

UNIVERSITY OF DERBY

PAIN RESPONSES IN ATHLETES: THE
ROLE OF CONTACT SPORTS

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Glossary

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|---------------|---|
| ACT | Attention Control Theory |
| BASE (Jumper) | Bridges, Antennas, Spans and Edges |
| DFA | Discriminant Function Analysis |
| HRV | Heart Rate Variability |
| MMA | Mixed Martial Arts |
| SIP15 | Sports Inventory for Pain |
| TCTSA | Theory of Challenge and Threat States in Athletes |
| TIPI | Ten Item Personality Inventory |
| VAS | Visual Analog Scale |

Preface

This thesis is submitted for the degree of Doctor of Philosophy at the University of Derby. This research was conducted under the supervision of Professor David Sheffield and Andrew Baird. This work to the best of my knowledge is original except where references are made to previous work. Neither this, nor any other similar work is being submitted for any other degree, diploma or other qualification at any other university. This research is ethically approved.

This thesis includes one published manuscript, and data from this thesis has also been presented at a UK conference. The details of all outputs related to this thesis are as follows:

Articles

Thornton C., Sheffield D. & Baird A. (2017). A longitudinal exploration of pain tolerance and participation in contact sports. *Scandinavian Journal of Pain*, 16, 36-44

Conference Presentations

Thornton C. & Sheffield D. (2105). A longitudinal exploration of pain tolerance and attendance in contact sports. Presented at the annual British Psychological Society Department of Sport and Exercise Psychology Conference, Leeds, 15th December 2015.

Abstract

High contact athletes differ from low or non-contact athletes in their responses to pain. The mechanisms for this have not been widely investigated and most sports-related pain research has not differentiated between the three sources of pain: contact, injury and exertion. This thesis aimed to explore differences between contact and non-contact athletes, in these three sources of pain. The first aim of the thesis was to develop an understanding of the pain experiences of different athlete groups, examining the proposed mechanisms of learning, attrition and individual differences. The first study addressed this by conducting semi-structured interviews with high, low/medium and non-contact athletes. Template analysis indicated that high contact athletes viewed pain differently to low/medium or non-contact athletes. High contact athletes described pain as something to be overcome, often celebrated contact pain and were more able to differentiate between potentially harmful and benign injury pain. The second study also addressed aim one, but directly compared high contact athletes to low/medium contact athletes based on the mechanisms of personality and learning. Learning was explored by measuring direct coping and pain bothersomeness while personality was measured using a short inventory based on the Big Five personality traits. High contact athletes found pain less bothersome, had higher direct coping than the other athletes and were less agreeable. Study three was a longitudinal exploration of pain responses over a contact sport athletic season, examining the mechanisms of learning and attrition. Cluster analysis placed athletes into participating or non-participating groups. Results showed that participating athletes were more tolerant of ischemic and cold pain at the end of the season (eight months follow-up) compared to those who disengaged from the sport; they also became more tolerant of ischemic pain at eight months follow-up compared to at the start of the season. Participating athletes also had higher direct coping for contact pain and found pain less bothersome than non-participating athletes. The final study further explored the role of experience in sport by examining novice and experienced high contact athletes' and non-contact athletes' responses to experimental pain. Athletes completed a simple motor task while being exposed to pressure pain. During the pain condition, challenge and threat states were manipulated to examine the role of task instructions. Results indicated that experienced high contact athletes had higher pain tolerance than the other groups, reported pain as less intense and had higher direct coping than the other athletes. Both groups of high contact athletes performed better in pain than non-contact athletes and were able to maintain their performance in pain. They also reported pain to be less bothersome and were challenged when in pain even if they received threat instructions. Taken together the results of

this thesis indicate that learning to cope with pain is the most plausible explanation for high contact athletes' lower pain bothersomeness, higher pain tolerance and performance in pain. It is proposed that experience of pain and having a direct coping style are important determinants of performance in contact sports and should be targeted by coaches.

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I would like to express sincere thanks to Professor David Sheffield for all of the support, encouragement and help he has provided me on this long journey. I would also like to thank Andrew Baird for his continued support and advice throughout my studies. Without both of them, I would not be where I am today. Thanks also must be extended to all of the participants and students who gave up their time to help me to complete this research. Finally thanks to my family and friends for their support, and in particular huge thanks to my husband Alastair for supporting me entirely through this process.

Chapter One: Introduction and Literature Review

1.1 Introduction

Pain is an integral part of sports participation and can set a limit on what athletes are able to achieve (Epstein, 2011). Athletes regularly experience pain through injury, contact with external objects, and exertion. The ability to maintain performance in painful conditions is crucial to continued participation in most sports and is a deciding factor in whether an athlete is successful or not (Egan, 1987). Understanding how pain affects athletes is critical for all stakeholders in sport and is key to the development of pain coping strategies (Kress & Statler, 2007). An athlete with an understanding of these could potentially perform better and adhere to sport longer than an uneducated athlete by diminishing the chance of exacerbating injuries (Scott & Gijssbers, 1981; Egan).

Pain is a subjective experience and is affected by physical, psychological, social and cultural influences (Taylor & Taylor, 1998). It is described as an unpleasant emotional and sensory experience, which is associated with, or described in terms of actual or potential tissue damage (International Association for the Study of Pain, 1994). Pain is understood in terms of how it affects behaviour and actions, how it is reported in terms of intensity and unpleasantness, and how it interferes with mood and day-to-day life or activities. As pain is a subjective experience, reporting of pain is the most reliable method available to assess the quality, intensity, location and duration of pain (Cox, 2009), and as such, most sports-related studies have used this method. Pain is commonly measured in terms of threshold, tolerance, perception and effect on mood and behaviour (Roessler, 2005).

Pain threshold refers to the point when an individual first experiences pain or discomfort whereas pain tolerance refers to the point where the individual can no longer bear pain and requests that the pain stimulus be stopped (Woodrow, Friedman, Siegelau & Collen, 1972). Pain perception is usually measured using inventories or measures such as visual analog scales (VAS) to determine how participants rate pain of a particular intensity (Hall & Davies, 1991) or to measure unpleasantness of pain (e.g. Manning & Fillingim, 2002). Increasingly within clinical research, pain has also been measured in terms of how bothersome it is (e.g. Dunn & Croft, 2005). Various inventories have been developed to measure pain bothersomeness for a number of pathologies including sciatica (Patrick et al., 1995), stenosis (Weinstein et al., 2010) and lower back pain (Dunn & Croft). There have been no sports-

specific measures developed to measure bothersomeness, however it can be measured on a simple Likert scale.

In sports research, pain has often been defined in very vague terms and the meaning of different types of pain has not been accounted for. Previous work has typically only addressed acute experimental pain and few studies of athletes have made any distinction between different causes of pain. Acute pain is short in duration but can cause anxiety and fear due to perceived or potential tissue damage (Kakiashvili, Tsagareli, Mjavanadze & Kvachadze, 2016). Chronic pain is persistent and is usually uncontrollable. This can have a negative impact on psychological well-being (Kakiashvili et al.).

