport psychology. It also worth considering the benefits of online psychological training to athletes based upon the context they are working in. Typically, elite athletes have very full schedules and often prioritise technical, tactical, and physical training, and then recovery from that training, that face-to-face sport psychology may then become less of a priority. In addition, athletes often spend a lot of time travelling between training and competition venues and can have quite busy competition schedules during the 'on-season'. All these things combined suggest that online psychological training and psychoeducation may offer benefit to athletes that may not be available through contact-based interventions.

6.2.4 Single session psychology/ education sessions

There has been a dramatic increase in single session psychology and therapy sessions in the counselling and therapeutic literature (Hymmen et al., 2013). This is not a new approach to therapy but a different outlook on what therapy or psychology is (Campbell, 2012). The key assumption in single session work is that change is a natural and normal part of life, ultimately inevitable, and requires only brief support from a professional to solve a problem (Campbell, 2012). One key statistic in the drive for single session therapy is the modal number attendances at therapy is 1 session, often regardless of therapeutic model, problem type, or diagnosis (Weir et al., 2007). This is rather surprising considering many therapeutic models assume that longer term therapy is needed to encourage good levels of sustained change. What is even more interesting or surprising is that many clients report that a single session has satisfied their need and that change had occurred (Young, Weir, Rycroft, 2012). This approach to therapy has several key good practice guidelines. Specifically, clarity on

what is needed from the session, staying on track and not deviating from the problem, providing direct feedback, making the most of the encounter, and in some cases a more directive style (Young et al., 2012). The outcomes of single session psychology are interesting. Basoglu et al. (2007) found that large effect sizes at 4 and 8 week follow ups when treating stress and improving coping strategies in earthquake survivors, stating that improvements in symptoms were sustained by 72% of the client group. Perkins (2006) showed that between 70% and 74% of clients showed improvement on problem frequency and severity when compared to a wait list control with large effect sizes across the population, and at 18-month follow up. Perkins & Scarlett (2008) found gains have been maintained with no adverse effects in up to 60% of the treatment group. This suggests that single session intervention can be a good choice of intervention, can be cost effective, and simple in its approach, albeit face to face rather than online. Since the COVID-19 pandemic psychologists have had to innovate in the ways in which they work, one of these innovations was online delivery of single session interventions. Schleider et al. (2022) found that compared with a control group, behaviour activation single session intervention and single session teaching about traits and social support reduced depressive symptoms at a 3 month follow up, decreased hopelessness, and increase post-intervention agency, confirming the use of single session online interventions, even in high stress contexts. Further findings in this area of online support and specifically online psychoeducation, Hazell et al. (2020) found that an online brief psychoeducation session resulted in improvement in illness beliefs in line with the aims of the intervention, suggesting support for a sole session of psychoeducation interventions. Finally, in their review and considerations for future direction of single session interventions, Schleider et al. (2020) found positive effects of self-directed, single

session psychoeducation on depression, anxiety, health related behaviours, and goal setting.

6.2.5 Aims of the chapter

In summary then, little is known about the effectiveness of interventions designed to increase social support among athletes. Of the strategies that have been examined, collectively there are compelling reasons to examine whether a single dose of online psychoeducation represents an accessible and feasible strategy to increase athletes perceived social support. The aim of this study then is to develop and test the validity of a psycho-educational social support intervention to increase perceived social support.

6.3 Method

6.3.1 Participants

An opportunity sample (N= 65) comprising higher education students enrolled on undergraduate sport science and sport psychology programmes together with athletes involved in recreational to national level competition took part in the present study. They were aged between 18 and 45 years consisting of both male and female participants and had a variety of sport experience from recreational to national level competition.

6.3.2 Design

A factorial design was used to examine the impact of group (control, experimental) and time (pre, post) on measures of perceived social support.

6.3.3 Intervention

6.3.3.1 Theoretical underpinning.

The polyvagal theory, more specifically the social engagement system is a receptive and expressive system that aids in effective social behaviour (Porges, 2003). When the social engagement system is defensive then social challenges arise, and perception of social threat goes up. Interactions between people generates social bonds (Porges, 2003). The behaviours that are associated with social bonds are intertwined with the function of the autonomic nervous system (Porges, 2003), and activation of the social engagement system dampens the neural circuits that promote the fight, flight, or freeze behaviours (Porges, 2003). This system provides a good theoretical justification for education and intervention of social engagement as a way of increasing social support. Given that (a) co-regulation is a biological imperative, and (b) as we connect with others we develop a sense of safety, reduction in stress, and increases in pro-social behaviours, improving someone's perception or awareness of their social engagements would be ripe ground for intervention. Goodyke et al. (2022) states that perceived social support contributes to an adaptive stress response and this result has repeatedly been found throughout the health and social care literature. Dana (2020) provides some excellent resources based on the polyvagal theory that are designed to increase safety and connection, for example increasing awareness of social belonging, identification of social network and connections, developing rules of reciprocity, developing a personal connection plan, identifying your clusters of connection, identifying how to more effectively connect with others in your network, and developing of social skills to improve the connections in your current system.

6.3.3.2 Intervention activities

The psychoeducation session begins with an overview of social support, the types of social support, sources of social support, and what makes a good social support provider. This increased awareness is a way of beginning the journey towards improving a social network. Dana (2002) suggests that this is a starting point of reconnecting with the autonomic nervous system, reconnecting with others, and starting to understand the social engagement system and social networks.

The first activity in the psycho-education workshop was an identification of the social network. Social network mapping and identification of social connections is a well-documented way in increasing perception of social support (Hogen et al., 2002). Within network therapy for addictions, phase 1 of the therapeutic process to enhance social support is identification of the social network (Copello et al., 2002). This is usually done by a network diagram. Specifically, who is in the network, who can support you during tough times, and what type of support (esteem, emotional, tangible, informational) a person may be able to give you. Typically, people who can go into this network map are people who are readily available for you in times of stress, will help you achieve your goals, will be able to offer positive support. Dana (2002) provides a good justification for this kind of social network map as who you connect with, how you connect with them, and the quality of the connection is a way for the autonomic nervous system to feel nourished and will nurture a sense of safety from stress.

The second activity is designed to identify and plan how to access support when it is required. Having an ability to mobilise and access social support in key situations is a pragmatic way of enhancing awareness of what support is available and how one might access it effectively. This again is part of the network therapy model

and is part of phase 2 of the approach in which engagement with a social support provider is emphasised and plans to access support are developed (Copello et al., 2002). Furthermore, Dana (2002) offers a personal connection plan in which awareness of connections and plan to access those connections are developed. It brings into focus what already works in a person's social network and what needs to be developed. Furthermore, the personal connection plan aims to invite a participant to increase their personal connections, explore new connections, and create socially adaptive behaviours that will support the social engagement system.

The final part of the psychoeducation session is communication skills awareness. Given that social networks are mobilised through the social engagement system, awareness of key communication skills both verbal and non-verbal is important. Of particular importance in the polyvagal theory is the importance of body language as a way of engaging with the external world. Communication training is also a key part of phase 2 of Network Therapy, where a person's ability to communicate is enhanced thus improving one's ability to access social support when it is required. Dana (2020) suggests that effective body language and non-verbal communication is an effective way of co-regulation of autonomic nervous system, an explicit awareness of body language is an important part of effectively engaging the social engagement system. This section of the session ended with some key tips on starting conversation with social support providers again from Network Therapy (Copello et al., 2002).

6.3.3.3. The intervention structure.

The intervention consisted of a 50-minute psycho-education workshop delivered via online methods (a video through a virtual learning environment) and

was developed by a HCPC accredited sport and exercise psychologist and cognitive behaviour therapist with 7 years' experience of supporting athletes and coaches in high performance settings. The aims of the workshop were designed to increase perceived social support in the group of participants, provide social network mapping, identify key people in a person's life that could provide specific types of support, and overview communication skills that can be useful in accessing social support. The intervention was pre-recorded and delivered via Virtual Learning Environment or YouTube video. The recording directed participants what to do at what time and provided opportunities for participants to pause, reflect, and complete tasks. The participant was unable to proceed without completing the tasks in order and was presented the questionnaires pre- and post- intervention.

6.3.4 Measures

The primary measure used to assess perceived social support in the present study was the Perceived Available Social Support Questionnaire (PASS-Q) developed by Freeman, Coffee, & Rees (2011). The PASS-Q is a 16-item questionnaire assessing 4 types of perceived available social support. The items were developed from statements made by athletes about their social support in a study by Rees & Hardy (2000) or were derived from other questionnaires assessing social support. Each item is assessed on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely so). This questionnaire has been used widely throughout the literature and has been shown to correlate (r= 0.15 to 0.33) with the Social Support Survey (Rees et al., 2007)

The PASS-Q (Freeman, Coffee, & Rees, 2011) social support questionnaire was designed using statements made by high level athletes about their experiences of

social support. They developed a four-factor model of social support consisting of emotional support with items such as to what extent would people care for you, provide you with comfort and security, and show concern for you. Esteem support with items such as to what extent would people reinforce the positives, enhance your self-esteem, and boost your sense of competence. Informational support with items such as to what extent would someone give you constructive criticism, give you advice when you're performing poorly. Finally, tangible support with items such as to what extent would someone help you with travel, and help you organise and plan your competitions. The four-factor model is supported by good concurrent validity, low correlations with social desirability, and a good test-rest reliability (Freeman, Coffee, & Rees, 2011).

6.3.5 Procedure

Prior to beginning data collection institutional ethical approval was gained, and participants consent was given to participate in the study. Participants were randomly split into two groups. The first group engaged in the intervention where each participant was given access to the videoed psycho-education session and the session materials. This access was either given via email, in person by the lead author, or via Udemy online learning platform. Prior to completion of the psycho-education session participants were asked to complete a demographic information questionnaire and the PASS-Q to measure initial baseline perceived social support. Once this was completed each participant completed the online video psycho-education session, working through each of the tasks guided by the lead author. Once participants had completed the psycho-education session they were asked to repeat the PASS-Q immediately to assess whether perceived social support had changed. After gaining

consent the second group of participants were given the PASS-Q questionnaire before and after an unrelated psychology workshop to act as a control group. Participants assigned to the control condition were invited to spend one hour participating in a video session that is not related to social support. The participants were given the PASS-Q pre and post -video session.

6.3.6 Data Analysis

The data analysis strategy used within this chapter was identified using Field's (2018) decision making tree. Given the 2 x 2 model, 2 conditions (control and intervention) and 2 time points (pre and post) it was decided that an ANOVA would be the most appropriate data analysis method for this study. This would allow the comparison of means for the groups on a linear model (Field, 2018). Data collected on human participants in psychology is rarely normally distributed (Micceri, 1989). In this case the data was non-normally distributed and there was a lack of homogeneity of variance.

In these circumstances there is debate about how to analyse the data appropriately. Some authors advocate transforming the data (Lo & Andrews, 2015), with others suggesting that when this is done, one is no longer comparing mean scores (Lo & Andrews, 2015). Alternatively, some authors (e.g., Toothaker and Newman, 1994) have advocated a non-parametric equivalent of a 2-Way ANOVA, such as the aligned ranks test (Sen, 1968). However, there is still some debate about the circumstances under which it may perform better than a 2-Way ANOVA when assumptions are violated (Oliver-Rodriguez & Wang, 2015). Ultimately, data analysis in the behavioural sciences can present a number of challenges to the researcher (cf. Kneif & Forstmeier, 2021). Kneif & Forstmeier (2021) contend that although there is a small risk that the type 1 error rate is increased (that is detecting a statistically

significant result by chance), when assumptions are violated, there remain many unknown risks that are difficult to quantify when performing a range of transformations. As Kneif & Forstmeier (2021) contend, it is not always easy to discern what approach to take under which circumstances and that ultimately the interpretation of these results should be undertaken circumspectly. The use of parametric tests has considerable advantages over their non-parametric counterparts to produce a p-value (Le Cessie et al., 2020), furthermore parametric methods have a direct link with regression models allowing effect estimates to be made (Le Cessie et al., 2020). Specifically, parametric tests can provide trustworthy results with skewed and non-normal data, they can provide trustworthy results when groups have differing amounts of variability, and they have greater statistical power. The justification for use follows here.

The central limit theorem is one of the most fundamental theories in statistics (Kwak & Kim, 2017). Within this theorem parametric tests have a higher statistical power than non-parametric tests. The key concept of central limit theorem is that a randomly selected sample size with a sufficient number of samples within it can be used to estimate the parameters of the general population (Kwak & Kim, 2017). This theorem determines the sampling distribution of the means and identifies the probable likelihood of a normal distribution in that sample size. Put simply if you take a sufficiently large sample size the means will be normally distributed even if the population isn't. The convention for a sufficiently large sample size is $n > 30$ (Sawada, 2021). Further, Sotos et al. (2007) suggests that we can assume that a population follows a normal distribution and that a sample size selected from that population is thus representative. Interestingly, Norman (2010) states that the idea of a specific

sample size being needed to conduct parametric tests is a fallacy, specifically that there is no reference to sample size in the parametric assumptions.

6.3.6 Ethical considerations

Regardless of methodological approach or the benefits or drawbacks of the approach the fundamental principle of informed consent is paramount to proceed in single session work. There are number of key benefits and contraindications of single session psychology that need to be considered. Non-clinical populations or people who experience non-clinical emotional problems typically are good candidates for single session psychology. Single session psychology is also beneficial for those who lack time and who need prompt action to resolve a single problem. There are a number of key contraindications of single session psychology, these are people who want on-going long-term work, those who have vague complaints and who can't be specific, those who are typically avoidant and anyone that has difficulty in accessing key information or believes they have little control over their own actions (Dryden, 2016)

With the increase in e-health interventions and accessibility to psychoeducation sessions, the ethics of delivering such interventions need to be considered. Key risks associated with online, non-contact interventions are potential breaches in confidentiality due to unencrypted methods of communication, data privacy, risks of self-selection, and self-diagnosis. From an ethical perspective Rozental et al. (2015) suggests that not all online interventions will be successful for consumers and some negative effects may occur. Rozental et al. (2015) found that 9.5% of participants reported at least one adverse event related to online treatment for

anxiety or depression. It is important in these kinds of interventions manage expectations and be clear in what will and will not be achieved.

6.4 Results

The aim of this study was to understand whether an online social support psycho-education session could increase perceived social support. To analyse the influence of the social support intervention on indices of social support, a 2 (condition: control, intervention) x 2 (time: pre, post) ANOVA was undertaken using the Statistical Packages for Social Sciences version 23, for each of the social support dimensions (see Table 8 for descriptive statistics).

Table 8: Mean and std. deviation for the intervention group and control group

	Intervention group		**Control group**	
	Mean (SD)		**Mean (SD)**	
Variable	**Pre intervention**	**Post intervention**	**Pre intervention**	**Post intervention**
PASS-Q total	40.77(10.01)	44.15 (10.39)	45.96 (8.35	47.10 (8.59)
Emotional support	10.36 (3.35)	11.83 (3.13)	11.93 (3.26)	12.13 (3.14)
Esteem support	10.11 (3.01)	11.25 (2.98)	11.31 (3.00)	11.79 (2.51)
Informational support	11.30 (2.85)	11.63 (3.00)	12.10 (2.27)	12.07 (2.32)
Tangible support	9.00 (2.79)	9.80 (2.97)	10.62 (2.85)	11.10 (3.12)

When testing the statistical assumptions for the ANOVA, the Kolmogorov-Smirnov test of normality suggested that all variables pre and post-test except informational support pre intervention were non-normally distributed. ($p=<0.05$). The informational support pre intervention was normally distributed on this test to a $P=0.200$. Further using the Shapiro-Wilk test of normality all variables except for tangible and esteem support pre was non-normally distributed ($p=<0.05$). Tangible

support was normally distributed to a level of p= 0.138. Esteem support was normally distributed to a level of p=0.053.

Table 9 Tests of normality for pre and post social support results

	Kolmogorov-Smirnov			Shapiro-Wilk		
Variable	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Emotional support pre	.111	65	.045	.946	65	.007
Esteem support pre	.131	65	.008	.964	65	.053
Tangible support pre	.115	65	.032	.971	65	.138
Information support pre	.095	65	.200	.962	65	.044
Emotional support post	.135	65	.005	.913	65	.000
Esteem support post	.168	65	.000	.925	65	.001
Tangible support post	.161	65	.000	.957	65	.023
Information support post	.125	65	.013	.951	65	.012

Table 10: Levenes' test of equality of error variances to test of homogeneity of variance.