Pain in sport can come from one of three sources: exertion/performance, contact with other people/objects, and injury (Loland, Waddington & Skirstad, 2006). Performance-related pain is associated with exertion and is experienced by most athletes. This type of pain does not usually elicit feelings of threat, is acute and within the control of the athlete. It is often associated with positive emotions and is viewed as facilitative to, and indicative of, sports performance (Anderson & Harahan, 2008). Another source of acute pain is contact; for example, tackling in rugby. The effect of this type of pain on athletes is relatively unexplored. Finally, injury-related pain is sometimes acute but can become chronic, is outside of the control of the athlete and can be perceived as threatening (Taylor & Taylor, 1998). It has been suggested that this type of pain may be becoming more common due to increased pressures of competing (Valovich Mcleod, Bay, Parsons, Sauers & Snyder, 2009) and the demands of elite sport (Levy, Polman, Nicholls & Marchant, 2009; Egan, 1987).

Most of the pain research within sport has focused on differences in pain reporting between athletes and non-athletes. It is generally accepted that athletes have higher pain tolerance than non-athletes but there are no differences for pain threshold (Tesarz, Schuster, Hartmann, Gerhardt and Eich, 2012). In addition, athletes have also been shown to report less pain intensity than non-athletes (Hall & Davies, 1991). Even within athlete groups there are differences in pain responses, with high contact athletes having higher pain tolerance than non-contact athletes (Ryan & Kovacic, 1966), and trained swimmers having higher pain tolerance than non-trained swimmers (Scott & Gijssbers, 1981).

To take measurements such as pain threshold or tolerance, researchers have a number of noxious experimental pain stimuli from which to choose. These are employed within controlled laboratory settings and typically do not reflect the pain that would be felt in sports,

however with the absence of more ecologically valid measures, authors have relied upon the following pain modalities: Cold pain is induced using a cold pressor protocol which consists of an ice bath of circulating water. This produces tonic pain that is intense but can sometimes wane if the water is not circulated or the limb remains still for a period of time (Mitchell, MacDonald & Brodie, 2004). Ischemic pain is usually induced by employing a sub-maximal tourniquet test (Reddy, Naidu, Rani & Rao, 2012). This produces an aching sensation similar to that of feeling fatigued (Addison, Kremer & Bell, 1998). Heat pain can be induced using radiant heat or via a thermode. This produces a throbbing, pricking or burning pain (Reddy et al.). Electrical stimulation is often invoked using electrodes attached to the surface of the skin and can produce different types of pain sensation depending on waveform and frequency (Handwerker & Kobal, 1993). Both electrical and heat pain are more phasic in their nature compared to cold and ischemic pain which are considered to be more tonic (Rainville, Feine, Bushnell & Duncan, 1992). Pressure pain can be induced using an algometer (e.g. Chesterton, Sim, Wright & Foster, 2007) or by using a sphygmomanometer containing a hard object that can press against a limb (e.g. Brewer, Van Raalte & Linder, 1990). This produces a dull pain that intensifies over time (Hezel, Riemann & McNally, 2012). Less common pain induction methods include chemical stimulation which is delivered via intradermal or intramuscular means. This pain has been described as deep and diffuse (Reddy et al.). Mechanical pain is delivered via weighted pin-prick and/or vibration and is usually used for pain threshold measures, as this can produce relatively light pain (Reddy et al.).

Very limited quantitative research has gone beyond measuring pain tolerance or perception within athletic populations. As such, the mechanisms for differences in pain reporting remain relatively unknown. Athletes may learn to cope with pain via experience (e.g. Ord & Gijssbers, 2003), or individual differences such as personality may alter pain tolerance (e.g. Tajet-Foxell & Rose, 1995). Furthermore, athletes with low pain-related self-efficacy or high pain-related anxiety may disengage from sport (e.g. DeRoche, Woodman, Yannick, Brewer & LeScanff, 2011). There is much speculation regarding these mechanisms but few studies have empirically tested them. In addition, very few studies have examined intra-athlete differences in pain reporting, for example, comparing non-contact athletes to contact athletes. High contact athletes are regularly exposed to pain and yet still continue to participate and perform in their sports. It is not clear how and why these athletes are able and willing to endure pain in comparison to others.

There has also been little exploration of the effects of pain on sports performance. This is surprising given that pain is a common occurrence within sport and the potential for athletes to develop long term pain conditions (e.g. Heidari, Hasenbring, Kleinert & Kellmann, 2017). Only one published study to date has examined performance in pain in relation to athletic status (Walker, 1971). Results showed that athletes and non-athletes did not differ in performance whilst undergoing experimental pain. Other studies using non-athletes have found that pain is usually detrimental to performance and that it interferes with decision making and motor control (Bank, Peper, Marinus, Beek & van Hilten, 2013). However, this does not explain how contact sports participants are able to maintain performance whilst experiencing high levels of pain.

Qualitative pain research has tended to focus on athletic culture (e.g. Nixon, 1992) or on the willingness to play hurt within contact sports (e.g. Liston, Reacher, Smith & Waddington, 2006). This research indicates that contact sports participants regularly play through pain. The reasons for this include being socialised into playing hurt through the culture of contact sports (e.g. Liston et al.), or due to masculine ideals and the sport ethic (Nixon). Other studies have focused on how endurance athletes overcome pain (e.g. Heil, 2012). These studies have typically examined coping strategies and the process by which athletes maintain performance over time (e.g. Kress & Statler, 2007). Further qualitative research has explored injury rehabilitation interventions and their efficacy (e.g. Driediger, Hall & Callow, 2006). This research suggests that using psychological interventions during painful rehabilitation can be facilitative to recovery (Johnston & Carroll, 1998). There has been little focus on the mechanisms for athletes engaging with painful sports or the reasons why some people thrive in pain whereas others do not.

The aim of this thesis is to explore pain reporting and responses within different groups of athletes. Both qualitative and quantitative methods will be employed to examine how high contact and non, low or medium contact athletes respond to pain. This will provide a platform for future research and will contribute to understanding why there are differences between athlete groups in their responses to pain. This will help coaches and athletic trainers to develop pain coping programmes and will help athletes to understand their own responses to painful sporting situations.

1.2 Literature Review

Until recently there has been little attempt to draw together the limited research into sports and pain, and most of the research has focused on differences in pain reporting between athletes and non-athletes. A recent systematic review and meta-analysis by Tesarz, et al. (2012) reviewed 15 studies that examined pain tolerance and threshold in athletic populations. Results showed that athletes had a higher pain tolerance than non-athletes (Hedges' $g = 0.87$), but there was no difference for pain threshold. Differences in pain perception and behaviour were not examined. The current review summarises research examining pain tolerance, threshold and perception as well as the effect of pain on performance. Research is also reported that was not included in Tesarz et al.'s review, including differences in pain reporting between athlete groups, for example between contact athletes versus non-contact athletes. Moreover, mechanisms underlying reported differences and methodological concerns regarding the corpus of athlete pain studies are raised along with a discussion of their implications for athletes and coaches.

Athletic status and pain.

In this first section, evidence that athletes perceive, report and respond to pain differently to non-athletes is reviewed. In addition, differences in pain reporting between athlete groups are also discussed. The review was performed by searching Sport Discus, PsychInfo, PubMed and PsycArticles. The key words were "pain", "athletes", "sport" and "exercise". These searches were extended by scrutinising reference sections from articles found within the databases. 14,307 articles were found that examined athletes and pain. Athletes were classed as participating in competitions or training for at least three hours per week as recommended by Tesarz et al. (2012). The search was then narrowed to include pain reporting measures, "tolerance", "threshold" and "perception". A total of 49 studies of athletes were found that measured pain reporting in any form. All studies either examined intra-athlete differences or compared athletes to non-athletes or normally active controls. These were all included in the thesis.

The majority of sports-related pain research has focused on reporting of pain; few studies have examined behavioural responses to pain or how pain may affect athletic performance. The most common measures of pain in athletic populations are pain tolerance ($k=20$), threshold ($k=17$), and perception ($k=13$). Pain threshold refers to the point when an individual first experiences pain or discomfort and tolerance refers to the point where the individual can no longer bear pain and requests that the pain stimulus be stopped (Woodrow et

al., 1972). Pain perception is usually measured using inventories or scales to determine the intensity of the stimulus. Finally, pain can also be considered in terms of how it affects performance or behaviour (Brewer et al., 1990). Each measure will be discussed in turn and the main research findings will be summarised.

Pain Threshold.

Research examining differences in pain threshold between athletes and non-athletes has yielded equivocal results. Seventeen studies have explored differences in pain threshold in athletes and non-athletes, and also within specific athlete groups. Tesarz et al. (2012) analysed nine studies, all of which are included here, apart from Smith (2004), an unpublished dissertation that could not be obtained. The findings are summarised in Table 1.1. When effect sizes were not provided within papers, Cohen's *d* was calculated where possible. However, there were a number of articles where this could not be calculated due to a lack of information/data.

Nine of 17 studies in Table 1.1 (Ryan & Kovacic, 1966; Walker, 1971; Scott & Gijbsbers, 1981; Janal, Glusman, Kuhl & Clark, study 2, 1994; Sternberg, Bailin, Grant & Gracely, 1998; Ord & Gijbsbers, 2003; Geva & Defrin, 2013; Tesarz, Gerhardt, Schommer, Treede & Eich, 2013; Leznicka et al., 2016) found no differences between athletes and non-athletes for thermal, ischemia, cold and electrical pain threshold. Furthermore, there were also no differences in pain threshold between athlete groups based on the amount of contact they experienced in sport. Athletes who played contact sports and those who played non-contact sports did not differ on cold pain threshold (Raudenbush et al., 2012; Ryan & Kovacic, 1966).

In the 10 studies that have found differences, seven reported that athletes have a higher pain threshold than non-athletes (note that Janal et al., 1994, Tesarz et al., 2013 and Leznicka et al., 2016 conducted multiple studies/measures within the same paper and therefore are not counted as separate studies). Four of those studies used cold pressor pain (Janal et al., study 1; Manning & Fillingim, 2002; Jaremko, Silbert & Mann, 1981; Tajet-Foxell & Rose, 1995). Two studies found that regular exercisers have a higher pain threshold than non-exercisers for pressure pain (Granges & Littlejohn, 1993; Leznicka et al., 2016); one found that athletes have a higher pain threshold to electrical stimulation than non-athletes (Guieu, Blin, Pouget & Serratrice, 1992) and another reported that marathon runners have a higher pain threshold for potassium iontophoretic pain (Johnson, Stewart, Humphries & Chamove, 2012). In a study that examined a number of pain stimuli, Tesarz et al. found that there were no differences in pain threshold between endurance athletes and controls for cold, heat and blunt pressure, however

athletes did have a higher pain threshold for pinprick pressure. There are two exceptions to these findings; Lokmaoglu, Yager and Cavlak (2013) reported that soccer players had a lower electrical pain threshold than sedentary males. In addition, Tesarz et al. found that endurance athletes were more sensitive to vibration than normally active controls.

It is concluded that there are no pain threshold differences between athletes and non-athletes. This is due to the ambiguity in the results discussed above. This accords with the meta-analysis conducted by Tesarz et al. (2012).

Table 1.1

Summary of Studies Examining Pain Threshold

| Author | Participants | Pain stimuli | Results |
|--------------------------|---|--|---|
| Ryan and Kovacic (1966) | 20 male high contact athletes 20 male non-contact athletes 20 male non-athletes | Thermal | No significant differences ($p = 0.06$), non-athletes had lowest threshold, non-contact athletes had the highest. |
| Walker (1971) | 24 female basketball players 24 female non-athletes | Electrical | No significant differences |
| Jaremko et al. (1981) | 28 male non-athletes 22 female non-athletes 10 male athletes 22 female athletes Split into 3 groups: athlete, non-athlete and control | Cold pressor [2°C, circulation not stated] Ischemic | <u>Cold pressor</u> Female athletes had higher threshold for cold pressor than other 3 groups ($p < 0.02$, $d = 0.37$) <u>Ischemia</u> No significant differences |
| Scott and Gijbers (1981) | 16 male and 14 female highly competitive swimmers 13 male and 17 female club swimmers 10 male and 16 female non-competitive athletes | Ischemic | No significant differences |

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| Guieu et al. (1992) | 2 female and 4 male athletes 1 female and 7 male non-athletes | Electrical in mAmp for leg flexion nociceptive reflex threshold | Athletes had higher threshold than non-athletes ($p < 0.05$) |
| Granges and Littlejohn (1993) | 60 fibromyalgia patients 30 non-exercisers (unfit control group) 30 regular exercisers (fit control group) | Pressure | Regular exercisers had higher pain threshold than unfit group ($p < 0.001$, Hedge's $g = 2.22$) |
| Janal et al. (1994) | Study 1: 12 male runners 18 active males Study 2: 36 male runners 24 active males | Ischemic Cold pressor [participants instructed to "wave" hands in water, temp not stated] Radiant heat | <u>Cold pressor</u> Runners had significantly higher threshold than active controls for cold pain only ($p < 0.01$) <u>Ischemia and Radiant Heat</u> No significant differences No significant differences for any stimuli |
| Tajet-Foxell and Rose (1995) | 26 male dancers 26 female dancers 27 male non-dancers 26 female non-dancers | Cold pressor [temperature not stated, circulation not stated] | Dancers had higher threshold than non-dancers ($p < 0.001$, $d = 1.17$) |
| Sternberg et al. (1998) | 33 female and 34 male athletes 14 female and 6 male non-athletes | Heat | No significant differences |