Variable	Sig.
Emotional support pre intervention	0.338
Emotional support post intervention	0.893
Esteem support pre intervention	0.874
Esteem support post intervention	0.381
Tangible support pre intervention	0.812
Tangible support post intervention	0.979
Information support pre intervention	0.200
Information support post intervention	0.351

6.4.1 Emotional support

A two-way repeated measures ANOVA (time x condition) was conducted to determine the effect of the intervention over time on perceived emotional support. There was statistically significant interaction between the intervention and time on emotional support, $F(1, 63) = 4.136$, $p = 0.046$. The main effect of time showed that there was a statistically significant effect of time on emotional support, $F(1,63) = 7.283$, $p= 0.009$. The main effect of group showed that there was no statistically significant interaction between conditions (control and intervention group), $F(1,63) = 1.592$, $P = 0.212$, partial $n^2 = 0.062$. This interaction can be seen in the graph below.

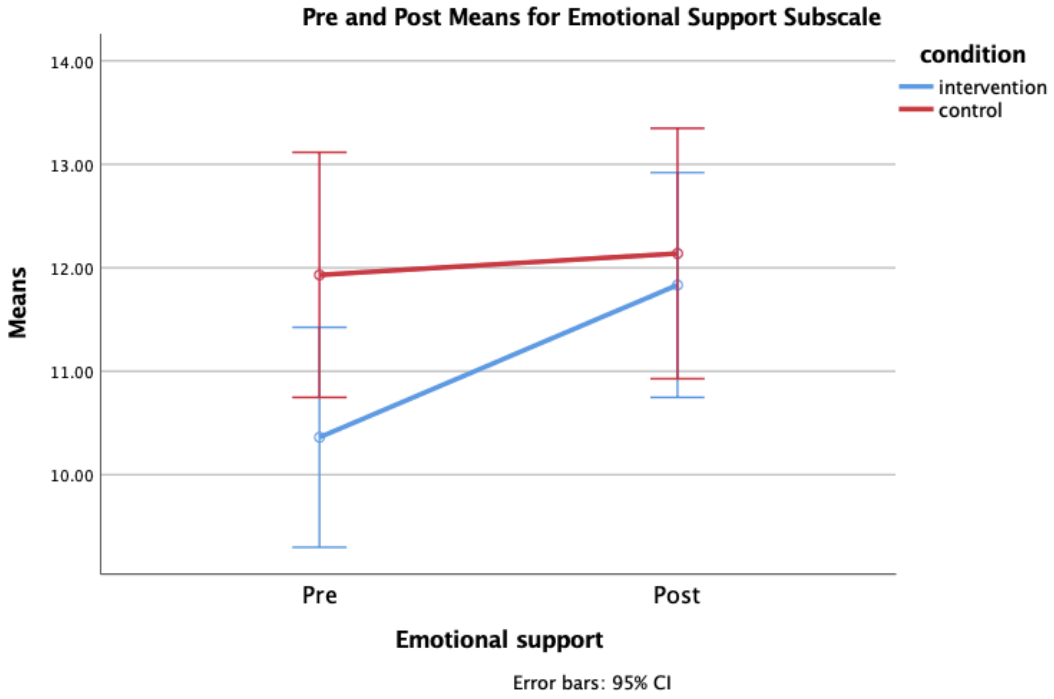

Figure 4 A graph to show the results of the two-way repeated ANOVA for emotional support.

6.4.2. Esteem support

A two-way repeated measures ANOVA (time x condition) was conducted to determine the effect of the intervention over time on perceived esteem support. There was no statistically significant interaction between the intervention and time on

esteem support, F(1, 63) = 2.079 , p = 0.154), partial n^2 = 0.047. The main effect of time showed that there was a statistically significant effect of time on esteem support, F(1,63) = 12.699, p= 0.001, partial n^2 = 0.944. The main effect of group showed that there was no statistically significant interaction between conditions (control and intervention group), F(1,63) = 1.609, P = 0.209, partial n^2 = 0.034. This interaction can be seen in the graph below.

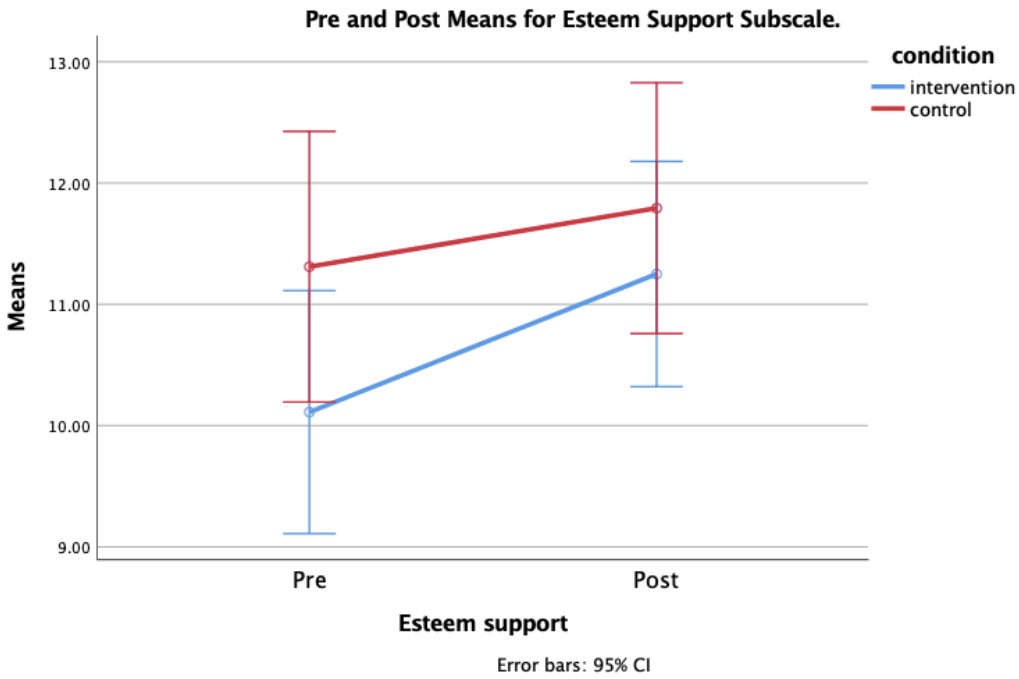

Figure 5 A graph to show the results of the two-way repeated ANOVA for esteem support.

6.4.3. Information support

A two-way repeated measures ANOVA (time x condition) was conducted to determine the effect of the intervention over time on perceived information support. There was no statistically significant interaction between the intervention and time on esteem support, F(1, 63) = 0.695 , p = 0.408, partial n^2 = 0.011. The main effect of time showed that there was no statistically significant effect of time on emotional

support, F(1,63) = 0.459, p= 0.007. The main effect of group showed that there was no statistically significant interaction between conditions (control and intervention group), F(1,63) = 0.954, P = 0.333, partial n^2 = 0.015. This interaction can be seen in the graph below.

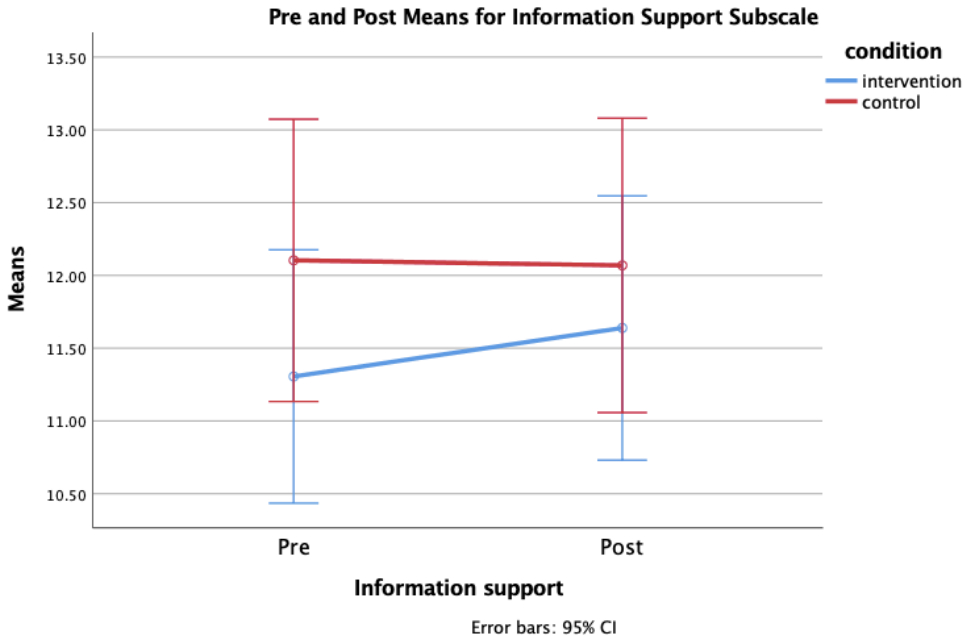

Figure 6: A graph to show the results of the two way repeated ANOVA for informational support.

6.4.4. Tangible support

A two-way repeated measures ANOVA (time x condition) was conducted to determine the effect of the intervention over time on perceived tangible support. There was no statistically significant interaction between the intervention and time on tangible support, F(1, 63) = 0.275 , p = 0.602, partial n^2 = 0.004. The main effect of time showed that there was a statistically significant effect of time on tangible support, F(1,63) = 4.386, p= 0.040, partial n^2 = 0.065. The main effect of group showed that there was a statistically significant interaction between conditions

(control and intervention group), $F(1,63) = 4.811$, $P = 0.032$, partial $n^2 = 0.071$. This interaction can be seen in the graph below.

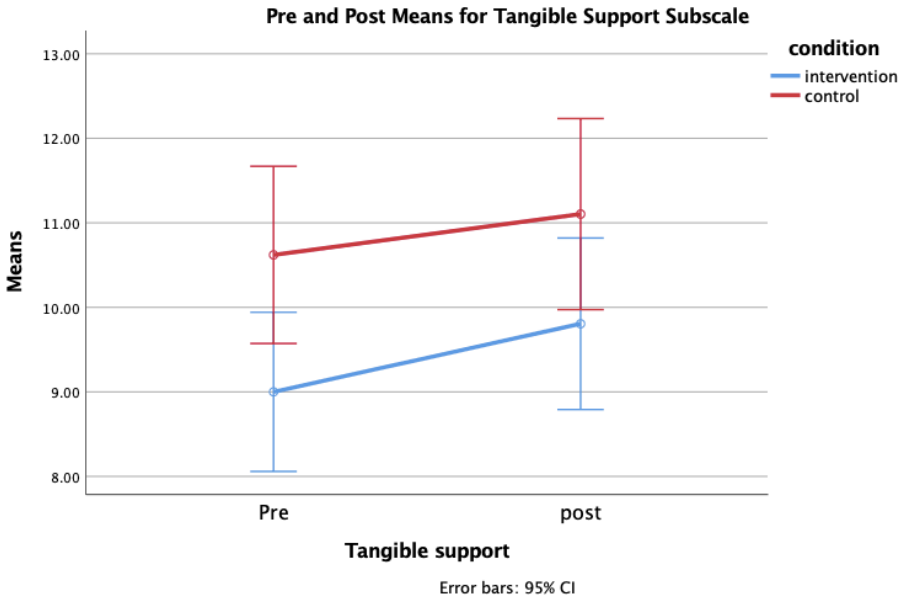

Figure 7: A graph to show the results of the two-way repeated ANOVA for tangible support.

6.5 Discussion

This study is the first online psycho-educational session that is specifically designed to enhance perceptions of social support among a sporting population.

Results from this study suggest that the intervention was effective in enhancing emotional support. In addition, although the change in esteem and tangible support did not reach statistical significance, the direction of change was in the hypothesised direction (i.e., mean changes in esteem and tangible support increased post-intervention in the intervention group). These results suggest that a psycho-education session delivered online could be used to increase emotional support in a group of people as assessed by the PASS-Q (Freeman, Coffee, & Rees, 2011). However, contrary to the hypothesis the results suggest that the intervention did not bring about statistically significant increases in esteem, tangible, and informational

support. There are 2 potential reasons for this this result. Firstly, the sample size used was fairly small and thus observed effects were also small. Previous injury and social support studies have used up to 100 participants in their studies however Freeman, Coffee, and Rees (2011) detected effects with single cases. In a meta-analysis by Hogan et al. (2002) found that 8 studies with individual interventions had no benefit to the participants. Secondly, it may be that emotional support is easier to portray within a psychoeducation session. It may be easier to increase the awareness and proximity of people in someone's life that can provide emotion support than perhaps for tangible support. Given that the participants in this study were mostly university students who play sport, this may have confounded the results as their context may be different from the typical athletic population. For perception of support to be increased there firstly has to be a support network in place (Eklund, 2001), university students in this study may have low levels of support networks due to moving home, making new friends, and not having typical providers close by. It appears that in this case perceived esteem, tangible, and informational support were not improved by this intervention and thus this would be a novel finding.

These results compliment previous research that suggests that social support skills training interventions can increase perceived social support and increase networks (Hogan, Linden, & Najarian, 2002). There are a number of potential reasons why these results may be different from the previous research. First, this intervention is delivered via online methodology a novel way of presenting this information but given the advantages of online interventions suggested by Melville et al. (2010) this could be good opportunity for sport psychology practitioners in their practice. Secondly, the intervention in this study was presented on a single time point whereas many of the interventions that aim to increase social support are delivered over

several weeks. Thirdly, the participants in this intervention completed it on their own via an online portal, or YouTube video, many group and individual based social support interventions use the group processes and individual relationships in therapy sessions as a way of increasing available social support, in this study this was not the case. However, it is worth mentioning that Linehan et al. (1979) and Cain et al. (1986) found no differences between group and individual based interventions that were designed to increase perceived social support, suggesting that participating as an individual online may be as helpful as a group based, in person intervention.

Contrary to what was anticipated, mean ratings of social support (all dimensions) were rated higher post-intervention, compared to pre-intervention among control participants. This may account in part for some of the non-statistically significant interactions. Several explanations may account for this. First, the mere measurement effect (Morwitz & Fitzsimons, 2004) may have increased the intention that participants must explore and access their social support. Which may explain the increase in social support in the control group. It may also have increased their awareness of their social support during the control condition. By asking questions about perceived social support we may have brought social support to the control participants attention, thus increasing their awareness of their own social support without providing any intervention. Second, it's possible that the control trial may have had an unintended impact on perceptions of social support. Sherman (1980) demonstrated that participants often over predict their likelihood to engage in tasks, or to perform socially desirable behaviour, this may explain the results of the control group by suggesting that participants may have overestimated their social support because of our approach to measuring it both pre- and post-control condition. In essence by measuring intention or perceived understanding there is a potential to

change the actual behaviour of a participant. Morwitz & Fitzsimons (2004) found results consistent to this idea that measuring something (in their case intention) can increase positive attitudes towards a product (in their case accessibility and choice). This may have played a role here, in that by measuring perceived social support we may have increased the positive attitude towards social support slightly thus increase someone's intention to engage in social support. For example, someone may have realised that they need to speak with their parents as a result of us measuring their perception of social support. To circumnavigate this in future research it would be beneficial to increase the number of participants tested and randomise the order in which questions are posed to participants.

Although this study provides tentative support for the idea that emotional support can be developed using a single psycho-education session in an intervention group compared to control, there are 2 distinct limitations. Firstly, the time-limited short nature of the intervention means that the impact may be lower, a longer more targeted intervention may increase the impact and increase perceived social support amongst the participants. Secondly the study did not observe the longer-term impacts of the intervention. It did not assess perceived social support in the days and weeks after the intervention, which means we cannot say that this intervention has lasting effects. This limitation is because of the methodological choices and feasibility in conducting an online single session psycho-education session. There was limited evidence prior to the start of the present study that an online psycho-education session would increase social support dramatically, it was therefore deemed ethically inappropriate to ask participants to return for follow up data collection given this limited evidence. Further research is needed to establish the lasting effects of an online social support intervention and should attempt to develop a longer-term

intervention that specifically targets the specific social support facets of the PASS-Q (Freeman, Coffee, & Rees, 2009). For applied practitioners this study shows that there is a possibility of using online psycho-education interventions to improve aspects of athlete's social support with a carefully designed and targeted intervention. This could be a cost-effective way of transmitting sport psychology education to athletes and coaches, provided that the interventions are well-designed, and learning is assessed effectively. Further research could look to develop this study by offering a more targeted intervention to increase social support and to consider collecting follow up data to identify the lasting effects of increasing perceived social support.

6.6 Chapter summary

This chapter aimed to explore whether psychoeducation delivered in a novel way can improve perceived social support. The present study suggested that an online psycho-education session designed to increase awareness of social support can enhance perceived emotional support in sport science students. More research is required to understand whether online psychoeducation can enhance other sub-scales of perceived social support. Furthermore, this study shows that psychoeducation can effectively be delivered online and can increase scores on psychological tests. Further exploration of different interventions that can increase perceived social support is required in order to understand the full effects of different types of interventions that can be used to increase perceived social support. People who are experiencing major life challenges (e.g., injury) often benefit from different types of support in order to help cope with the stressor (Thoits, 1995). Further research in this area should consider the dosage of the psycho-education interventions, the longer-term impacts, and other uses for online psycho-education delivery.

7. A single case using counselling methods to improve social support: an investigation of stress, healing, and heart rate variability.

7.1 Chapter introduction

This chapter is catalysed by several observations in the preceding chapters. First, in the reviews of literature, it was illustrated that there was limited experimental research examining the influence of social support on speed of injury recovery. In the empirical chapters, it was tentatively suggested that (a) emotional support seemed to moderate the daily stress-healing relationship (chapter 2 and 5), and (b) that the perception of social support could be enhanced through intervention (chapter 6). However, this latter study did not address whether increases in social support were associated with changes in either the autonomic nervous system (HRV) or healing rate. Alongside examining the influence of social support on HRV and healing rate, it was apparent in chapter 5 that there was quite large inter-individual heterogeneity in many of the HRV and wound-healing data. Such heterogeneity may mean that assessing group mean changes are problematic, and perhaps mask situations whereby some participants change, and others do not (cf., Estrada, Ferrer, & Prado, 2018).

Social support interventions that are delivered on a one-to-one basis outside of a laboratory, within a consulting room or workshop often involve the provision of emotional, informational, and/or tangible support (Hogen, Linden, & Najarian, 2002). In their meta-analysis, Hogen, Linden, & Najarian (2002) found that nine studies reported positive effects of social support interventions delivered by professionals. Specifically, supportive therapy, CBT, and Systemic Therapy was found to reduce depressive symptoms (Birmaher et al., 2000). The meta-analysis conducted by Hogen et al. (2002) found a variety of different types of intervention conducted by

professionals, these included systemic therapy (Brent et al., 1997), Cognitive Behaviour Therapy (Burgess et al., 1987), Assertive Community Treatment (in which a team provided tangible support 24hrs a day, Calsyn et al., 1998), the provision of informational support (where information was given on the events likely to occur in hospital (Finesilver, 1978), supportive therapy (which involved discussion around stressful events, Irvine & Logan, 1991; Lando, et al., 1996; Markowitz et al., 1998), and a range of emotional support specific interventions (Moorey, Greer, Bliss, & Law., 1998; Villar et al., 1992; Thompson., 1989; and Wolfer & Visintainer, 1875). A limitation of these studies is that procedural details regarding the manner in which social support was provided is largely absent. Indeed, although (a) single-case designs have been used to examine the influence of social support on varying attributes (see above) and (b) a single case study was used to assess the influence of social support among golfers (Rees et al., 2010), to date, there appears to be no single-subject designs examining the influence of social support on healing rate. For these reasons, a single-subject design was considered to represent a useful addition to the "bricks" (Forscher, 1963) in this programme of research where polyvagal theory is used as a bridge to connect the bio-, psycho-, and social-aspects of healing.

In the most recent review of single case designs in sport psychology, 66 single case designs had been conducted between 1997 and 2012 (Barker et al., 2011). Single case designs have a number of unique features that make them useful in conducting applied research: firstly, these designs offer an opportunity to demonstrate effectiveness on the individual level, secondly, we can explore the effectiveness of interventions in naturalistic settings which can encourage treatment effects and ecologically valid tasks, thirdly, single case designs offer the opportunity to evaluate practice by investigating the outcome of interventions in the way in which they are

actually delivered, and finally, in group based controlled studies we may find statistically that an intervention didn't work however it may have worked for individuals within a group, single case designs mitigate this by focussing on the impact on the individual (Barker et al., 2011).

Broadly then, single-subject designs are characterised by rigorously evaluating effects of interventions on an individual or small number of participants (Barker et al., 2011) and typically possess at minimum a baseline (A) phase, and intervention (B) phase. To enhance the likelihood that it is the intervention that is impacting the outcome, several adjustments to this minimum approach have been advocated. First, an ABA design is associated with assessing what happens when an intervention is removed (cf. Virues-Ortega & Martin, 2010). However, the re-introduction of a baseline can raise ethical (e.g., removing successful treatment from an individual may cause increased distress) or practical (e.g., these single case designs often are more time consuming than other options) problems for the practitioner therefore may not be suitable for real world application. A second design is the multiple baseline design in which data is collected across two or more people concurrently, after which each person engages in the intervention sequentially. This design is a flexible approach to collecting single case data and can offer more experimental control by delaying the intervention across behaviours, context, or individuals (Virues-Ortega & Martin, 2010), however again there are ethical considerations around with-holding potentially useful treatment from participants that may benefit from it. One further design is the alternating treatment design in which conditions are alternated and repeated across a single participant. In this design participants are exposed to multiple different treatments over a longer time period each with their own return to baseline. Each of these designs has their own benefits and drawbacks therefore it is critical to select the

design that adequately reflects and tests the research question and intervention being presented.

One of the most simple and effective strategies for single case research is the ABA design (Ottenbacher, 1986), this design withdraws treatment after the intervention phase to provide a level of confidence that the intervention has had a specific effect on the participant. This design increases the strength of the relationships between the intervention and client's improvements (Ottenbacher, 1986). Simply put these designs offer an opportunity to provide strong experimental control whilst allowing for ease and simplicity of use in an applied setting (Byiers, Reichle, & Symons, 2012).

In summary, this study has a number of aims, (1) to explore the impact of social support on heart rate variability, (2) to examine the influence of a counselling intervention on perceived social support (emotional, esteem, informational and tangible domains), and (3) to examine the impact of the increases in social support on the rate of wound healing.

7.3 Method

7.3.1 Participants and selection criteria

Following university ethical approval, emails were initially distributed to the researcher's networks inviting participants to take part in the study. The selection criteria for the study were male or female individuals who are over the age of 18 and willing to participate in a healing study. One individual who had an interest in the study based on their own injury-performance experiences, agreed to participate after a briefing about the structure and the acquisition of informed consent.

The participant in this study was a 24-year-old female with a job in the university sector who participated in CrossFit. CrossFit is a competitive fitness sport which emphasises major compound weight and body weight-based movements. She would train between 4 and 6 times per week in a 'Box' with other people and a coach. At present she did not compete in CrossFit but was in training to complete her first competition before the end of the year.

7.3.2 Design

This study adopted a single case (A-B-A) design to examine the effects of a counselling based social support intervention on heart rate variability, stress, social support, and healing. A 4-session baseline, followed by a 4-session intervention, and a 4-session return to baseline was conducted. The gold standard length of baseline for single case designs is between 4 and 6 data points (Ottenbacher, 1986). The benefits and drawbacks of shorter and longer baselines were considered. On the one hand a longer baseline may increase the stability of baseline measures and afford greater confidence that any changes post-baseline is associated with the intervention. However, given the multiple measures, in which it would arguably be necessary to attain stability for all outcomes, alongside the participant desiring more immediate support from the practitioner in accord with her competitive aims, a longer baseline, although desirable was problematic.

7.3.3 Measures

The same measures used in Chapter 5 where heart rate variability, daily stress, social support, and trans-epidermal water loss were assessed were also used in this study.

7.3.4 Data collection procedure

Data were collected at 4 time points across pre-intervention, these were taken at a one-week interval on the same day and time each week. A wound was created using the tape stripping procedure (Lademann, Jacobi, Surber, Weighmann & Flurh, 2009) on the participant's arm each week for the baseline period. Different sites on the participants arm were used for tape stripping across each of the time points to ensure adequate return to normal TEWL. TEWL data was collected immediately after the wound was created to ensure that TEWL reached the same level each time, and then again after 1 hour to assess amount of healing. Questionnaire data was collected during the 1-hour time lapse between TEWL measurements. During the intervention phase, which again last 4 weeks where each data point was taken on the same day and time each week, questionnaire data was collected at the end of the counselling session, heart rate variability data was collected over 15 minutes during the session, and trans-epidermal water loss data was collected after creating a wound using a tape stripping procedure (Lademann, Jacobi, Surber, Weighmann, & Flurh, 2009) at the beginning and end of each of the counselling sessions (immediately after the tape stripping and then 1 hour post tape stripping). Finally, during the post intervention phase, again taken over a 4-week period at the same day and time each week, data were collected at 4 time points again using different arm sites for tape stripping to ensure adequate return to normal TEWL.

7.3.5 Data analysis

Traditionally the analysis of single case designs includes a visual analysis, analysis of descriptive statistics with an inspection of the trends and patterns

throughout the data (Bloom, Fischer, & Orme, 2009). Further analysis will usually take the form of a graphical analysis (White, 1971), statistical testing, and a time series analysis (Kazdin, 2011). In their review, Barker et al. (2013) identified the typical data analysis procedures used in single case design studies in sport psychology. They found that of the 66 studies identified, all employed a visual analysis, 16 of the 66 use statistical analyses with a variety of statistical methods used. Barker et al. (2011) offers a series of considerations when conducting single case research specifically within the analysis phase of the research, they state that the to determine meaningful change having good quality baseline data is necessary. Traditionally, a visual inspection of trends and changes in data (see below) alongside the use of time-series or statistical analyses are used to assess the impact of interventions on outcomes in single-subject designs (Barker et al., 2013). The approach/es to analysis are often predicated, at least in part on two key considerations when it comes to the baseline data, namely stability and length (Barlow et al., 2009). The idea of developing a baseline is not a simple one and there are competing ideas. Barlow et al. (2009) confirms that there are no agreed guidelines that can be applied across all situations. Variability in a baseline can make it difficult to infer meaningful change (Barker et al., 2011). Given that the participant acts as their own control in single case designs, Hrycaiko & Martin (1996) suggest the need to have a stable baseline before beginning an intervention phase. They advocate that a stable baseline in performance is important in determining change (Hrycaiko & Martin, 1996) however in performance and sport situations it is possible that baselines will never be stable due the conditions and context in which athletes and performers operate (Nicholls et al., 2005).

Baseline length is the second consideration when working with single case research. The tension here is between the demands of the research and then the demands of working in applied practice. In a practical sense the participant may not be willing to undergo lengthy baseline data collection. Given that the purpose of the baseline is to provide a standard with which change be compared, a lengthy baseline is not always necessary (Barker et al., 2011). Ottenbacher (1986) offers three key elements in identifying an effective baseline, firstly, consistency, where possible all the measurements should be similar, similar devices, times, days, locations, and instructions, secondly, frequency of the data collection, the data should be collected repeatedly over time, he states that there is no rules on the frequency of the data but at least 3 data points is a minimum with 4 to 6 data points per phase being a good guideline. Finally, stability, each phase should gain a degree of stability, however this is often based on the variables that are examined and the conditions in which they examined (Ottenbacher, 1986)

As mentioned, there are benefits and drawbacks to the Hrycaiko & Martin (1996) approach and the Ottenbacher (1986) approach to obtaining baselines in single-subject designs. There is a trade-off between the variability or stability of the baseline and the length of the baseline phase. This trade-off needs to consider tedium effects where, participants can become disenfranchised and unmotivated with lengthy baselines that will impact upon the effectiveness of the baseline data (Winship, 2007), there are ethical concerns of withholding interventions from participants that may require it to obtain a stable baseline, and finally the key purpose of the baseline is to avoid the snapshot error associated with cross-sectional research.

Visual inspection of the data was guided by suggestions made by Ottenbacher (1986). These were level, variability, trend, and slope. Level refers to the changes in

magnitude of the data, specifically the change in value of the series of data at the point of intervention (Ottenbacher, 1986). This change in level often represents an immediate or abrupt rise or fall in the variable once the intervention is introduced. Variability refers to the amount of fluctuation of data points in the series, if there is too much variability in the data this could indicate that the data is unstable, Tawney & Gast (1984) suggest that 80-90% of the data should fall within a 15% range of the mean for that phase. However, Ottenbacher (1986) suggests that there can be a tolerance of variability in the results, and that this can often be judged by the researcher. This judgement should be based on typical expectations of the intervention on the participants. For example, if there is an expectation that the change should be rapid then more variability is acceptable, if however, the change is more gradual then less variability is acceptable. In this study, Ottenbacher's (1986) approach was used. Trend refers to the direction in which the series of data is progressing. A trend that is increasing systematically will indicate an accelerating trend, and a trend that is decreasing may suggest a decelerating trend. Changes in trend are reflected in the direction in which the data is moving. Data may accelerate in which data points increase over time, it may decelerate in which data points decrease over time, and finally it may increase and then decrease over time causing an inverted U which would be described as a quadratic trend (Ottenbacher, 1984). The final part of a visual inspection is the slope, this refers to the pitch of angle of trend, which can be visually represented in a trend line (Ottenbacher, 1984). Effect sizes were calculated by using the pooled standard deviation suggested by Ottenbacher (1984) and reported accordingly. Statistical analysis was considered however due to the short length of the baseline this was not pursued.

7.3.5 Counselling support session structure

Counselling support sessions were conducted by the author. The author is a Health Care Professions Council registered practitioner psychologist and trained CBT therapist, with over 7 years' experience of supporting people in both elite sport and mental health. The aim of these sessions was to provide emotional and esteem support to the participant. Session 1 began with an overview of the aims of the session with some ideas about what could be discussed in the sessions (e.g., work stressors, life stressors, general challenges etc.) and an intake process was conducted to begin to build a therapeutic relationship, whilst understanding the participant context. At the beginning of each session the participant was asked for their agenda of specific topics they wish to discuss, and time was allocated to each of the items. The participant and practitioner worked through each agenda item with an emphasis placed upon providing emotional and esteem support. This was done by probing questions around emotions, containing emotions in the session, probing the agenda items effects on esteem and providing opportunity for the participant to reflect upon and process their emotional and esteem experiences.

An important component of change in a therapeutic setting is the therapeutic relationship. The working alliance is an implicit or explicit contract between the client and psychologist where the psychologist has some level of face validity or a level of credibility with the client (Dryden, 2016). Some key factors that facilitate the management of the working alliance are what Rogers (1951) termed as his core conditions, specifically unconditional positive regard, empathy, and congruence. The relationship serves a dual purpose in individual support, firstly as a way of regulating emotions and facilitating emotional processing, this is often accomplished by offering a soothing, emotion focussed bond with a client, whilst providing acceptance of the

client and congruence which is much more likely to occur within positive, effective, and safe relationships (Greenberg, 2007). When an empathetic connection is made emotion processing centres of the brain are affected (Greenberg, 2007) which creates an environment where client feel safe to explore emotions and generate new learning whilst having a level of interpersonal soothing, over time Greenberg (2007) suggests that this regulation is internalised, and the client becomes more self-sufficient in emotional processing.

The specific discussions within the sessions were guided by an intervention and case study designed and delivered by Freeman et al. (2009) in which a sport psychology practitioner aimed to increase social support in a golfer during their golf round. Specifically, to increase emotional support they employed active listening, talking through challenges, and allowing participants to vent frustrations to the practitioner. To increase esteem support they employed encouragement, reinforcing the positives, and reassurance. To increase tangible support the practitioner offered practice assistance with tasks, and by helping the client to practice specific situations by using roles plays etc. Finally, to increase informational support the practitioner offered advice, feedback, constructive criticism, helping with decision making, and help with perspective on situations. The specific content of each session for the participant is presented below.

Session 1

This session contained psychoeducation about social support (e.g., the types and uses of social support), an overview of the intervention process, and discussion about specific agenda items presented by the client. Specifically, the client asked to talk about a work situation and some stressful training that she had been through that week. The practitioner offered esteem support by reflecting the positive experiences

back to the client and enhanced the awareness of the clients' strengths. Questions and dialogue such as "what do you think are your key strengths?", "can you identify some situations where these strengths have been particularly prevalent?", and "how have these strengths helped you in the work and sport you have been doing?" were used.

Session 2

This session continued with the clients' agenda. Specifically, she wanted to talk to through a number of work questions that had arisen that week. In addition, she wanted to talk through her current approach to work and ask the practitioner for specific advice about specific situations. Further, the client suffered an ankle injury prior to this session. The practitioner focussed on providing esteem and emotional support regard the work that the client had been doing, further the practitioner offered a large amount of informational support and advice based on their experiences in similar situations. Finally, the practitioner offered some emotional support around the ankle injury. By using questions and comments such as "what feelings are you experiencing at the moment around your ankle?", "how are you making sense of those emotions?", and "what thoughts are you experiencing that are causing those emotions?"

Session 3

This session focussed on three key agenda items for the client. The first two agenda items were focussed on work related problems. The practitioner took the opportunity to increase informational support by providing feedback on the clients' thoughts and approaches, by asking questions that aim to enhance self-esteem (e.g., what do you think you did well here?) and highlight the good practice that is

happening (e.g., that sounds like an intelligent option.). In addition to this the practitioner used Socratic Questioning and active listening to enhance emotional support (e.g., what emotions are you experiencing? Those emotions seem reasonable and normal in this situation) around a personal matter that the client had be struggling with.

Session 4

The final session of the intervention focussed primarily on the clients' personal life issues that have been causing stress. The practitioner used Socratic questioning in order to elicit alternative views (e.g., what do you mean by that? What would someone else say about this problem?), and provide esteem (e.g., it seems like you are focussing on the right things? What are your strengths in this area?), and emotional challenge support (e.g., what emotions are you experiencing? Is there an alternative way of viewing these emotions?). Further the practitioner provided listening support to further enhance emotional support.