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| Manning and Fillingim (2002) | 12 male athletes 12 female athletes 12 male non-athletes 12 female non-athletes | Pressure Ischemic Cold pressor [1°C, constantly circulated] | <u>Cold pressor</u> Athletes had higher threshold than non-athletes (p <0.05) <u>Pressure and Ischemia</u> No significant differences |
| Ord and Gijssbers (2003) | 20 male competitive rowers, 20 recreational sport participants (males) not in training | Ischemic | No significant differences |
| Johnson et al. (2012) | 19 male marathon runners 7 female marathon runners 19 male non-athletes 7 female non-athletes | Potassium iontophoresis | Marathon runners had higher pain threshold than control group (p <0.001) |
| Raudenbush et al. (2012) | 54 male lacrosse players (contact athletes) 24 male track athletes (non-contact athletes) 51 male soccer players (contact athletes) 30 male basketball players (non-contact athletes) 24 male swimmers (non-contact athletes) | Cold pressor [3°C, constantly circulated] | No significant differences |

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| Lokmaoglu et al. (2013) | 37 male soccer players 24 sedentary males | Electrical | Soccer players had lower threshold than sedentary group (p = 0.0001) |
| Geva & Defrin (2013) | 19 triathletes 17 non-athletes | Heat (cold pain modulation used) | No significant differences |
| Tesarz et al. (2013) | 25 male endurance athletes 26 normally active controls | Heat, vibration (tuning fork) Mechanical pain (weighted pinprick and blunt pressure). Cold pain modulation used | Athletes had higher threshold for mechanical pain (weighted pinprick) (p <0.05). Athletes had higher sensitivity for vibration (p <0.05) No other significant differences |
| Leznicka et al. (2016) | 140 male martial artists 181 non-athletes | Cold pressor [0-5°C, constantly circulated] Pressure | Martial artists had higher threshold for pressure pain only (p <0.0001) |

Pain Tolerance.

Results regarding pain tolerance have been more consistent than threshold findings (Tesarz et al., 2012). Twenty studies to date have examined differences in pain tolerance between athletes and non-athletes, and between athlete groups. Tesarz reviewed 11 studies, all of which are included here. Findings are summarised in Table 1.2.

Eleven of the 20 studies have found that athletes are able to tolerate more pain than non-athletes (Ryan & Kovacic, 1966; Ryan & Foster, 1967; Walker, 1971; Tajet-Foxell & Rose, 1995; Manning & Fillingim, 2002; Paparizos, Tripp, Sullivan & Rubenstein, 2005; Johnson et al., 2012; Lokmaoglu et al., 2013; Geva & Defrin, 2013; Freund et al., 2013; Leznicka et al., 2016). In addition, two studies have shown that athletes who are engaged in training and competition have higher pain tolerance than control groups comprised of active or recreational participants (Ord & Gijbsbers, 2003; Scott & Gijbsbers, 1981). Furthermore, athletes who play contact sports have demonstrated a higher pain tolerance than athletes who play non-contact sports (Ryan & Kovacic; Ryan & Foster; Eitter, 1980 cited in Tesarz et al., 2012; Raudenbush et al., 2012; Leznicka et al.). Five studies found no differences in pain tolerance between athletes and non-athletes (Ellison & Freischlag, 1975; Jaremko et al., 1981; Egan, 1987; Janal et al., 1994; Sternberg et al., 1998).

In studies where differences between groups were observed, cold pain and ischemia have been the most common pain stimuli (e.g. Manning & Fillingim, 2002). Other methods that have yielded differences are gross pressure (e.g. Ryan & Kovacic, 1966), electrical pain (e.g. Walker, 1971) and heat (Geva & Defrin, 2013). In studies where no differences have been observed, many pain stimuli have been utilised; pressure (e.g. Manning & Fillingim), cold (e.g. Jaremko et al., 1981), ischemia (e.g. Janal et al., 1994), radiant heat (e.g. Janal et al.) and muscular endurance tasks (e.g. Ellison & Freischlag, 1975).

The pain tolerance research has yielded more consistent findings than the pain threshold literature. Despite some disagreements, it is concluded that athletes do appear have a higher pain tolerance than non-athletes and that high contact athletes may have a higher pain tolerance than non-contact sports participants. This accords with Tesarz et al. (2012).

Table 1.2

Summary of Studies Examining Pain Tolerance

| Author | Participants | Pain stimuli | Results |
|-------------------------------|---|--|---|
| Ryan and Kovacic (1966) | 20 male high contact athletes 20 male non-contact athletes 20 male non-athletes | Gross pressure Ischemic | <u>Gross pressure</u> High contact athletes had higher tolerance than non-contact athletes ($p < 0.0001$, $d = 1.033$) and non-athletes ($p < 0.0001$, $d = -0.13$) <u>Ischemia</u> High contact athletes had higher tolerance than non-contact athletes ($p < 0.0001$, $d = 1.13$) and non-athletes ($p < 0.0001$, $d = -1.44$) |
| Ryan and Foster (1967) | 20 male high contact athletes 20 male non-contact athletes 20 male non-athletes | Gross pressure | High contact athletes had higher tolerance than low contact athletes ($p = < 0.01$) and non-athletes ($p < 0.01$) Low contact athletes had higher tolerance than non-athletes ($p < 0.01$) |
| Walker (1971) | 24 female basketball players 24 female non-athletes | Electrical | Athletes had higher tolerance than non-athletes ($p = 0.01$, $d = 1.39$) |
| Ellison and Freischlag (1975) | 12 male baseball players 12 male basketball players | Muscular endurance task (finger flexion) | No significant differences |

| | | | |
|-----------------------|--|---|---|
| | <p>12 male football linesmen</p> <p>12 male football backs</p> <p>12 male track distance runners</p> <p>12 male track and field sprinters</p> <p>12 non athletes</p> | | |
| Eitter (1980)* | <p>29 male athletes</p> <p>Contact athletes</p> <p>Endurance athletes</p> <p>16 male non-athletes</p> | <p>Pressure</p> <p>Ischemic</p> | <p><u>Pressure</u></p> <p>Contact athletes had higher tolerance than controls</p> <p>Endurance athletes had lower tolerance than controls</p> <p><u>Ischemic</u></p> <p>No significant differences</p> |
| Jaremko et al. (1981) | <p>28 male non-athletes</p> <p>22 female non-athletes</p> <p>10 male athletes</p> <p>22 female athletes</p> <p>Split into 3 groups: athlete, non-athlete and control</p> | <p>Cold pressor [2°C, circulation not stated]</p> <p>Ischemic</p> | <p><u>Cold Pressor</u></p> <p>No significant difference between athletes and non-athletes</p> <p>Males had higher tolerance than females at pre-test ($p < 0.05$, $d = 0.48$).</p> <p>Female athletes had higher tolerance than female non-athletes ($p < 0.05$, $d = 0.53$)</p> <p>All groups had higher tolerance than female non-athletes ($p < 0.05$, $d = 1.20$)</p> <p><u>Ischemic</u></p> |