7.4 Results

Initial descriptive statistics are presented in the tables below.

Table 11: Descriptive statistics of baseline, intervention, and post-intervention.

	Mean (SD)		
Variable	**Baseline**	**Intervention**	**Post-intervention**
Heart rate	80.83 (11.07)	75.68 (11.07)	78.75 (11.45)
RMSSD	43.15 (20.37)	47.68 (19.87)	44.28 (24.34)
SDNN	71.87 (22.29)	72.33 (19.93)	68.98 (37.90)
PASSQ total	10.50 (0.35)	13.63 (1.09)	13.19 (0.83)
Emotional support	2.75 (0.46)	3.13 (0.14)	3.00 (0)

Esteem support	2.44 (0.24)	3.44 (0.55)	2.94 (0.13)
Informational support	2.81 (0.55)	3.88 (0.25)	3.75 (0.35)
Tangible support	2.25 (0.50)	3.56 (0.31)	3.50 (0.35)
Daily stress	97.00 (12.62)	104.25 (12.42)	99.50 (15.59)
TEWL start	30.00 (0)	30.00 (0)	30.00 (0)
TEWL end	22.10 (4.62)	16.28 (3.51)	13.53 (2.47)
TEWL change	7.90 (4.62)	13.72 (3.51)	16.48 (2.47)

Visual inspection analyses suggest that a social support intervention was effective at enhancing perceived social support, specifically esteem, tangible, and informational support, and slightly increasing emotional support. Social support assessed by total PASS-Q increased during the intervention phase (29.80%) and decreased slightly in contrast to intervention phase (3.22%) but remained above (10.5) the baseline. When social support is broken down into its 4 subdomains, we find that emotional support increased slightly during intervention (13.97%) and decreased very slightly during post intervention phase (4.15%). Esteem support increased during intervention phase (40.98) and decreased in post intervention (14.53). Informational support increased during intervention phase (38.07%) and again decreased slightly during the post intervention (3.35%), and finally tangible support increased during the intervention phase (58.22%) and decreased very slightly in post intervention (1.68%).

Changes in perceived social support were accompanied by changes in rate of wound healing. Specifically, the change in healing time decreased during the social support intervention phase and began to increase again when the intervention was withdrawn. Trans-epidermal water loss change increased during the intervention phase by 73.79% and again increased from intervention to post intervention phase by

another 21.85%. This is suggesting that during the social support intervention healing rate increased.

Alongside changes in wound healing, the intervention was further associated with changes in HRV. Specifically, a small mean increase in RMSSD and SDNN was observed between pre-intervention, and during-intervention phases. Heart rate variability assessed by RMSSD increased slightly during the intervention phase (10.49%) and reduced slightly back to baseline in the post intervention phase (7.13%). In addition, heart rate variability assessed by SDNN also increased slightly during the intervention phase (0.64%) and decreased below baseline during the post intervention phase (4.63%). This is indicative of the suggestion that social support may impact upon the autonomic nervous system in accord with polyvagal theory. Effect sizes for each variable are as follows; Heart Rate (0.22), RMSSD (0.05), SDNN (0.09), TEWL post (2.31), TEWL change (2.31), PASS-Q total (4.22), Emotional support (0.77), Esteem support (2.59), Informational support (2.03), Tangible support (2.90), and Daily Life Stress (0.18). In addition to effect sizes, trend lines were analysed using the split middle technique suggest by White (1971). This analysis can be seen on the graphs in Figure 8 as a dotted line. The trends for TEWL percentage change, RMSSD, SDNN, PASS-Q total, esteem support, informational support, tangible support all appear to be accelerating during the intervention phase in a therapeutic way. The trend for emotional support appears to be accelerating slightly in a therapeutic way. However, the trend for daily life stress appears to be accelerating in a contra therapeutic way.

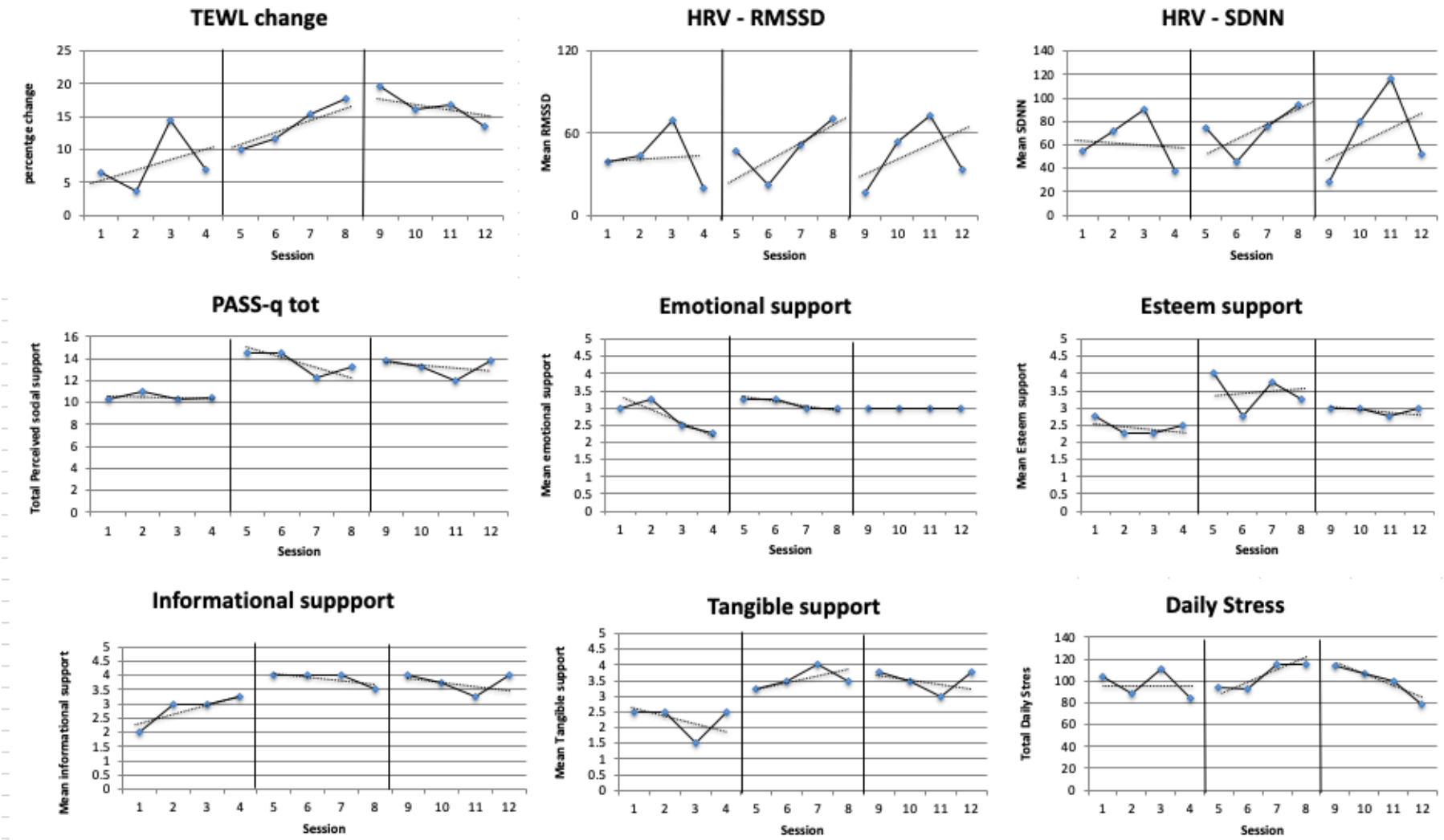

Figure 8: Graphs to show change in variable during baseline, intervention, and post intervention phases of this single case design study.

7.5 Discussion

The aim of this study was to examine the effects of a social support intervention on heart rate variability, perception of social support, and healing in a single participant over time. Findings indicate that a counselling-based intervention delivered over a 4-week period can increase social support, specifically the 4 sub-components of social support including esteem support, emotional support, informational support, and tangible support. Further this increase in social support was associated with an increase in the amount of wound healing that occurred across an intervention, finally there was an increase in heart rate variability during the social support intervention phase.

Similar to the results of Freeman et al. (2009), this single-subject design suggests a one-to-one intervention may enhance the perception of social support, and where circumstances are favourable, may offer an alternative to the online psychoeducation intervention reported in chapter 6.

Secondly, the results show that during the intervention phase the speed of healing measured by the difference in pre- and post-trans-epidermal water loss increased. Once again this suggests that the intervention may have influenced the participant's ability to heal during the intervention phase. This is contrary to the results found by Robles (2007) in which a confederate was used to provide social support. In a study in which a confederate provided emotional, esteem, and informational support to a participant during a short-term laboratory stress test, no effect on participants' perception of social support or on skin barrier recovery was observed. There may be several key reasons for the difference in the results of the present study. The social support provision was specifically tailored and bespoke to

the participant, this meant that the participant could focus on their needs for the social support provision rather than being given prescribed social support by a confederate. The therapeutic relationship that was built up over time between the researcher and the participant could have increased the uptake and willingness of the participant to engage with the social support, specifically it has been shown in therapy that an effective therapeutic relationship can increase emotional coping, self- esteem, and effective use of information (Greenberg, 2007). This study was able to develop one of the limitations of Robles' (2007) work by removing the confederate and supplying the participant with a specific social support provider, expanding their social network, and providing bespoke social support to the participant.

Finally, the results show that heart rate variability measured by RMSSD and SDNN increased slightly during the intervention phase. This result shows that social support given by a social support provider can influence, at least in a small way heart rate variability. It suggests that there is a link between social interactions specifically emotional support, tangible support, esteem support, and informational support and a biomarker of the ANS. Although, the single-subject design cannot rule out the possibility that alternative variables may have impacted the relationship, it remains a novel finding and consistent with the polyvagal theory underpinning this intervention.

Some tentative support has been found here then for the use of the social engagement system in social support and injury. Given that we are hard wired for connection and that it is a biological imperative vital to survival (Porges, 2015) the provision of psychological social support may be viewed as a way of increasing connectedness and allowing for adaptive responses from the autonomic nervous system that prompts healing. The trust and connection that is built between a practitioner and client in these sessions may allow the client to move into connection

and share a level of safety. This safety allows the autonomic nervous system to create the possibility for health, growth, and restoration (Dana, 2020).

In this study the results show that during this intervention daily stress increased during the intervention. This is result is counter-intuitive and unexpected, the increase in social support may have reduced the daily life stress experienced during the intervention phase. However, as this study was conducted on a person who was continuing to live their daily life during the intervention, it was found that unforeseen personal circumstances increased her daily life stress during the intervention phase. More specifically she experienced a relationship breakdown in between session data collection point 6 and 7, which increased her daily stress. This continued to stay high for the remainder of the social support intervention. It is worth mentioning however that the participant felt that having someone to talk to about the relationship breakdown was helpful, this was shown by the increase in heart rate variability as well as the awareness of social support during the intervention phases and perhaps was able to mitigate some of the emotional distress she experienced.

One limitation of the present study is the same researcher conducted pre- and post-intervention data collection and designed and delivered the intervention phase of the study. One thing that could impact on the validity of the results here is the relationship between the support provider and the support receiver, as previously mentioned the vehicle for social support is the relationship, which in this study was built through a therapeutic relationship. It is well documented throughout the psychotherapy literature that there are a number of positive effects that the relationship has on the outcome of treatment (Crits-Cristoph et al., 2006) thus in this study the researcher and the participant built a relationship during the pre-intervention phase and continued this relationship throughout the study. This could have

confounded the results. It has the potential to slow down the return to baseline in the post-intervention phase (due to the relationship being continued into the post-intervention phase) thus not showing the true impact of the intervention. Future research should aim to control for this relationship by using different researchers to social support providers. In this study social support was also provided by only one person, research suggests that different types of support are often better delivered by different people, so this may be a consideration to tailor the intervention to the individual more specifically (Dakof & Taylor, 1990). Further, the type of injury studied here produces a limitation for generalisability to the wider injured population. In this study we explored the use of skin barrier disruption (graze) as an injury. This method of studying healing has been used in multiple studies aimed at observing the healing processes (see Robles 2007, and Gouin & Keicolt-Glaser, 2011), however it may not be possible to extrapolate the rate of wound healing on skin barrier disruption to the rate of healing of a bone fracture or muscle tear for example. Further research here would be necessary to explore the effects of social support on this type of healing however there are a number of ethical and participant recruitment challenges associated with such research.

The results in this study suggest that there is an applied implication for the use of social support in healing or recovery. With further corroborative research, it can be speculated that if the social support network around an injured or ill person can be trained or knowledge in the use of specific elements of social support can be enhanced, it may be possible for the healing rate to be improved. The difficulty here is that social support provision could be likened to a cake in this study. Specifically, although the social support cake was associated with improvements in healing, the specific ingredients that help to account for this, cannot be disentangled.

7.6 Chapter summary

This chapter aimed to examine 1) the influence of social support and healing relationship over a longer period of time, 2) to identify a possible counselling based social support intervention process that can improve perceived social support, and 3) to understand if improvements in perceived social support can in fact improve healing rate and moderate stress. The results suggest a counselling-based intervention delivered by a trained psychologist can increase all areas of perceived social support as measured by the PASS-Q, when this intervention was designed specifically to increase emotional, esteem, informational, and tangible support. Secondly trans-epidermal water loss decreased during the intervention phase when support was being provided suggesting increased healing during the social support counselling intervention. This study suggests that the social support intervention was able to increase heart rate variability slightly. Further research is required to understand the full effects of social support on these variables; however, this study provides promising evidence that it is worthwhile to investigate healing, stress, social support over time.

8. Too Close For Comfort? An Journey of Research on Social Support.

8.1 Introduction

Chapter 2 and 3 identified the limited evidence associated with the impact of social support on wound healing and in addressing this "gap", chapters 6, and 7 gestured towards the possibility that social support, and specifically, emotional support may be associated with improved rates of wound healing. The preceding empirical chapters have reported what appears to be a sequential, logical and systematic process of examining the aims of this thesis. The aim of this chapter is to report what has largely been obscured within the document thus far – namely me, Matt, the researcher and the process of this document's becoming. As explored in Chapter 4, drawing on a pragmatic ontology, and a pluralistic epistemology associated with wound healing afforded a pragmatic methodological approach to conducting this program of research. In this chapter, a confessional tale (Sparkes, 2020) is reported, whereby my authorial presence is associated with a subjectivist epistemology and how the knowing of the influence of social support on wound healing is impacted heavily by the researcher (Sparkes, 2020).

8.2 Confessional tales and ethnographic research

Kierkegaard argued that while we can only live our lives moving forward, we can only understand them looking backwards (cited in Hayler, 2012, p. 1). Indeed, this document has been "lived forward, and written backwards". There have been some extensive revisions to the preceding chapters based on the recommendations of the examiners who scrutinised and examined the thesis. This chapter is an addition that

was invited by the examiners and that has required reflection and deliberation about (a) how to insert this in a manner that "makes sense", and (b) adjustments to the previous chapters to accommodate for this insertion. Although initially, what might have been perceived as "informational support" (i.e., these adjustments will help with the content and style of the thesis) *felt* more adversarial, and the extent of these revisions felt extreme.

Eisner (2008) suggests that generating and communicating knowledge requires a variety of perspectives. In his words: 'Each variety of knowing bears its own fruits and has its own uses" (p.5). From this perspective, rather than there being a single way of knowing, there is a multiplicity of "knowings". Van Maanen (1988) has argued for the use of confessional tales in social science research on the basis that they provide a counterpoint to realist accounts which tend to (1) be methodologically silent, (2) adopt the conceit that data must be cleanly separated from fieldwork, and (3) offer only the fieldworker's closely controlled account of the studied culture. Sparkes (2002, p. 61) suggests that confessional tales 'do not replace realist accounts but stand beside them by elaborating extensively on the formal elements of the methodology and saying what is unsayable in the realist telling'.

The details that matter in confessional tales are those that constitute the experience of the author. This human bundle of exposed nerve-endings stands alone in the culture supposedly perceiving and registering the various happenings around him. Emotional reactions, new ways of seeing things, new things to see, and various mundane but unexpected occurrences that spark insight are all conventional confessional materials that suggest how a field worker came to understand a studied scene. Thus, what follows is an exploration of a PhD researchers experiences that aims to expose the nerve endings and provide authenticity.

8.3 Aims of the chapter

The aims of this chapter are three-fold, firstly, to provide an authentic and revealing account of the PhD process. Secondly, to provide an account of the development in understanding of social support and the polyvagal theory. The learning process that I went through during the PhD and the depth of experience with both phenomena over 6 years of study. Thirdly, and finally to provide some key learnings that have emerged from an in-depth study into social support, neurophysiology, and research methods.

8.4 Beginnings

At the inception of this program of research there was, and continues to be, a desire to 'do' research that has relevance for stakeholders such as athletes and coaches. Initially, this desire was informed by literature associated with evidence-based practice in psychology. Evidence-based practice was arguably catalysed by Sackett et al., (1996). He wrote:

> "Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and

> compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care. By best available external clinical evidence we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient centred clinical research into the accuracy and precision of diagnostic tests (including the clinical examination), the power of prognostic markers, and the efficacy and safety of therapeutic, rehabilitative, and preventive regimens." (p. 71).

I wanted to make a contribution to the current best-available evidence to underpin practitioners' use of social support in injury recovery. Associated with the body of literature associated with evidence-based practice, is the recognition that randomized control trials (RCTs) are typically considered the gold standard in the type of evidence that is used to underpin clinical practice (Hariton & Locascio, 2018). This recognition posed a problem for my planned research. Indicative of this aim, an initial plan was to work on a project that include a laboratory-based experiment examining the influence of the Trier Social Stress Test (Allen et al., 2017), on participants' heart rate variability, healing, psychological stress in the presence of, and absence of social support (see Robles, 2007 for a similar protocol). This project was both ambitious and would have involved not only my time, but others from within the university to contribute to this methodological design.

A compromise was to conduct a cross-sectional study (reported in chapter 5). Without the rigor associated with the control (no support), and experimental (social support) conditions that would have been associated with the RCT, the sample size

according to power calculations was large. Nevertheless, I was initially excited about "throwing myself into" this endeavor and beginning an initial phase of data collection. The research felt *properly* underway.

As acknowledged in chapters 5 and 7, the measures used were quite "noisy" in colloquial terms. Effect sizes based on previous research are ostensibly a "best guess" about the characteristics of the magnitude of relations that one expects to see in a research study (Sheppard & MacDonell, 2012). With all other things remaining equal, where these estimates deviate from the 'live' data collection, the chances of making either a type 1 or type 2 error change. Specifically, we recognize that HRV is a measure that is affected by external environmental factors quite often, and trans-epidermal water loss is affected by ambient temperature. What is worth mentioning is the change that we are looking for within these two measures is tiny. The inter-beat interval is extremely small and so is the healing rate measured by reduction in water loss that occurs throughout healing. Thus, the size of change we are expecting to see within these measures is very small compared to say heart rate or cortisol level when someone is under physical or psychological stress.

What seemed to be implicated from this provisional analysis was that this initial project would need to continue for much longer than initially planned. The critical issue is to "determine whether the incremental improvement in power associated with more subjects is worth the [marginal] effort required to continue the study" (Baroudi & Orlikowski, 1989, p.92). Of course, as this study unfolded, I was not the same researcher who embarked on the study. New information and ideas were sliding into my awareness. For example, even if social support is associated with HRV and wound healing, how might the provision of social support be enhanced? In

the end Covid19 represented an external impact to the data collection process that could not have been anticipated or planned for.

8.5 The PhD processes

I value honesty above all else. I truly believe that providing an authentic account of my experience to the world is one way in which I can break down barriers and explore some of the key problems that we face within research and applied sport psychology practice. The confessional tale appears to be becoming increasingly popular as a tool in exploring the experiences of an author throughout their research journey (Watts, 2011). It's worth pointing out I was given a pretty good opportunity. I was employed at a university with a small 0.5fte teaching contract for the next 4 years, combined with a 0.5fte research position to aid in the completion of a PhD. This is probably one of the more coveted PhD study set ups available and I had a lot of time to get settled into the life of an academic. Not only that, I was in a cohort of other PhD students like me on the same contract, in the same office, all of whom were doing their own work, as set ups go, this was a pretty good one. Like with most PhD students I set out with a goal to do something amazing with my PhD and to do something that 'changed the world'. I wanted to work on something that was interdisciplinary and that took a real stab at the mind-body interaction. I wanted to do something groundbreaking that hadn't been done before and that pushed some boundaries.

This however proved quite difficult and the PhD had to change to fit the life events that kept occurring whilst I was studying for my PhD. I started my PhD in 2015 at the age of 25 and at the time of writing it is 2022. During those years so many things have happened and my life and the world around me has changed dramatically.

First, I want to turn to relationships, during the completion of my PhD I have had 3 different girlfriends 2 of whom failed miserably and have met so many different people that have played a part in the shaping of the PhD it is impossible to name them all. Around 2017/2018 I applied for two jobs and got them both. The first was to a national team as a practitioner psychologist and the second was as a full time academic at a UK university and being the ambitious person I am, I accepted both with the idea that I would find a way to do both and complete a PhD. This was probably the biggest headache and one of the most stressful time of my career to date and a decision that came to shape the changes to the PhD thesis and eventually shape my career for the next 5 years. I was working 2 days a week at a national team and 3 days teaching the university. I took at a look at my PhD project and something had to change. I couldn't see a way where the project was going to be completed in its current form whilst preparing for a Paralympic Games and having a heavy teaching load. A candid conversation with my supervisor was needed and shift in direction for the PhD had to happen in order to make it more manageable. Not to mention (we will discuss more later) that COVID19 put a huge barrier in the way in early 2020. In addition to these major barriers and life events a few other things happened during the 5+ years I spent working on my PhD research, I brought a house, I left the national team, I supported athletes at multiple World and European championships, I returned to full time teaching, and I restarted my applied practice. All of which played a role in managing the ups and downs of the PhD process.

Then finally came the viva voce exam. There was a significant delay between my thesis submission and my viva date due to professional commitments of both me and my assessors (one of the drawbacks of working with excellent applied practitioners is they are often busy with teams in different countries and we had to

work around some pretty major competitions). The delay meant a number of challenges came up and the context of the world I was working in had once again changed. Two new books on the psychology of sport injury had been published and a number of theories had been updated and had become more popular. Interestingly a number of key arguments that I had made during my PhD (i.e. the lack of experimental research in sport injury, and the contribution of emotional support to the injury process) had been found and explored by other authors in the time between submission and examination. My preparation therefore had to be thorough, updated, and I needed to be candid in noting there were a few updates to the document that needed to be addressed. My preparation was a 4 -week process which was well planned out and would take me through the key chapters, theories, and ideas that underpinned my PhD. Week 1 consisted of 3 read throughs of my PhD document, and I quickly realized that I was at a minimum going to be asked for major corrections. There was an unholy amount of spelling and grammatical errors, paragraph errors, and structural problems that I had noticed. This was a little demoralizing but also something that I knew I could deal with. My final read through worked on making sure that all of those mistakes were picked up and noted in order to make the final corrections a little bit easier. Week 2 and 3 were when I started to drill and focus more on the theories that I used within my PhD. Specifically, I spent time focusing on my understanding of polyvagal theory and how it relates to psychology and psychotherapy. I undertook some further on-demand training on polyvagal theory from the Polyvagal Institute and began to recap in some depth that nuances, critiques, and applications of the theory. I also practiced how to explain the theory in a engaging and simple way. I spent time going back through the social support literature looking at the key developments in the area and recapping the key updates

of the past few years to bring the thesis into the present. I also worked to fill in any gaps that I found and prepare answers for any questions that I didn't want to answer. I developed a 1 pager for each of the chapters in the PhD that detailed the following information: the title of chapter with a basic overview of the introduction to the chapter, the methodology and theory used, the key results and findings presented, the strengths, and the limitations of the chapter. Finally, I developed a table that detailed the statistical tests that I used throughout the PhD along with the strengths and weaknesses of each statistical test and possible alternatives. My final week of preparation was a final read through of the thesis document, attempting to memorise answers to the above questions, and spending some time away from the PhD and the thesis to recover and have a clear mind going into the viva voce.

8.6 Stress and healing

At the start of my viva-voce exam I used an example to illustrate the ideas of stress, healing, and social support to bring to life some of the key ideas throughout the PhD. I am avid cook. I like to cook good food and bake. One of the major hazards with this as a hobby is that I regularly get burnt or accidently cut myself with a cooking knife. Two weeks before my viva-voce exam such an accident happened, and I burnt my hand on the hot oven. I would say that two weeks before my major event, the thing I had been working towards for the past 5 years was quite a stressful build up. I was preparing hard for the exam, making sure I had covered all the bases, and was working long hours to get in as much preparation as I could. This was a relatively stressful time. Interestingly I am also quite a good healer, usually I heal from these accidents pretty quickly however something interesting happened to this minor burn on my hand in the lead up to my viva. It didn't heal as quickly and was still quite a

wound on the day of my viva. Further I have been tracking my HRV throughout my PhD as a way of understanding my own physiological status and maximising my own training, health, and wellbeing. At the point of my PhD viva my HRV was on the lower side of my normal range. On the day of my exam, I had a low HRV and an injury that was refusing to heal quickly. I had become a great example of the key ideas that my PhD explores, and I was able to use this an example to explain the basis of my thesis.

8.7 Injuring people.

"What you're going to injure your participants?", "How did you get ethical approval to do that?", "No I don't think so, I don't fancy being injured?".

The number of times I've heard these questions and phrases since the start of this research has been laughable. In the pursuit of understanding social support and injury there is very little or even no research in sport psychology that has extended the idea of creating a wound in order to watch it heal, examine the psychological, and the physiological mechanisms that might impact the processes. As previously mentioned in chapter 2 and 3, social support in injury is usually an observed phenomenon, similarly with injuries, psychosocial responses to injuries are observed through questionnaires and interviews. Therein lies the surprise (from friends and family, other psychologists, sport scientists, other academics, and the general population) that I was hit with an uncountable number of times when I actually suggested injuring people in order to observe the effects of social support and stress on the process.

Even I was surprised when the ethical approval for these studies came back with no comments and no amendments. I was fully expecting to at least must further justify the process and the need for the research, however the ethics panel at the university read over the forms and approved the project without delay. When initially

discussing the idea about injuring people with my supervisor, I remember having conversations about what the other sport scientists in the department were doing, and a comment 'well the physiologists take blood from people' was made. We couldn't really see why making a small wound would be much different and it was only the fact I was a psychologist that perhaps made us a little uncomfortable about doing this. Looking back over the history of psychology we can see why perhaps we have moved towards the notion of 'protecting clients from harm' and only doing research that is going to have a benefit to society. Throughout my training as a psychologist the need to consider ethical challenges, ethical concerns, and boundaries of practice have drilled into me and injuring someone at least on the face of it seemed to go against all of the ethical principles that the BPS and HCPC put into place. However, when I began to look into it more there were scientifically and more importantly, ethically valid way of observing wound healing. The tape-stripping procedure and TEWL measurement seemed the most ethically appropriate but also the most usable when doing observational and experimental research in the field. This provided me with an ethically appropriate measure, that allowed for ethical approval to be given.

Once ethical approval had been given there was a further problem that arose that I hadn't fully foreseen. On the most part people were willing to engage in the research and actually saw the novelty and interest in the study. For example, watching your body heal itself through the numbers on the TEWL can be quite fascinating, and the 'harm' being created made some people curious about what would happen, thus participating through curiosity. When you ask someone if they want to participate in a research study where we injure them and watch their body heal, some people recoil with surprise. The mental image that comes to mind when you say you are going to create a small wound on someone's arm is that of a scientist in a white coat with a

scalpel, not a guy in a polo shirt with a roll of Cellotape. It became quickly apparent that I needed to effectively manage expectations when 'selling' this research to participants in order to ask them to participate. The phrasing went from creating an injury, to a small wound, then to a small graze. In order to manage the expectations of the participants. Some more interesting and somewhat humorous comments came out from participants, some asked 'will it hurt', others when realising it was almost painless showing surprise that 'it hurt less than waxing', and some not even noticing what we had done. Needless to say, there was a few other comments that probably shouldn't be written in an academic document. People's reactions were widely different, sometimes humorous, and in some cases, people out right refused to participate, which of course is their right.

As someone who was desensitised to injury, illness and death in my early career as an ambulance technician I was surprisingly desensitised to the fact I was creating wounds on people. I had an understanding of infection control, wound management, and realistically the size of the wound I was creating was minor compared to doing a skin biopsy. The difficulties came when trying to ask people to participate with informed consent. This was a difficult challenge because understandably the research is a little 'out there' compared to what some people are used to participating in. If you take undergraduate psychology students for instance, they are constantly told about reducing harm and are only really exposed to research methods that involve questionnaires and interviews, and this was replicated through the population of people that I encountered and asked to do this work. As I got better at predicting people's reactions to the initial introduction to the study, participants reactions became more favourable and it became more normal for me a researcher to create graze's on people's arms and then show them how their body healed.

8.8 COVID19 and understanding of social support

Just as I was getting used to working with people on this project, effectively explaining the procedure, and then gathering good data, the universe decided to throw the biggest curve ball into the work on a scale that had not been seen in the United Kingdom at least in living memory. The COVID19 pandemic had impact on multiple levels (including international, national, political, cultural, physiological, psychological, and sociological) and the world was thrown into 'lockdown', we were told by our governments that going outside was not possible, a virus was on the loose that was uncontrollable, never seen before, and deadly. All teaching and research that was being conducted stopped. Right when I was collecting data for my thesis. This was obviously frustrating, but it had another impact on the understanding and use of social support. For the first time in history, we were being told we could not interact (at least face to face) with other people. Daily routines changed, work was uncertain, and social isolation was everywhere.

Social support is usually seen as a proximity related construct. Our social networks are designed and interacted with in a situational context. Relationships are built based upon proximity to people that we interact with every day (Dyer, Aroz, & Larson, 2018). So, we had no idea what would happen to social support when we take away the proximity part of relationship. In the depths of the pandemic, in the UK we were asked to limit interactions to our immediate household and were given special dispensation to form a 'support bubble' if we lived in a single person household. For me (who lives alone) this meant I could interact with one other household as a form of social support. Since the pandemic is has been well documented that there was an

increase in fear, worry, and stress, on a national level (Martens et al., 2020), and whilst we know that social support has a buffering effect on social stress (due to the stress-buffering models) the lack of social support during the pandemic due to social isolation had a negative effect on psychological health (Szkody et al., 2021). Support became a hot topic of conversation and the idea that other people had a profound impact on the health and well-being of the nation was thrown into the public spotlight. It was extremely apparent that when we take away people's social support networks, and when we throw people into social distancing and isolation there are negative effects to mental health and well-being. Social support therefore is paramount to human functioning, and through this research I have suggested that it is also useful when your body needs to heal itself.

8.9 Social support

Definitions of social support typically identify it as a multifaceted process, where a person is aided in their day-to-day life by a caring and supportive network, and the perception of the availability of the support to be provided when needed (Rees, 2007). The multiple facets of social support are the structure and functionality of the support through either formal or informal systems. The size and existence of a social support network is what characterizes its structure, and the functionality is the appraisal of the key uses of social support that people experience. These uses have been characterised and summarized as emotional, esteem, informational, and tangible support. Prior to the research into social support and healing I would consider that social support is something that exists to either a greater or lesser extent depending on the person, and that this is something that as researchers, especially in sport psychology, that we observe, quantify, or define but rarely manipulate.

Towards the end of the PhD the understanding of social support has become much more interesting and has grown from the initial ideas that perception of social support is recorded and observed, to something that can be intervened in and improved upon. As a researcher my role within social support changed from an observer of a phenomenon to someone who has provided social support, intervened and attempted to improve social support, and using social support myself throughout the process. The decision to intervene in social support certainly had its routes in my own need for a pragmatic and active solution to the social support, stress, and healing problem. As a researcher my role changed to becoming more of a pracademic offering social support and becoming a social support provider for my participants. The use of an online workshop as a way of delivering and improving perceived social support asynchronously. Then finally a development of a synchronous intervention where I was delivering social support to the participant meant that my ideas around how social support is characterized in the literature changed. Further to this my own use of social support throughout the PhD was dramatic, from the informational support that was sought from a multitude of sources (e.g., my supervisor, my colleagues, and friends), the emotional and esteem support required to complete a long and arduous study, and to manage the life changes and stages that occurred throughout the PhD. Social support therefore has not only been something that I have observed through the literature and through research methodologies it was something that was lived and experienced by the participants and myself as the researcher.

8.10 The Polyvagal theory

At the start of the PhD the polyvagal theory was at best a paragraph to explain the point of measuring HRV. It was a theory I had found that explain that HRV was a

marker of stress and I thought that was going to be its purpose in this PhD. I had spent a lot of time reading the literature around social support, stress, and healing, and all of these phenomena appeared to be linked. The stress and healing literature was saying that stress impacted upon healing rate. The social support literature suggested it buffered against the stress response, and even in some literature there was argument that social support was important in the healing process. However, there was very little to link these together and that really was the beginning idea of the PhD. The polyvagal theory really didn't play much of a role to begin with and I certainly didn't appreciate the importance that it was going to play over the next few years, and how my interest in the theory would grow into something that post viva I found absolutely fascinating and can see a considerable amount of potential in.