| | | | |
|--------------------------|--|--|--|
| | | | Athletes were higher at pre-test than non-athletes ($p < 0.003$, $d = 1.06$) |
| Scott and Gijbers (1981) | 16 male and 14 female highly competitive swimmers 13 male and 17 female club swimmers 10 male and 16 female non-competitive athletes | Ischemic | Competitive swimmers had higher tolerance than club swimmers ($p < 0.0001$, $d = 1.03$) and non-competitive athletes ($p < 0.0001$, $d = 1.74$) Club swimmers had higher tolerance than non-competitive athletes ($p = < 0.05$, $d = 0.62$) |
| Egan (1987) | 50 male athletes (5 groups of 10, split by sport played) 10 male non-athletes | Cold pressor [0-3°C, constantly stirred] | No significant differences between athletes and non-athletes. Football players had higher tolerance than fencers ($p < 0.05$, $d = 1.56$) and karate participants ($p < 0.05$, $d = 1.42$). Cross country skiers had higher tolerance than fencers ($p < 0.05$, $d = 0.84$) and karate participants ($p < 0.05$, $d = 0.81$) |
| Janal et al. (1994) | Study 1: 12 male runners 18 active males | Ischemic Cold pressor [participants instructed to “wave” hands in water, temp not stated] Radiant heat | No significant differences |

| | | | |
|------------------------------|--|---|--|
| | Study 2: 36 male runners 24 active males | | No significant differences |
| Tajet-Foxell and Rose (1995) | 26 male dancers 26 female dancers 27 male non-dancers 26 female non-dancers | Cold pressor [temperature not stated, circulation not stated] | Dancers had higher tolerance than non-dancers ($p < 0.001$, $d = 1.71$) |
| Sternberg et al. (1998) | 33 female and 34 male athletes 14 female and 6 male non-athletes | Heat | No significant differences |
| Manning and Fillingim (2002) | 12 male athletes 12 female athletes 12 male non-athletes 12 female non-athletes | Pressure Ischemic Cold pressor [1°C, constantly circulated] | Athletes had higher tolerance than non-athletes for ischemic ($p < 0.05$) and cold pressor ($p < 0.05$) |
| Ord and Gijsbers (2003) | 20 male competitive rowers, 20 recreational sport participants (males) not in training | Ischemic | Competitive rowers had higher tolerance than non-training group ($p < 0.05$, $d = 0.94$) Competitive rowers used mental strategies more than non-training group ($p < 0.05$), and used multiple strategies more ($p < 0.05$) Pain tolerance positively correlated with number of strategies used while in pain ($r = 0.70$, $p < 0.01$). |

| | | | |
|--------------------------|--|--|---|
| | | | “Quality” of strategy positively correlated with tolerance ($r = 0.68$, $p < 0.01$). Athletes using high quality pain coping strategy significantly higher tolerance than those who did not ($p < 0.01$) |
| Paparizos et al. (2005) | 25 female high skilled dancers 22 female low skilled dancers 26 female non-dancers | Cold pressor [1-3°C, circulation not stated] | High skilled dancers had higher tolerance than low skilled and non-dancers. ($p < 0.05$) All dancers had higher tolerance than non-dancers ($p < 0.05$) |
| Johnson et al. (2012) | 19 male marathon runners 7 female marathon runners 19 male non-athletes 7 female non-athletes | Potassium iontophoresis | Marathon runners had higher tolerance than control group ($p < 0.001$) |
| Raudenbush et al. (2012) | 54 male lacrosse players (contact athletes) 24 male track athletes (non-contact athletes) 51 male soccer players (contact athletes) 30 male basketball players (non-contact athletes) 24 male swimmers | Cold pressor [3 °C, constantly circulated] | Lacrosse and soccer players had higher tolerance than other groups ($p < 0.01$). |

| | | | |
|-------------------------|--|---|--|
| | (non-contact athletes) | | |
| Lokmaoglu et al. (2013) | 37 male soccer players 24 sedentary males | Electrical | Soccer players had higher tolerance than sedentary group (p = 0.0001) |
| Geva and Defrin (2013) | 19 triathletes 17 non-athletes | Heat (cold pain modulation used) | Triathletes had higher tolerance than non-athletes (p <0.0001) |
| Freund et al. (2013) | 11 male ultra-marathon runners 11 male normally active matched controls | Cold | Ultra-marathon runners had higher tolerance than control group (p = 0.0002) |
| Leznicka et al. (2016) | 140 male martial artists 181 non-athletes | Cold pressor [0-5°C, constantly circulated] Pressure | Martial artists had higher tolerance than non-athletes for cold pressor (p = 0.0002) and for pressure (p <0.00001) |

*this paper could not be obtained, information is taken from Tesarz et al. (2012)

Pain Perception/Reporting.

Athletes may not only tolerate more pain than non-athletes, but also perceive pain differently. Tesarz et al. (2012) did not review any of the literature based on pain reporting, however thirteen studies have examined differences in pain perception in athletes and non-athletes as well as dancers and non-dancers. Results are summarised in Table 1.3.

In research focusing specifically on athletes, six studies concluded that athletes report pain as being less intense than non-athletes (Hall & Davies, 1991; Manning & Fillingim, 2002; Sullivan, Tripp, Rogers & Stanish, 2000, Straub, Martin, Williams & Ramsey 2003; Geva & Defrin, 2013; Freund et al., 2013). In addition, two studies examined differences in pain reporting amongst athlete groups and found that contact sports participants perceived pain as less intense than non-contact athletes (Raudenbush et al., 2012; Straub et al.). These studies used cold pain, pressure pain, ischemia, heat and a pain apperception test to determine responses to pain.

In two studies focusing on dancers however, results are less clear. Tajet-Foxell and Rose (1995) found that dancers perceived pain to be more intense than non-dancers, whereas Papparizos et al. (2005) reported that there were no differences in pain perception between dancers and non-dancers. Both of these studies used the cold pressor test as a means to induce pain. Four other studies have found no differences in pain perception between athletes and non-athletes, using ischemia, thermal pain, vibration and pressure (Janal et al., 1994; Sternberg et al., 1998; Monnier-Benoit, Gros Lambert & Rouillon, 2006; Tesarz et al., 2013).

It should also be noted that the instruments used to measure pain perception have varied widely. Visual Analog Scales (VAS) tend to be the most common methods used to measure pain intensity in sports settings, and have proved to be reliable and valid (Bijur, Silver & Gallagher, 2001). Numerical Rating Scales (NRS) have also been used within sports research, and are equally as robust as using VAS (Hawker, Mian, Kendzerska & French, 2011). Both scales are unidimensional however and do not account for the many ways in which pain can be experienced. Further studies have employed specific pain questionnaires such as the McGill Short Form Pain Questionnaire (SFMPQ, Melzack, 1987). This questionnaire is a multidimensional inventory and rates affective as well as sensory aspects of pain (Hawker et al.). This scale is often used for its brevity and ease of use. It has shown adequate reliability and validity when tested in clinical populations (Hawker et al.). As pain perception has been measured in many ways, it should be acknowledged that results may reflect the tool used.