I became increasingly aware of the polyvagal theory through social media and seeing discussions about it between clinical and counselling psychologists on private practice forums. It wasn't until I reached out to a counselling psychology colleague who is currently using polyvagal theory integrated with Yoga that I really began to understand the importance of the theory to this PhD. She helped me to understand the basic concepts of the theory and what it means in terms of the trauma response and the idea of co-regulation. On the face of it the theory is quite complex, and it is not immediately apparent as to how the ANS interacts with the outside world. There is a complicated mix of evolutionary hierarchies, that explain the purpose of each part of the ANS. As mentioned in chapter 2 it was not initially meant as a practical theory but more an explanation of safety and connectedness related behaviours. Once I began to understand the basic concepts, I went on some training with the Polyvagal Institute to further understand the theory. This brought me to Deb Dana's work which explored the practical applications of the polyvagal theory and I began to see the that exercises

and techniques that I regularly use in sport psychology and some the techniques that others use to increase social support in network therapy or addiction were also shown to impact upon the ANS and build neuroception and co-regulation. It began to click, this theory had the potential to underpin and connect everything I was reading from the social support literature, the stress literature, the healing and injury literature, and the measurement of HRV.

My understanding of the polyvagal theory has influenced my understanding and respect of social support. The knowledge of the social engagement system and the concept of co-regulation has grown dramatically. The idea that as humans we find purpose in our social connections, and we have a direct need for social engagement makes complete sense when you think about it. However, when this PhD started, I hadn't quite realised how much this idea had influenced me throughout my career. For example, for many years I have been promoting the idea the Self-Determination Theory as one of the most applicable theories in psychology and relationships between coaches and athletes are motivating. The polyvagal theory would assume that when we have social connectedness, we are safer to behave in way that allows for motivation and performance to occur. Our autonomic nervous system is designed to help us navigate the world, helping us shape our day-to-day experiences, assessing levels of risk, and inhibiting and initiating responses to allow for behaviours that promote protection or connection. These behaviours will mean that we move toward or away from people and connect or disconnect from them depending on what our nervous system is doing at any given time. The idea that social support therefore can help us to regulate our autonomic nervous system is not necessarily new but to my knowledge has not been considered in much depth in the sport psychology literature. The different types of support (e.g., emotional, esteem, informational, and tangible

support) could influence the ANS to allow for connection and safety. Emotional and esteem support would provide opportunities for people to co-regulate their ANS thus providing connectedness, in turn reducing stress, allowing for high autonomic activity, and having a positive effect on the body.

8.11 Social support and the sport psychology landscape.

The operational definition of social support presented in section 2.8 presented an approach to understanding social support based on an authoritative position, it enabled methodological decisions to be made, but was imbued with my own blindness to the broad spectrum of knowledge-making practices, and disguised the deep-seated dread that tended to surface when encountering research that led me into the unknown.

The social in social support within the previous chapters was grounded in an interpersonal context (Williams et al., 2004), that is social support is something that happens through a connection with two or more people within a network and is characterized by the transactions of various support types. To some extent, acknowledging the interpersonal factors, particularly social support, associated with injury recovery helps to redress the limitations associated with locating the onset and recovery of injury within the individual, a symptom of individualism, (Truong et al., 2020). However, there remain a number of challenges. On the one hand the provision of social support becomes difficult to disentangle from variables that in positivistic language at least, may confound the support: such as intimacy (a sense of closeness to the individual), or trust (Timmerman, 1991). In addition, the "social" is narrow compared to cultural factors and norms that may permeate a sport organization which nevertheless may have an important role to play in the degree to which individuals

experience support. Qualitative or indeed post-qualitative research (Pierre, 2014) may help to explicate the assemblages that collectively shape individuals' support with injury.

Knowledge and practice in sport psychology has made a shift towards the use of organisational and system level psychology to improve athlete performance (Wagstaff, 2017). Whilst now this work is still in its infancy, the shift towards this approach has been dramatic and conversations on 'working at the organisational' level have been front and centre in the work that we do. The greater need for a duty of care in organization is evident from the media reports that have been rife from Larry Nassar in the USA gymnastics team, through to the lack of care identified by the White report at British Gymnastics. There have been many claims that mental skills training alone is insufficient to support athlete performance and therefore this shift towards providing supportive environments has been in response to the increasing needs of sport organisations. However, once again Wagstaff (2019) posits that there is a desperate need for intervention research work to be done in this area to fully understanding the social and environmental factors that promote individual and team performance and well-being.

These developments in sport psychology are slightly behind the organsational culture literature where a term has emerged that explores how organisations can offer social support to their members. Perceived Organisational Support (POS) is a term that explains the beliefs people have about how much an organization cares about them and how much their contribution is valued by the organisation (Aselage & Eisenberger, 2003). It is thought that perceived social support from the organisation may improve self-esteem, perceived value of person in the organisation, satisfaction and commitment (Ng & Sorensen, 2008), and an increased engagement (Salanova,

Agut, & Peiro, 2005). An organisational culture that is high in social support, high in supervisor support is positively related to employee self-efficacy, learning, and motivation (Chiaburu et al., 2010). The antecedents of perceived organizational support fall into three categories, these are 1) fairness (good appraisal, opportunity to voice concerns), 2) supervisor support (emotional, esteem, informational, and tangible support. 3) rewards and job conditions (job stress and growth opportunities (Krishnan & Mary, 2012). Following the shift in sport psychology towards an understanding of perceived organizational support may offer some more opportunities for people in positions of power such as coaches, performance directors, team managers etc. to use social support as a way increasing well-being, self-efficacy, learning, and motivation.

8.12 Lessons learned

This research has involved creating minor wounds on individuals. As I reflect on this process and the assumptions that narrowed the empirical gaze towards a "small abrasion" on an individual's arm, and the generation of stories of healing in the preceding chapters the process of making these "marks" have somehow got beneath *my* skin. That is, as the above vignettes illustrate, if not wounds as such, this research has left some marks on me.

First, as many PhD students before me might attest, the process is a long one, I firmly believe that this a qualification in persistence as much as a research training program. The ups and downs of life have to be taken into account when working on a PhD and it is not something that is completed in isolation. The use of social support throughout the process has been fundamental to the completion of the process. I have had the privilege of emotional support from the people that are close to me, esteem support from the wider community who recognize my work and who have come to

listen to what I have to say at the various conferences and workshops that I have presented, informational support from my supervisor, my colleagues, and other professionals in the area, and finally tangible support from my friends and family, the institutions that I have worked for, and the participants who literately gave up some of their skin for my research has had a huge impact on the work that I have done and the ability to complete this process. Some of the key lessons I learnt are: 1) the management of life around a PhD is almost as big of a challenge as the PhD itself, 2) continue to be persistent, if it doesn't go your way keep going until it happens, 3) think about how you can summarise your work simply and if possible, with metaphor or stories, 4) if it can be written on one page, then it should be. A one pager for each chapter is a good summary and good preparation for the Viva Voce exam.

Second, the vignettes gesture towards a broader conception of the "social" (beyond interpersonal) factors impacting healing, than was initially conceived at the outset of this programme of research. A broader conception of the social, alongside those personal values, that desire to do research that has relevance for stakeholders such as athletes and coaches, has evoked some reflections regarding what broader types of social support may be helpful for athletes experiencing injury. Collectively, there is at least one shift that has arisen from this turn in my research: a move from stories of healing to stories for healing.

To understand this shift further, one unintended consequence of writing this chapter was to embrace literature exploring "writing as healing" (Anderson & MacCurdy, 2000). Recognizing the initial hurt that arose at being 'invited' to write this chapter, it feels as though this writing process has generated a more benign rendering of these circumstances. Within the literature I was reading was a quote by Frank (2010) who alluded to stories as companions. Together with this broader

conception of the "social" in my thinking, the prospect of stories to promote wound healing affords a hitherto unforeseen avenue for research, and something that feels simultaneously exciting and ripe with uncertainty.

Although the types of evidence (e.g., RCTs) have been particularly valued in evidence-based practice, there are signs that narrative ways of knowing are being translated to interventions for change. The use of stories as a way of transmitting knowledge has been in use since the dawn of human civilization. They can evoke emotion, record emotion, build esteem, and transmit information or experience (Brookes et al., 2022). A story can provide education, modelling, persuasion, training, and enablement thus offering a way of initiating change through increasing capability and motivation.

Third, the biggest and most important improvement in the research and practice that can add to this area is the improvement and increase in intervention research in social support and injury. There are a number of difficulties with doing intervention research in sport injury and social support that have been outlined in the discussion section of this thesis, however single case designs can be a good way of dealing with this problem. There is a desperate need for more clarity of the intervention protocols used in the studies presented in the literature, that would allow for effective replication by practitioners in the field.

8.13 Summary

However, what is less evident in scholarly appropriation of Van Maanen's (1988) work is his implicit and subtle critique of the genre. This is evident in at least three fronts. First, he describes the confessional genre as often attempting to make qualitative fieldwork scientifically acceptable: "Most confessionals have at their core

some hope of making fieldwork, if not fully safe for science, at least respectable in terms of upholding some community standards and disciplining the undisciplined of fieldwork" (p. 74). Second, confessional tales are often sequestered into a methods section, chapter, or appendix, "interesting only insofar as there is something of note to confess as well as something of note to situate the confession" (p. 81). And finally, confessional tales are often saturated with dreary conventions surrounding the need to create an aura of personal authority, reinforce the difficulties and hardships involved in fieldwork, and ultimately demonstrate the competence of the fieldworker. (Ganesh, 2014)

It is easy to see then, that the confessional tale as rendered by Van Maanen (1988) buttresses and reinscribes the representative authority of realist tales by serving as a warrant for the scientific rigor of ethnographic work, being relevant only insofar as it further supports the "real" or "objective" analysis that precedes it and boosting the scientific and cultural credibility of the fieldworker. Furthermore, the very semantics of the term *confessional* construct a somewhat privatized and sequestered notion of researcher subjectivity; as Pillow (2003) implied, it rests on a form of reflexivity that is thoroughly modernist in that it presumes a knowable self that can be accessed, be reflected upon, and not be lost during the process of fieldwork. (Ganesh, 2014)

9. General discussion

9.1 Introduction

The aims of the research programme were:

1. To examine the current state of knowledge of psychophysiological stress (heart rate variability and psychological stress), social support, and the links with healing.
2. To (a) explore the relationships between time domains of heart rate variability, daily life stress, 4 sub-domains of social support (emotional, esteem, informational, and tangible support) and skin barrier disruptions healing and (b) to examine whether perceived social support moderates the relationship between stress and healing.
3. To examine the impact of an online psycho-education intervention on perceived social support among sports and exercise participants.
4. To explore how a counselling-based intervention delivered by a Health Care Professions Council registered psychologist will impact time domains of heart rate variability, daily life stress, 4 sub-domains of social support and healing from skin barrier disruption.

The purpose of this chapter is to summarise and discuss the main findings, consider the limitations of the research, consider the applied implications, and future research. Finally, it will conclude with a statement of the contributions this programme has to the existing literature.

9.2 Summary of findings

In what was the first scoping review exploring the associations between social support and wound healing, results suggested at least three important avenues for inquiry. First, studies examining social support are required that assess the impact on rehabilitation outcomes. Second, there is limited use of intervention research that manipulates the provision of social support. Third, of the rehabilitation outcomes assessed, the rate of recovery represents an area of investigation that is intuitively appealing to a range of stakeholders.

Chapter 5 reported a cross-sectional study that suggested emotional support was a moderator of the stress and trans-epidermal water loss (healing) relationship. Second, and like previous research, the PASS-Q possessed good internal consistency and appears a relatively brief and useful tool for assessing perceived social support, good correlations were found between variables and within subscales. This adds to the current literature base in assessing social support via the PASS-Q questionnaire.

Chapter 6 and Chapter 7 examined the use of 2 different interventions designed to increase social support. Chapter 6 demonstrated that a brief online psychoeducation intervention could enhance perceptions of emotional support, whereas chapter 7 suggested that the provision of a counselling-based intervention was associated with enhanced perceptions of social support, HRV and wound healing. Chapter 8 detailed a confessional tale using an autoethnographic approach to tell stories of the research process, the key events throughout the life cycle of this PhD, and the lessons learned. The key lessons detailed in this chapter are that social support is a lived construct that has had an impact throughout the PhD process, that social support can become a much broader construct than just the interpersonal interactions

that occur between two people, and finally that research in social support and injury needs to be innovative to adapt to the major challenges posed by this research area.

9.3 General discussion

Now that we have reviewed the findings of each of the chapters in this program of research it is important to clarify the scope. Firstly, the scope of this research is limited to the exploring social support on stress and healing outcomes. This extended the previous literature by initially considering what the current literature says about social support and its relationship to rehabilitation outcome. The research considered the effects of social support on actual healing as measured by trans-epidermal water loss, rather than just exploring the perception of the effects of social support on the rehabilitation process. In addition, this program of research also extended the previous research by attempting to use both psychological and physiological measures of stress. Secondly, this program of research aimed to explore some of the interventions that may be beneficial in improving perceived social support. The consideration of two different types of intervention reflects two key modalities in which psychologists work with athletes, specifically group-based interventions with the added novelty of an online pre-recorded delivery, and individual work through the use of counselling skills. Much of the previous research into the effects of social support has been focused on the perception of social support, however very little has looked at increasing that perception with interventions. This program of work showed that increasing esteem support (Freeman & Rees, 2009), emotional support (Taylor & Taylor, 1997), and informational support (Freeman & Rees, 2009) using a tailored intervention by someone trained in providing psychological support is possible. This program of work adds to social support

theories by in part confirming the stress buffering model (Anderson & Williams, 1988), whereby social support is seen as a buffer to stress. The program of work contributes and informs the social support aspect of the Weise-Bjornstal et al. (2009) suggesting that increase social support may impact upon the rehabilitation process, and finally informs and contributes to the biopsychosocial model (Brewer et al., 2002) suggesting that social support may have an impact upon recovery outcomes

9.3.1 Cross- sectional research

One methodological discussion worth having is the use of cross-sectional research in investigating healing and heart rate variability. Cross-sectional designs are cost effective, quick to deliver, and can control for extraneous variables rigorously (Mann, 2003). However, there are a number of problems with them, specifically cross-sectional studies do not fully explain the findings (Mann, 2003). This specific problem was encountered within this program of research, specifically in chapter 5. Given the variability in 2 of the measures used (HRV and TEWL) which is discussed later in the limitations section, the study did not fully explain the findings, in addition it is possible that a single data point as collected by Robles (2007) and the minimum recommendations by the 1996 HRV task force guidelines was not enough to fully identify links in the variables. It is possible that multiple data points (also suggested by the 1996 HRV task force guidelines) would be needed to fully understand the interactions between heart rate variability, trans-epidermal water loss, and stress. This was evidenced in chapter 7, where multiple data points were collected across a single subject and the hypothesised results were found. Thus, there may be benefit in exploring other types of study design (e.g., single case designs or longitudinal designs) in order to explore HRV and social support.

9.3.2 The Polyvagal Theory

Porges' (2007) polyvagal theory offers an opportunity to link social support to the physiological systems in the body. The results from this thesis offer at least in part some support for the social engagement system of the polyvagal theory. The social engagement system in its fully operational state can use facial expressions, vocal tone, social interaction, and communication to regulate ANS activity (Poges, 2007). The promotion of social behaviours in theory should impact upon ANS activity, parasympathetic activity, and physiological health. This effect was in part shown in chapter 5 where emotional support assessed by the PASS-Q (Freeman et al., 2011) was found to moderate the relationship between stress and trans-epidermal water loss and therefore healing. This means that the higher level of emotional support available (e.g., will be people be there for you, will others care for you, and will other provide you with comfort and security) the reduction in the level of stress, and then the increase in healing rate. This relates directly to neuroception in the autonomic hierarchy (Porges, 2017) where an individual will assess cues as either safe or dangerous creating patterns of social connection thus to limit danger and increase safety. Increased levels of safety will impact upon increased parasympathetic activity and therefore increase HRV, and physiological efficiency. Similar findings were found in chapter 7. Using a psychotherapeutic methodology to improve social support based on a study by Freeman et al., (2009) increasing emotional, esteem, informational, and tangible support. Where an increase in all forms of support was found. In addition to this, during the intervention phase it is noted that trans-epidermal water loss decreased (healing faster), and heart rate variability increased slightly during the intervention phase. Whilst not assessed directly in this programme of

research there is also possible support for the social engagement system within the polyvagal theory.