Table 1.3

Summary of Studies Examining Pain Perception

| Author | Participants | Pain stimuli | Pain ratings | Results (perception) |
|------------------------|--|--|---|--|
| Hall and Davies (1991) | 7 male athletes 7 female athletes 7 male non-athletes 7 female non-athletes | Cold pressor [1-2°C, stirred continuously) | VAS (150mm line) for pain intensity (no sensation to strongest sensation I can imagine) and affect (not bad at all to most intense bad feeling for me). | <p>Female non-athletes had higher pain intensity than male non-athletes ($p < 0.05$, $d = 9.49$), female athletes ($p < 0.05$, $d = 12.05$) and male athletes ($p < 0.05$, $d = 19.13$).</p> <p>Female non-athletes had higher pain affect than male athletes ($p < 0.05$, $d = 15.52$) and female athletes ($p < 0.05$, $d = 10.38$).</p> <p>Male non-athletes had higher pain affect than male athletes ($p < 0.05$, $d = 9.63$).</p> <p>Non-athletes perceived affect to be higher than intensity ($p < 0.01$, $d = 0.50$), athletes perceived intensity to be higher than affect ($p < 0.01$, $d = 1.64$).</p> |

| | | | | |
|------------------------------|--|--|---|---|
| Janal et al. (1994) | Study 1: 12 male runners 18 active males | Ischemic | 6 point scale: Nothing-severe pain (within each of the categories, excluding “nothing” participants rated sensation using a 10 point scale, anchors not specified). | No significant differences |
| | | Radiant Heat | 5 point scale: Hot-very painful. | No significant differences |
| | | Cold pressor [participants instructed to “wave” hands in water, temp not stated] | 8 point scale: Nothing-severe pain (within severe pain an additional 10 point scale was used – anchors not specified) | No significant differences |
| | Study 2: 36 male runners 24 active males | Radiant heat | 8 point scale: Nothing-severe pain | No significant differences |
| | | Ischemic | As experiment 1 | No significant differences |
| | | Cold pressor | As experiment 1 | Runners reported very cold, moderate and faint pain later than controls ($p < 0.02$) |
| Tajet-Foxell and Rose (1995) | 26 male dancers 26 female dancers 27 male non-dancers 26 female non-dancers | Cold pressor [temperature not stated, circulation not stated] | VAS (0 – no pain, 2 = moderate pain, 3 = severe pain) SFMPQ (0 – no pain, 2 = moderate pain, 3 = severe pain) | Dancers perceived pain to be more intense than non-dancers ($p = 0.001$, $d = 0.37$) |

| | | | | |
|------------------------------|---|---|---|---|
| Sternberg et al. (1998) | 33 female and 34 male athletes 14 female and 6 male non-athletes | Cold pressor [0-2 °C, circulation not stated] | Gracely Box Scale (0 = no pain, 20 = intense pain) | No significant differences |
| Sullivan et al. (2000) | 26 male athletes 28 female athletes 27 male sedentary individuals 27 female sedentary individuals | Cold pressor [2-4°C, circulation not stated] | Verbal pain intensity measure (0 = no pain, 10 = extreme pain) | Pain was less intense for athletes (p <0.001) |
| Manning and Fillingim (2002) | 12 male athletes 12 female athletes 12 male non-athletes 12 female non-athletes | Pressure Ischemic Cold pressor [1°C, constantly circulated] | VAS measuring intensity and unpleasantness, anchors not stated. | Athletes rated pain as less unpleasant than non-athletes (interview) |
| Straub et al. (2003) | 83 male athletes 25 female athletes Divided into 49 contact and 59 non-contact participants (not clearly stated whom) | None used | Pain Apperception Test (1= no pain, 7 = cannot stand the pain) | Females had lower apperception than males (p <0.001, $\eta^2 = 0.267$) Contact athletes had lower apperception than non-contact athletes (p <0.017, $\eta^2 = 0.23$) |
| Paparizos et al. (2005) | 25 female high skilled dancers 22 female low skilled dancers 26 female non-dancers | Cold pressor [1-3°C, circulation not stated] | SFMPQ (0 – no pain, 2 = moderate pain, 3 = severe pain) NRS (0 = no pain, 10 = extreme pain) | No significant differences |
| Monnier-Benoit et al. (2006) | 10 male cyclists | Pressure | Borg Scale (0 = no pain, >10 = highest pain possible) | No differences in pain perception between groups |

| | | | | |
|--------------------------|---|--|--|---|
| | 10 sedentary males | | | pre-exercise and post exercise ($p = 0.94$, $ES = .02$) |
| Raudenbush et al. (2012) | 54 male lacrosse players (contact athletes) 24 male track athletes (non-contact athletes) 51 male soccer players (contact athletes) 30 male basketball players (non-contact athletes) 24 male swimmers (non-contact athletes) | Cold pressor [3 °C, constantly circulated] | Likert Scale (0 = no pain, 10 = pain is no longer tolerable) | Lacrosse players perceived pain significantly less intense compared to other groups ($p < 0.05$). |
| Geva and Defrin (2013) | 19 triathletes 17 non-athletes | Heat (cold pain modulation used) | VAS (0 = no pain sensation, 10 = most intense pain sensation imaginable) | Triathletes perceived pain significantly less intense than non-athletes ($p < 0.05$) |
| Tesarz et al. (2013) | 25 male endurance athletes 26 normally active controls | Heat, vibration, mechanical pain (weighted pin-prick and blunt pressure) (cold pain modulation used) | Pain Experience Scale (sensory and affective dimensions, 1 = applicable, 4 = not applicable) | No significant differences |
| Freund et al. (2013) | 11 male ultra-marathon runners 11 male normally active matched controls | Cold | NRS-11 scale (0 = no pain, 10 = worst pain imaginable) | Ultra-marathon runners perceived pain significantly less intense than controls ($p < 0.05$) |

The research into pain perception has been equivocal, however where athletes have reported pain as less intense than non-athletes effect sizes have typically been large (Hall & Davies, 1991). In the one study to find the opposite, the effect size was small (Tajet-Foxell & Rose, 1995). Therefore, whilst it is difficult to draw a clear conclusion about pain perception, there does appear to be some evidence that athletes perceive pain as less intense than non-athletes.

Pain and performance.

There is a paucity of research focusing on how pain affects performance in motor tasks using athletes as participants. This is surprising, since understanding how pain might have an influence on performance is important for athletes who experience pain regularly. To date only one study has examined the role that pain plays when a motor task is executed in laboratory conditions using athletes as participants (Walker, 1971; see Table 1.4).