9.4 Strengths and Limitations

There are 3 key strengths that run throughout this programme of work. Firstly, this program of research has used an integrated biopsychosocial approach. Whilst this approach is not new in the literature (Engel, 1977) it's use in sport injury related research is limited. Furthermore, there is very limited evidence (as found in chapter 4) that previous research into injury, healing, and social support has used physiological measures to focus on rehabilitation outcome, nor has much research used physiological measures of stress combined with psychometric stress data to explore and examine these phenomena. Finally, this research combined this methodology with measures of perceived social support further adding to the strength of this research. Secondly this program of work used a multi-method approach to explore the aims. Typically, within social support and healing research cross-sectional survey research or qualitative interviews are used to examine the benefits of social support on rehabilitation processes retrospectively. This is problematic, as shown in chapter 3 much of the research fails to examine the actual effects of social support on rehabilitation outcome but focusses more on the effect on the process of rehabilitation, in addition most of the research fails to provide adequate information or examination on the types of social support interventions that may improve perceived social support and the effects this has injury rehabilitation. This program of research has attempted to fill in these gaps, offering some options to practitioner psychologists to improve social support during injury rehabilitation. This research has aimed to explore the impacts of social support on healing in the real world. Previous

research Robles (2007) has explored whether social support could impact upon stress and healing in a laboratory-based experiment. The findings of this research found that social support by a confederate did not impact upon healing or reduction in stress. Contrary to Robles (2007) work this research found that social support does impact healing in the real world when provided by someone who has built a relationship with the social support receiver, this extends previous research and adds to the strength of the program of work.

Despite the novel contributions to the research and the strengths that the work has, it is important to acknowledge that there are a number of limitations within the sampling, measures, and scope of the research. The opportunity sampling that was used throughout this research has several key limitations. Firstly, there is limited control over the selection of the participants. The sampling method can be seen as biased, and therefore cannot be effectively generalised to a full population as it may not be representative of the target population. Furthermore, there are limitations related to the size of the sample throughout the project, meaning generalisation of the research is limited. In addition to the sampling methodologies, it is important to acknowledge that there are limitations of the physiological measures used throughout the research. Firstly, it is worth acknowledging that minor changes between testing sessions (e.g., noise, distractions, heat etc.) in the environment could have impacted heart rate variability results, whilst these measures have been validated by Plews et al. (2014) it was noticed that differences between testing conditions between participants was highly variable throughout the data collection process, a drawback of the ecologically valid and pragmatic approach. In addition, measuring trans-epidermal water loss is highly sensitive to ambient temperature and humidity within the environment (Lautenschlager, 2008). Given that this research aimed to increase the

ecological validity of healing and stress research it was near impossible to control for these changes in environment, it was deemed that this was an acceptable limitation during this research, but we need to acknowledge that it does influence the validity and reliability of the measure (Miteva et al., 2006).

9.5 Use in applied practice

The primary methodological philosophy that guided decisions in this research is the importance of real-world application. It is reasonably suggested that a number of key findings from this research can be used in applied practice. Firstly, the use of online psycho education, as a method of psychology delivery is developing and given the current world climate with the ever-increasing risk of global pandemics, online psychological delivery will be more prevalent. Psychologists are having to find ways to improve access to psychological techniques and skills and the internet or learning technology appears to an effective way to disseminate this information. A number of key considerations need to be made before using technology or virtual learning. Practitioners will need to consider the key messages that they want to deliver and the most effective way to get this message across to the participants. Whilst voice over PowerPoints appear to work in this research, we did not test the satisfaction of the participants in the intervention, it was beyond the scope of this research to suggest different ways of getting the same message across. In addition to the specific messages being sent the psychologist needs to consider the content being delivered. The easiest form of content to deliver online is information as it is didactic and easily prepared. It is much more difficult to monitor the interaction with tasks that are presented with online content, and thus learning efficacy is harder to monitor. Some online platforms (Moodle or Blackboard) do allow for some monitoring of

engagement however there is a trade-off here between cost and ease of access. It will be up to the applied practitioner as to how they monitor this learning and how they evaluate this online practice. It is beyond the scope of this project to suggest ways in which practitioners monitor online practice.

Secondly, it is recommended to applied practitioners to consider interventions that increase social support in their athletes. Whilst much of the previous research (at least in sport) appears to suggest that social support just occurs and can affect other variables, there is limited research that aims to increase social support. Applied practitioners should not shy away from using increased social support as an intervention with athletes that are injured. Whilst an obvious approach when working with injury is to manipulate the appraisal of the injury, or the behaviours that occur during rehabilitation it is also beneficial and useful to increase social support. There are a number of challenges to doing this. The applied practitioner would have to identify what types of social support are required by the individual athlete and identify which significant people in the athletes, life can provide that support. This would increase the perception of social support, however, to increase the use of social support the athlete may need to increase their communication skills, or their ability to access to the support available to them.

The polyvagal theory was not initially intended to be used in therapeutic settings (Porges & Dana, 2018). It was initially proposed as a way of understanding and testing the autonomic nervous system and how it influences cognitive, behavioural, and physiological processes. Essentially it was originally designed as way of exploring the brain-body connection. However, in recent years the polyvagal theory has had a large uptake in clinical and counselling practice, with limited uptake within the sport psychology field. The reason for the uptake in clinical practice is

discussed by Porges in their book on the clinical applications of the polyvagal theory (Porges & Dana, 2018). Porges (2018) states that the theory provides a good explanation for how a person can shift from fight or flight mode into a state of calmness that would promote social engagement, optimise health, personal growth, psychological restoration, and down regulating defensive actions. The newer mammalian circuit was labelled the social engagement system (Porges, 2001) suggesting that trust, connection, and emotional safety was a way of regulating the fight or flight system. It was, when it was first presented a missing link to explaining trauma and a stress response. Whilst sport and exercise psychologists would not normally be focussed on PTSD or trauma responses the usefulness and applicability of the polyvagal theory to sport cannot be understated. To the knowledge of the author that whilst there are studies considering the use of HRV in sport and performance settings there are very few studies using or considering the use of polyvagal theory in sport and performance settings and even less practitioners considering the use of polyvagal theory in their applied practice. This leads to the potential for good growth of the use of psychophysiological biofeedback and the key pathways of the polyvagal theory in sport and performance psychology. The underlying systems of the autonomic hierarchy, neuroception, and co-regulation offers a significant number of possible interventions that may be applicable in sport. Dana (2020) offers a number of interventions for counselling that can be directly translated into the sport and performance settings. For autonomic awareness Dana (2020) suggests that we can develop awareness of body-based feeling that are associated with stress-responses and learning to tune into specific autonomic states (e.g., fight, flight, freeze mode), attending to and naming, tracking, and noticing moment to moment shifts in the autonomic systems, shaping the system away from

typical habits to establish new and more effective patterns of social connection and staying anchored in the here and now. Integrating these shifts into daily life making small daily shifts towards a more regulated state, and connect to experience of self, create new and deeper relationships, and move through the world with new abilities for regulation. Within these approaches many of the techniques that we use as sport psychologists from different modalities can be used and Dana (2020) suggests a number of techniques that are observable in different therapeutic modalities, for example in creating awareness and mindfulness from Acceptance and Commitment Therapy can be helpful, using daily pie charts to identify and track different autonomic states appears in Cognitive-Behaviour Therapy, using art and nature to connection and expand attention from play or art therapy, and using imagery, reflection, breathing techniques can all be used to help integrate new autonomic rhythms into daily life. Finally, social support interventions, connection planning, connection identification, deepening connections with others, and improving interpersonal skills are all suggested as effective techniques to increase and improve the social engagement system and thus improve autonomic regulation.

One further application of the polyvagal theory or perhaps more specifically another way of impacting upon the autonomic nervous system is through the use of movement. In recent years Yoga therapy and movement therapy have emerged as ways of improving self-regulation, and whilst it is beyond the scope of this section, the implications of exercise on health and well-being cannot be overlooked for discussion. Sullivan et al. (2018) propose a convergent view of Yoga and polyvagal theory, they suggest that Yoga provides a form of neural exercise and regulation of the autonomic nervous system and that this type of movement and introspection can be a way of improving the autonomic regulation. Further, Lucas et al. (2018) suggests

that physical activity and mindfulness-based movement can be used to promote autonomic regulation by offering social connections within group settings, mindful attention with our bodies during movement has a positive impact on the vagus nerve, and the mindful movements can promote the reduction of immobilisation or avoidance that may be a result of an increased freeze response. Heywood (2011) takes this further and suggests that sport and physical activity is an evolutionary experience and developed alongside many of the pathways expressed within the polyvagal theory. Immersive sport can provide a level of safety where there are no direct threats to life, where competition is seen as linked to the evolutionary competition for resources and is linked to the fight or flight response. Conversely, inclusive non-competitive physical activity can be seen as a response of the social engagement system. It wouldn't therefore be a big jump to suggest that the polyvagal theory may be used as an explanation for the psychological benefits of exercise that we see reported throughout the research and given the uptake of yoga-based or mindfulness-based movement to influence autonomic function, health, psychological well-being, and reduce stress may point to some interesting applications of the polyvagal theory.

The use of heart rate variability in sport and performance psychology is receiving growing interest (Mosley & Laborde, 2022). There are a number of key reasons for this, firstly it effectively reflects the link between self-regulation and health (Smith et al., 2017), both of which important areas considered by sport psychology professionals. HRV is a non-invasive, easy, and cheap physiological measure that is accessible to researchers and practitioners (Mosley & Laborde, 2022). HRV effectively reflects the parasympathetic nervous system functioning which through the polyvagal theory offers an explanation for the link between the self-regulation and health described by Smith et al. (2017). Mosley & Laborde (2022)

found 118 articles in the sport and exercise psychology domain yielding a total participant number of 4979. They suggest that typically sport and exercise psychologists would use HRV as a measure of psychological stress (as it's associated with the stress response through its links with the autonomic nervous system), competition anxiety, cognitive functioning, recovery, overtraining, and injury (where HRV is positively linked to subjective indicators of recovery), challenge and threat states, pain, motivation, self-confidence, and emotions (through understanding the physiological reactions to emotions as well as the psychological reactions). The results from the previous studies in this scheme of work would support the use of HRV in sport and performance settings exploring psychological and physiological stress, emotions, recovery, and injury. There are however a number of common pitfalls and challenges that need to be considered when working with and measuring HRV in an applied setting. Firstly, the choice of measurement modality, whilst an ECG is the gold standard in measurement this is not necessarily practical in an applied setting, therefore it is deemed perfectly acceptable to use a smartphone and heart rate measuring strap such as the Polar H7 to make measurement more straight forward, easily accessible, and useable. Secondly, a clear understanding of the theoretical underpinning is key in applying HRV as a method of psychophysiological measurement or biofeedback. It is crucial that practice in this area is driven by research and a clear framework of theory to support the decision making. It is suggested that the polyvagal theory may be useful in explaining this and in the experience of the author many participants are fascinated by the psychophysiological mechanisms that are being shown when HRV is being measured and used. Finally, Mosely & Laborde (2022) suggest that there are key challenges in interpreting HRV data, they created a useful table that helps to understand the myriad of data that HRV

measurement provides. It is also worth noting that the smartphone applications do offer some interpretation of the data they collect which is much more accessible to the average athlete and coach.

Given the applied nature of some of the previous chapters and the discussions above about the possibilities of the use of polyvagal theory, HRV, social support interventions in sport it is now important to discuss how this might be sold to a team or an individual who wants to reduce their injury rehabilitation time. The primary target market for a product like this would be an athlete who is currently injured, or a team of athletes and coaches who have a high injury incidence rate. The product is based on 3 key pillars, firstly consistent monitoring of HRV of athletes on a daily basis. This can be achieved through the use of a smartphone app or smart wristband. The technology now exists to run a program like this and organise it through a team. This would allow teams to monitor athlete recovery, psychological stress, and physiological and psychological load. Furthermore, over time this would help a team to potentially predict potential illness and injury once a sufficient amount of data is collected. Secondly when athletes do become injured the importance of social connectedness should not be overlooked. Many athletes report isolation during injury rehabilitation and therefore effective social mapping, connectedness interventions need to be put in place to maintain the emotional support required to enhance the rehabilitation process. Typical interventions such as coach and staff check ins, continued involvement in the team, and an effective home life would be paramount in improving rehabilitation outcomes. Finally, a culture of social connectedness within a team has been shown to have multiple performance benefits usually underpinned by effective attachment, self-determination theory, and polyvagal theory will help to improve rehabilitation outcomes. The key benefits of having a system like this in

place would be; 1) to effectively monitor stress, psychological and physiological load, and knowing the link to the polyvagal theory, use it to reduce athlete down time, and increase their availability to perform, 2) to provide effective social connectedness within teams thus improving the culture, but also effectively reducing injury time, 3) this research program emphasises the increased importance of social connectedness in sport settings and injury prevention and rehabilitation.

9.6 Future research

The use of polyvagal theory in this programme of work offers some interesting opportunities for future research. Given the impact of the social engagement system, and the use of social behaviour to regulate and optimise autonomic function (Porges, 2021), the use of polyvagal theory may be a useful way of exploring the impacts of social support on key markers and outcomes of health, illness, psychological well-being, injury, and the link between physiological, psychology, and social behaviour. It may help to build on the stress-buffering and main effect models of social support offering a more detailed explanation as to why social support works. Specifically, building on the research presented in this thesis it would be pertinent to explore in more depth the links between the social engagement system and both perceived and received social support.

In the wider area of sport psychology, the polyvagal theory is currently under used. Whilst in the clinical and counselling practice settings there is an uptake in the use of polyvagal theory, and Mosley & Laborde's work exploring the cardiac vagal tone in various areas such as whilst using breathing techniques, self-talk, and emotion regulation, there is limited research on the use of polyvagal theory within the sport and exercise psychology literature. This thesis provides some scene setting in the possibilities that the polyvagal theory may offer us in developing further research in

the area but is by no means complete. Further exploration of key elements of sport psychology, performance, recovery, emotion regulation, and wider applications not yet considered may offer interesting avenues for exploration of the use of polyvagal theory. In addition to performance psychology, it may also be worth exploring the links between polyvagal theory, autonomic nervous function and exercise. With one of the key directives of our profession being the effect of sport and exercise on well-being and improving well-being through exercise. Polyvagal theory may give us an avenue to explore why exercise and physical activity have positive effects on well-being, stress, emotion regulation etc.

Mosley & Laborde (2022) provide an excellent scoping review of the use of heart rate variability in sport and exercise psychology. They mention the polyvagal theory as a useful theoretical underpinning to the use of HRV in sport and exercise psychology and found 71 papers in sport psychology and 47 in exercise psychology exploring HRV in these settings. This is an emerging area of research and use of HRV in performance settings is significant. They mention there are some areas that would be beneficial for further exploration for example the application of HRV to pain or motivation. Finally, Mosley & Laborde (2022) suggested a benchmarking overview to use HRV in sport and exercise psychology research to ensure that future research is robust. There are key methodological limitations and challenges that need to be overcome when working with HRV and some have been proposed in this programme of work, specifically the sensitivity of the measure, the accessibility of technology to measure it, and the interpretation of the results, along with a clear theoretical rationale for the use of HRV is needed.

One of the key limitations and themes that has emerged from this research is the lack of applied experimental research in injury and healing. This research supports

the assertions made by Leadingham et al. (2021) that there is a lack of experimental research in the sport injury domain. Whilst there are several methodological reasons for the lack of experimental research along with a prior appetite for cross-sectional or semi-structured interview type research in sport injury this problem needs to be addressed. A replication of the present studies with a larger sample size, which has been specifically selected for the research with an increase in diversity of the sample. Development of standardised treatment protocols would be beneficial for sport psychology professionals and coaches working in the area. Detailed intervention protocols for working in sport injury need to be developed, whilst this has been attempted here for using social support wider interventions such as imagery, mindfulness, and autonomic function interventions could be developed to further expand the experimental research base in sport injury. It is a possibility that the single-case design approach may be a way overcoming the methodological challenges associated with large scale randomised controlled trials in this area allowing for an expansion of experimental research.

The present research focussed on the use of quantitative methodologies to explore the research questions. Future research should aim to explore the use of qualitative and mixed method approaches in order to fully explore the phenomena. It would be interesting to explore the objective measures of autonomic function and polyvagal theory (e.g., HRV) along with the qualitative exploration of the participants experience of their injury, healing, well-being. This would allow for more in-depth, accurate, applied solutions to be developed, thus deepening our knowledge in the area of sport injury and healing.

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11 Appendix

11.1 Information sheet and consent form chapter 5

CONSENT FORM

Title of Project: Exploring the links between heart rate variability, stress, and recovery.

Name of Researcher: Matthew Cunliffe

Contact details:

Address:	AF87, Anselm Building, Canterbury Campus
Tel:	1718
Email:	Matthew.cunliffe@canterbury.ac.uk

	Please initial box
1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	
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 personal information that I provide to the researchers will be kept strictly confidential	
4. I agree to take part in the above study.	

Name of Participant	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

Copies: 1 for participant
1 for researcher

Canterbury Christ Church University

Exploring the links between heart rate variability, stress, and recovery

PARTICIPANT INFORMATION SHEET

A research study is being conducted at Canterbury Christ Church University (CCCU) by Matthew Cunliffe.