It is generally accepted that pain demands attention (Eccleston & Crombez, 1999) and as such performance can be impaired when pain is present, however this is dependent upon task complexity: Evans and McGlashan (1967) employed a relatively simple task where participants pumped a rubber bulb to displace water whilst experiencing ischemic pain. Results demonstrated that participants exerted more effort when in pain and that they performed better in pain. In this study, the task may not have been complex enough to elicit any performance decrements due to pain and as such, participants may have been able to attend to both the pain and the task itself. To examine this, Brewer et al. (1990) measured the effects of pressure pain on performance of three tasks of varying complexity. Results demonstrated that a simple bench press task was not hampered by pain but more complex golf putting tasks were hampered by pain. The authors suggested that the complex task demanded more attention and because pain also demands attention, resources were stretched resulting in poor performance.

In the only published study to use athletic participants, Walker (1971) used 24 female basketball players and a control group of non-athletes. Electrical pain was induced while the participants performed a neuromuscular task, which required them to hold a stylus in progressively smaller holes without touching the sides. This task was relatively complex and required constant attention to execute very fine motor skills. Results showed that pain had a detrimental effect on performance of the motor task in both groups. This indicates that pain can affect how a task is performed, which has implications for sports performance where pain is often a common occurrence. There were no differences between athletes and non-athletes in this study, indicating that athletic status does not alter performance whilst in pain.

In a recent study, currently in preparation for publication, Sheffield, Thornton and Jones (2017), reported that high contact athletes performed better in pain compared to low contact athletes and non-athlete controls. Participants completed a motor task that involved throwing tennis balls at sequentially numbered targets on a wall. The complexity of the task was increased by adding in extra targets that were not to be attended to. Results indicated that high contact athletes performed better in pain than the other groups. They also were not hampered by pain and performed better in pain on the hard task. This indicates that the amount of contact experienced in sport may moderate performance in pain.

Table 1.4

Summary of Studies Examining Pain and Performance

| Author | Participants | Pain stimuli | Task(s) | Results Performance | Other results |
|----------------------------|--|---------------------|---|--|---|
| Evans and McGlashan (1967) | 24 students, assumed male, athletic status not specified | Ischemic | Rubber bulb pumped in time to a metronome to displace water. | Rate of work (cubic centimetres/sec) between threshold and tolerance increased compared to before threshold ($p < 0.05$) | |
| Walker (1971) | 24 female basketball players 24 female non-athletes | Electrical | Hole-Type Steadiness Tester for preferred and non-preferred hands | Performance in pain was significantly worse for both groups ($p = 0.01$, $F = 11.94$ for preferred arm and $p = 0.02$, $F = 6.29$ for non-preferred arm) | |
| Brewer et al. (1990) | 54 male students, athletic status not specified (18 per group, between subjects) | Gross pressure | 22.68 kg bench press for 75s at 0%, 30% or 60% tolerance. Maximal exertion. | Performance differences according to intensity of pain stimulus approached significance ($p = 0.06$). Performance in pain resembled an inverted U according to pain intensity – highest no. bench presses were in 30% group ($p < 0.02$, post hoc) | Pain ratings showed that intensities were significantly different ($p < 0.001$) |

| | | | | |
|---|----------------|---|---|---|
| 30 male students, athletic status not specified (within subjects) | Gross pressure | 2m simple golf putt (3 trials of 10) at 0%, 25% or 75% tolerance | Performance was better (putts made) in 0% condition compared 75% condition (p <0.01, d = 1.70) | Pain ratings showed that intensities were significantly different (p <0.001) |
| 24 male students (within subjects) | Gross pressure | 1.8-2.23m complex golf putt (3 trials of 5) at 0%, 25% or 75% tolerance | <p>Performance was better (putts made) in 0% condition compared to 75% condition (p <0.05, d = 1.3). Number of putts made in 0% condition compared to 25% condition approached significance (p <0.06, d = 0.97) – 0% better than 25%.</p> <p>Distance from hole was significantly better in 0% condition compared to 25% (p <0.05, d = 0.3) and 75% condition (p <0.005, d = 1.61). No difference between 25% and 75% conditions.</p> | Pain ratings showed that intensities were significantly different (p <0.0005) |
| | | | <u>Overall</u> | |
| | | | Pain adversely affected performance. 75% intensity condition - complex golf task saw 30% decrease in putts made and 41% increase in distance from hole compared to simple golf task which saw 15% | |

| | | | | |
|--|--|--|---|---|
| Sheffield et al. (2017, in preparation). | 25 high contact athletes 25 low contact athletes 21 non-athlete controls | Cold pressor, constantly circulated, 3°C | Target based motor task (easy and hard). Measured in terms of time to complete the task and number of targets hit. Cognitive task (easy and hard). Measured in terms of time to complete the task. | decrease in putts made and 17% increase in distance from hole High contact athletes performed better in pain compared to low contact athletes ($p = 0.005$, $\eta^2 = 0.17$) and the control group ($p = 0.002$, $\eta^2 = 0.19$) High contact athletes performed better at the hard motor task when in pain compared to when not in pain and maintained performance in pain in other tasks ($p = 0.001$, $\eta^2 = 0.18$) Low contact athletes and control group performed worse in pain than when not in pain ($p < 0.001$) |
|--|--|--|---|---|

Whilst results obtained by Brewer et al. (1990) suggest that pain is detrimental to performance of complex tasks, this study did not use athletes as participants. When athletes were examined, Sheffield et al. (2017) found that high contact athletes maintained performance in pain and performed better in pain compared to low contact athletes and non-athletes. The effect of pain on motor task performance in different athlete groups therefore warrants further attention. More research is needed to establish what effect pain has on performance and if athletes perform differently in pain compared to other populations.

Limitations

The standard of studies that have examined differences in pain reporting in athletes and non-athletes is variable and there are some methodological concerns. Some studies carry a risk of bias in terms of sampling methods and pain assessment methods used (Tesarz et al., 2012). Perhaps the most important consideration in pain research is that of the pain stimulus used. Often pain studies lack ecological validity and therefore it is questionable whether the results are readily translated to the real world of sports (Addison et al., 1998). In laboratory studies, participants are aware that the pain induction technique is safe and can be stopped at any time, unlike pain felt while playing sports (Pen & Fisher, 1994). Therefore, when tolerance is measured, athletes are aware that the pain will not cause any long-term damage; this is very different to pain experienced during sport where pain may not be as benign. For example, Ellison and Freischlag (1975) used a simple finger flexion test to measure pain tolerance. The authors acknowledged that this test bears no resemblance to pain felt in sports. However, despite this, such studies provide a valuable insight into reactions to pain, which would be difficult to measure during actual sports participation.