Background

Whilst most of the causes of injury are physical of biomechanical there is a growing body of research that suggests that stress contributes to the incidence of injury (Kerr & Goss, 1996: Anderson & Williams, 1998). Each of the main models of sport injury (Weise-Bjornstal, 1998 integrated model, & Brewer et al., 2002 biopsychosocial model of sport injury) includes an emotional factor within them. Porges (2003) states that the environmental context can influence the neurobiological state and a person's ability to deal with the challenges placed upon them. The Polyvagal Theory gives predicts that social processes can influence physiological measures of stress (e.g., heart rate variability). The sport injury models mentioned above (Weise-Bjornstal et al., 1998, Brewer et al., 2002) also state that social support can have an influence on injury incidence and on rehabilitation outcomes. The aim of this study is to investigate these links.

What will you be required to do?

Participants in this study will be required to undergo a variety of tests to assess the links above. Firstly you will be required to take baseline heart rate variability data using a polar heart rate monitor and a task force monitor, you will have a number of ECG markers placed on your shoulders and hips and be asked to lay on a physiotherapy bed for around 15 minutes. In addition you will also be asked to complete a questionairre related to your perceived social support and daily life stress. The final baseline test will require us to remove a few layers of skin from your forearm using Celotape, which will be measured using a waterloss meter. You will be required to return to the lab after 3 hours and 24 hours to measure the progress of wound healing and heart rate variability. After this baseline period you will be assigned to one of three groups, to repeat the tests and be put under a short period (5-10 minutes) of psychological stress, where you will be asked to present on a topic chosen by you to a panel of research whilst this will be video and audio recorded, you will be asked up to 3 questions at the end of your presentation.

To participate in this research you must:

- Be over the age of 18

- Be willing to participate in every part of the study
- Be aware of the risk of minor harm and discomfort you may experience whilst engaging in the tape stripping procedure.

Procedures

You will be asked to complete questionnaires, a social stress procedure, tape stripping procedure, and have heart traces taken.

Feedback

You will be given the option to engage in a debriefing interview after the study is complete where you can ask any questions, and deal with any issues that have arisen as a result of participation in this study.

Confidentiality

All data and personal information will be stored securely within CCCU premises in accordance with the Data Protection Act 1998 and the University's own data protection requirements. After completion of the study, all data will be made anonymous (i.e. all personal information associated with the data will be removed). On occasion supervisors, and examiners may ask to see the raw data from a PhD project, this will be confidential and anonymised.

Dissemination of results

This study will make up part of my PhD thesis which will be submitted to the university. It will also be presented at conference and written up for publication in an academic journal.

Deciding whether to participate

If you have any questions or concerns about the nature, procedures or requirements for participation do not hesitate to contact me. Should you decide to participate, you will be free to withdraw at any time without having to give a reason.

Any questions?

Please contact Matthew Cunliffe at matthew.cunliffe@canterbury.ac.uk, or Dr Mark Uphill (supervisor) at Mark.uphill@canterbury.ac.uk.

11.2 Information sheet and consent form chapter 6

PARTICIPANT INFORMATION SHEET

A research study is being conducted at Canterbury Christ Church University (CCCU) by Matthew Cunliffe.

Background

The benefits and links shown between social support and health has spurred the development and evaluation of interventions that aim to improve peoples' social support (Hogan, Linden, Najarian, 2002). There is very limited consensus on the most effective way to increase social support amongst any particular population, but attempts have been made to identify the most effective types of interventions (Hogen, Linden, Najarian, 2002). However, when considering the development of effective social support interventions House (2001) suggests a single question to help; who should provide what to who and when? In essence who should give the social support, what type of social support should they given, and when should this social support be given. Social support can be given by various different types of providers (*who*) these can be both un-professionals such as friends and family and we know that long standing social connections have unique capabilities when it comes to providing social support (Feeney and Collins, 2003), or can be professionally provided by trained helpers which may be better suited to specific types of support (e.g., informational support, Gottlieb, 2000).

What will you be required to do?

Participants in this study will be required to undertake a 1 hour video psycho-education session based on social support or what a 1 hour video lecture on a psychology related topic. You will be required to take baseline data via completing a questionairre related to your perceived social support. After the intervention you will be asked to repeat the social support questionairre.

To participate in this research you must:

- Be over the age of 18
- Be willing to participate in every part of the study
- Be aware of the risk of minor harm and discomfort you may experience whilst engaging in the tape stripping procedure.

Procedures

You will be asked to complete questionnaires before and after watching an online psycho-education session or pre-recorded psychology lecture.

Feedback

You will be given the option to engage in a debriefing interview after the study is complete where you can ask any questions, and deal with any issues that have arisen as a result of participation in this study.

Confidentiality

All data and personal information will be stored securely within CCCU premises in accordance with the Data Protection Act 1998 and the University's own data protection requirements. After completion of the study, all data will be made anonymous (i.e. all personal information associated with the data will be removed). On occasion supervisors, and examiners may ask to see the raw data from a PhD project, this will be confidential and anonymised.

Dissemination of results

This study will make up part of my PhD thesis which will be submitted to the university. It will also be presented at conference and written up for publication in an academic journal.

Deciding whether to participate

If you have any questions or concerns about the nature, procedures or requirements for participation do not hesitate to contact me. Should you decide to participate, you will be free to withdraw at any time without having to give a reason.

Any questions?

Please contact Matthew Cunliffe at matthew.cunliffe@canterbury.ac.uk, or Dr Mark Uphill (supervisor) at Mark.uphill@canterbury.ac.uk.

CONSENT FORM

Title of Project: Investigating the validity of an online psychosocial intervention to increase perceived social support.

Name of Researcher: Matthew Cunliffe and Dr Mark Uphill

Contact details:

Address: AF87 Anselm Building
Canterbury Campus

Tel: 01227 767700 Ext 1718

Email: Matthew.cunliffe@canterbury.ac.uk
Mark.Uphill@canterbury.ac.uk

	Please initial box
1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	
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 personal information that I provide to the researchers will be kept strictly confidential	
4. I agree to take part in the above study.	

Name of Participant	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

Copies: 1 for participant
1 for researcher

11.3 Information sheet and consent form for chapter 7

CONSENT FORM

Title of Project: Exploring the links between heart rate variability, stress, and recovery: A case study.

Name of Researcher: Matthew Cunliffe and Dr Mark Uphill

Contact details:

Address:	AF87, Anselm Building, Canterbury Campus
Tel:	1718
Email:	Matthew.cunliffe@canterbury.ac.uk Mark.Uphill@canterbury.ac.uk

	Please initial box
1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	
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_____ Name of Participant	_____ Date	_____ Signature
_____ Name of Person taking consent (if different from researcher)	_____ Date	_____ Signature
_____ Researcher	_____ Date	_____ Signature

Copies: 1 for participant
1 for researcher

Exploring the links between heart rate variability, stress, and recovery: A case study.

PARTICIPANT INFORMATION SHEET

A research study is being conducted at Canterbury Christ Church University (CCCU) by Matthew Cunliffe and Dr Mark Uphill (supervising).

Background

Whilst most of the causes of injury are physical or biomechanical there is a growing body of research that suggests that stress contributes to the incidence of injury (Kerr & Goss, 1996: Anderson & Williams, 1998). Each of the main models of sport injury (Weise-Bjornstal, 1998 integrated model, & Brewer et al., 2002 biopsychosocial model of sport injury) includes an emotional factor within them. Porges (2003) states that the environmental context can influence the neurobiological state and a person's ability to deal with the challenges placed upon them. The Polyvagal Theory gives predicts that social processes can influence physiological measures of stress (e.g., heart rate variability). The sport injury models mentioned above (Weise-Bjornstal et al., 1998, Brewer et al., 2002) also state that social support can have an influence on injury incidence and on rehabilitation outcomes. The aim of this study is to investigate these links.

What will you be required to do?

Participants in this study will be required to undergo a variety of tests to assess the links above. Firstly you will be required to take baseline heart rate variability data using a polar heart rate monitor. you will have a heart rate monitoring strap placed around your chest and be asked to lay on a physiotherapy bed for around 15 minutes. In addition you will also be asked to complete a questionnaire related to your perceived social support and daily life stress. The final baseline test will require us to remove a few layers of skin from your forearm using Sellotape, which will be measured using a waterloss meter. This will be done up to 6 times over 6 days. You will then be offered up to 3 counselling sessions where the same measures will be taken. Finally you will be asked to repeat the measure for up to a further 4 days to measure any decreases in effect of the intervention.

To participate in this research you must:

- Be over the age of 18

- Be willing to participate in every part of the study
- Be aware of the risk of minor harm and discomfort you may experience whilst engaging in the tape stripping procedure.

Procedures

You will be asked to complete questionnaires, tape stripping procedure, and have heart monitoring completed along with up to 3 counselling sessions.

Feedback

You will be given the option to engage in a debriefing interview after the study is complete where you can ask any questions, and deal with any issues that have arisen as a result of participation in this study.

Confidentiality

All data and personal information will be stored securely within CCCU premises in accordance with the Data Protection Act 1998 and the University's own data protection requirements. After completion of the study, all data will be made anonymous (i.e. all personal information associated with the data will be removed). The data will be accessible by myself, my supervision and on occasion examiners may ask to see the raw data from a PhD project, this will be confidential and anonymised.

Dissemination of results

This study will make up part of my PhD thesis which will be submitted to the university. It will also be presented at conference and written up for publication in an academic journal.

Deciding whether to participate

If you have any questions or concerns about the nature, procedures or requirements for participation do not hesitate to contact me. Should you decide to participate, you will be free to withdraw at any time without having to give a reason.

Any questions?

Please contact Matthew Cunliffe at matthew.cunliffe@canterbury.ac.uk, or Dr Mark Uphill (supervisor) at Mark.uphill@canterbury.ac.uk.

11.4 Perceived available support in sport questionnaire (PASS-Q)

Below is a list of items referring to the types of help and support you may have available to you as a sportsperson. **Please indicate to what extent you have these types of support available to you.**

0 = not at all
1 = slightly
2 = moderately
3 = considerably
4 = extremely

If needed, to what extent would someone . . .

		not at all	slightly	moderately	considerably	extremely
1.	provide you with comfort and security	0	1	2	3	4
2.	reinforce the positives	0	1	2	3	4
3.	help with travel to training and matches	0	1	2	3	4
4.	enhance your self-esteem	0	1	2	3	4
5.	give you constructive criticism	0	1	2	3	4
6.	help with tasks to leave you free to concentrate	0	1	2	3	4
7.	give you tactical advice	0	1	2	3	4
8.	always be there for you	0	1	2	3	4
9.	instil you with the confidence to deal with pressure	0	1	2	3	4
10.	do things for you at competitions/matches	0	1	2	3	4
11.	care for you	0	1	2	3	4
12.	boost your sense of competence	0	1	2	3	4
13.	give you advice about performing in competitive situations	0	1	2	3	4
14.	show concern for you	0	1	2	3	4

15.	give you advice when you're performing poorly	0	1	2	3	4
16.	help you organise and plan your competitions/matches	0	1	2	3	4

11.5 The Daily Stress Inventory

Participant Name:	**Date:**
Below are listed a variety of events that may be viewed as stressful of unpleasant. Read each item carefully and decide whether or not that even occurred in the past 24 hours. If the event **did not** occur, place and X in the space next to that item. If the even **did** occur, indicate the amount of stress that it caused you by placing a number from 1 to 7 in the space next to that item (see numbers below). Please answer as honestly as you can so that we may obtain accurate information.	
X = did not occur (past 24 hrs) **1 – occurred by was not stressful** **2 – caused very little stress** **3 – caused a little stress** **4 – causes some stress** **5 – caused much stress** **6 – caused very much stress** **7 – caused me to panic** 1. Performed poorly at a task 2. Performed poorly due to others 3. Thought about unfinished work 4. Hurried to meet a deadline 5. Interrupted during task/activity 6. Someone's spoiled your completed task 7. Did something that you are unskilled at 8. Unable to complete a task 9. Was unorganised 10. Criticised or verbally attacked 11. Ignored by others 12. Spoke or performed in public 13. Dealt with rude waiter, waitress, salesperson 14. Was interrupted whilst talking 15. Was forced to socialise 16. Someone broke a promise/ appointment	18. Was stared at 19. Did not hear from someone 20. Experienced unwanted physical contact (crowded/pushed) 21. Was misunderstood 22. Was embarrassed 23. Had your sleep disturbed 24. Forgot something 25. Feared illness/pregnancy 26. Experienced illness/ physical discomfort 27. Someone borrowed something without your permission 28. Your property was damaged 29. Had a minor accident (broke something or tore clothing) 30. Thought about the future 31. Ran out of food/ personal article 32. Argued with spouse/boyfriend/girlfriend 33. Argued with another person 34. Waited longer than you wanted 35. Interrupted while thinking/relaxing 36. Someone 'cut' ahead of you in a line 37. Performance poorly at a sport/game 38. Did something that you did not want to do

17. Compete with someone	39. Unable to complete all plans for today 40. Had car trouble 41. Had difficulty in traffic
42. Money problems 43. Store lacked a desired item 44. Misplaced something 45. Bad weather 46. Unexpected expenses (fines, traffic ticket etc.) 47. Had confrontation with an authority figure 48. Heard some bad news 49. Concerned over personal appearance 50. Exposed to feared situation or object 51. Exposed to upsetting TV show, movie, book.	52. 'Pet peeve' violated (someone fails to knock etc.) 53. Failed to understand something 54. Worried about another's problems 55. Experienced a narrow escape from danger 56. Stopped unwanted personal habit (overeating, smoking, nail-biting) 57. Had problems with kid(s) 58. Was late for work/appointment Any stressors that we missed (list below 59. 60.

11.6 Slides for the psycho-education session chapter 6

Summary

- Your friends, family, coaches, team mates provide you with support during your training.
- You can engage with specific people for specific needs.
- Social support is a vital part of being an excellent performer.

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Now take the quiz

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Section 2

Social Network Development

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Your network members need to...

Be readily available to help with stressful problems

Be able to offer one or more of the types of support referred to in the previous section

Have a number of the qualities identified in the previous section

Agree to help you with your goals

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Task – My social network

Download the 'my social network worksheet'

Step 1 - In each box fill in the name of significant people in your life (parents, siblings grandparents, coaches etc.)

Step 2 – identify what type of support they offer you

Step 3 – identify the quality of the relationship on a scale from 1 to 10 (ideal quality should be above 7)

Use additional sheets if required. You should aim to cover all of the types of support from section 1.

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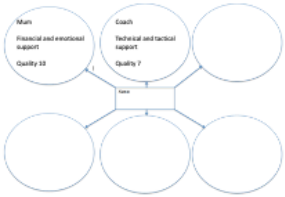
Example of 'My Social Network'



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Suggestion

To increase the usefulness of your social support network you should have a discussion with some of your key supporters

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Task- 'People in my life'

Download and complete the 'People in my life' worksheet.

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Section 3

Communication skills

Why develop communication skills?

Good communication has been proven to help people use their social networks more effectively.

Being able to have effective conversations will help with the support you get.

This part of the course will give some hints and tips on developing communication skills.

You will need to practice these with other people to improve your social support and communication skills.

Non-verbal communication

Body language plays a huge part in the messages we convey to others

Non-verbal behaviour can help or hinder communication

Developing your non-verbal communication will make massive differences to your conversations with people.

Non-verbal skills guidelines

Posture	A relaxed posture makes you look natural. Being comfortable is key to good communication. Sit or stand directly facing the person you talk to.
Personal space	Keep a comfortable distance between other people. Roughly 2 foot is normally appropriate.
Eye contact	Eye contact shows that you are following what others are saying. Although staring is un-nerving. Keep eye contact for about half the conversation
Head nods	An occasional head nod will convey interest. It lets people know you are following the conversation
Facial expression	A pleasant facial expression can put everyone at ease. Laughing and smiling will convey that you are pleasant and knowable.
Nervous moment and hand gestures	Hand movements can be distracting. If you send messages of comfort then others will too.
Tone of voice	Your tone of voice can aid communication, when it is warm and relaxed the conversation will follow.

Starting conversations

Common misconceptions :

- You should only talk about important things
- You are responsible for keeping the conversation
- You should never talk about yourself

Conversations can be fun and should be two way.

It's important for you to share about yourself when conversing.

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Tips for starting conversations

1. Listen for clues about discussion topics
2. Speak up and let the person know you want to talk. Use eye contact, say anything first.
3. Use open ended questions
4. Check for interest, keeping conversations the right length means people will come back for more.
5. Ending a conversation gracefully will help people feel you have enjoyed their company.

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Summary

The way you communicate with people can influence the support they give you

Effective use of non-verbal and verbal communication can develop a sense of belonging

Now complete the second questionnaire follow the link below.

Social support questionnaire

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