Protocols in pain research are often poorly described and are variable in quality. For example, where cold pain was induced the temperature of the water was frequently not stated, nor was circulation of the water mentioned (Jaremko et al., 1981; Janal et al., 1994; Tajet-Foxell & Rose, 1995). This is a potential confound and a common problem with studies using the cold pressor test because warming round the submerged appendage can occur (Mitchell et al., 2004).

Some of the protocols used suffer from ceiling effects when pain tolerance is measured. Egan (1987), for example, found that over 50% of participants were able to reach the 12-minute ceiling time for the cold pressor test, which raises questions about differences observed between groups. In contrast, some studies have used much shorter ceiling times for the cold pressor test. Janal et al. (1994) used a ceiling time of just three minutes and found no differences

between athletes and non-athletes. It could be argued that differences may have been found if participants were able to continue the task for longer. In addition, the experimenters also used quite general terms to label participants pain tolerant or pain sensitive, based on whether they withdrew before three minutes or whether they reached the ceiling time. The difference between a pain sensitive individual and a pain tolerant person could therefore be reduced to a matter of seconds.

Pain perception measures have varied in their use and quality. Many authors have used scales such as VAS to measure pain intensity (e.g. Tajet-Foxell & Rose, 1995), whereas others have used measures such as the Borg scale (Monnier-Benoit et al., 2006). On occasions the descriptions of the scales used are vague and there is no indication of the anchors used (e.g. Manning & Fillingim, 2002). In addition, Hall and Davies (1991) recommended that pain affect and intensity should be measured due to difficulties participants may encounter when attempting to quantify their pain experiences. Very few studies have examined perception in these terms, and as such, the measures obtained may not be an accurate reflection of how the participants felt about the pain.

In other studies descriptions of athletes are vague; for example, Granges and Littlejohn (1993) assumed fitness levels of participants according to attendance in fitness classes to assign them to a “fit” or “unfit” group without formally assessing fitness levels. In addition, definitions of athlete sub-groups have sometimes been unclear. Straub et al. (2003) for example used a pain apperception test to assess responses to various painful situations in contact and non-contact athletes; however, it was not clear in this study what constituted a contact athlete. In addition, Monnier-Benoit et al. (2006) did not specify the criteria used to define a participant as sedentary in their study that focused on fitness levels. A further issue with this particular study was the pain stimulus that had clear floor effects. Pressure was induced on the finger and it was noted that some participants may not have registered enough pain to be able to report it accurately.

Finally, sample sizes in some studies have been small. Egan (1987), for example, used only 10 participants per group when comparing athletes from different sports. Small sample sizes such as this greatly increase the risk of committing a type II error and therefore finding no group differences (Clark-Carter, 2008). Manning and Fillingim (2002) reported a large effect size for some differences they observed, but a relatively small sample size meant that differences were not statistically significant.

Mechanisms

Relatively little is known about the mechanisms behind the potential differences between athletes and non-athletes pain responses. There is a great deal of speculation about why differences may be present, but very few studies have actually attempted to objectively measure or account for possible mechanisms. There are at least three possible explanations for differences in pain reporting between athletes and non-athletes: Individual differences, learning to cope with pain and attrition. In the next section studies are discussed where mechanisms were directly tested or measured, rather than those that have been merely suggested.

Individual differences.

In 1966 Ryan and Kovacic raised the question of cause and effect; that is, does playing sports raise pain tolerance or do people with higher pain tolerance choose to play sports? An individual differences approach suggests that athletes and non-athletes are somehow different from one another at the outset, meaning that athletes may naturally be more tolerant to pain or more willing and able to deal with it than non-athletes (Manning & Fillingim, 2002). Little attention has been given to this notion. There has been speculation regarding physical or biological differences that may exist between athletes and non-athletes (e.g. Manning & Fillingim). However, these factors have yet to be explored empirically and remain tentative at best. However, a small number of studies have attempted to measure this.

Anshel and Russell (1994) suggested that aerobic fitness may moderate pain tolerance. They assigned 48 unfit males to one of four conditions: aerobic training; strength training; aerobic and strength training combined; and a no training control group. Results showed that after 12 weeks of training, the aerobic training group exhibited increased pain tolerance compared to baseline. This suggests that regular exercise and aerobic fitness may influence tolerance to pain. Pain tolerance may therefore be a function of duration of pain rather than intensity, meaning that athletes who have experienced pain for long durations (for example long-distance runners) may appraise laboratory pain differently to those who experience only short bursts of pain (for example a weightlifter). Differences observed in experimental pain tolerance may be due to the higher fitness levels of the athletes compared to non-athletes and whether any previous pain experienced was acute or chronic. Exercise is also known to have a hypoalgesic effect on pain (Ugurlu et al., 2014). In a study examining the effects of eccentric exercise on pain threshold and tolerance, Ugurlu et al. reported that eccentric exercise increased pain tolerance and threshold in athletes up to 48 hours post activity. It is not known how long the effects of exercise may last, but it is likely that in experimental studies, athletes may have exercised within 48 hours of the pain stimulus being applied.

Furthermore, Hoffman, Lee, Zhao and Tsodikov (2007) measured pain perception in ultra-marathon runners and a normally active control group pre and post a 100 mile ultra-race. Up to 2 hours after the race, faster runners had reduced pain perception compared to pre-race, whereas the slower runners and control group did not change. This lends support to the idea of exercise induced analgesia, and indicates that intensity or duration of exercise may moderate this effect. It should be noted however that the results may simply be a function of slower runners not exercising hard enough during the latter stages of the race to produce an analgesic effect.

More recent work focusing on endurance athletes supports the notion that participation in endurance activities can moderate pain modulation and pain responses through enhanced endogenous pain inhibition (Geva & Defrin 2013). In a study examining pain modulation in endurance athletes, Scheef et al. (2012) used neuroimaging and biochemical data to determine that running for two hours had a modulatory effect on pain processing and resulted in lower pain ratings when compared to a walking condition. In addition, Geva and Defrin found that triathletes had higher pain tolerance and increased pain modulation compared to a normally active control group. Therefore, increased pain modulation may be a combination of exposure to chronic, exhausting training, less fear of pain and unique traits.

Psychological individual differences in pain responses may also be responsible for variances in pain reporting between athletes and non-athletes, but this is relatively unexplored. Researchers have attempted to examine personality differences between athletes and non-athletes as well as athletes from different types of sport (Allen, Greenlees & Jones, 2013). Research demonstrates that team based athletes have higher extraversion and lower conscientiousness than individual athletes (Allen, Greenlees & Jones, 2011). In addition, high risk takers in sport are also more extraverted and less conscientious than those who take fewer risks (Castanier, LeScanff & Woodman, 2010). These findings suggest that the personality traits of extraversion and conscientiousness may be moderating factors in sport choice, though they cannot explain variances in pain reporting. In non-athletic studies, however certain personality traits such as neuroticism have been linked to lower pain tolerance (e.g. Boggero, Smart, Kniffin & Walker, 2014).

Linked to risk-taking behaviour, Schroth (1995) examined sensation seeking amongst contact athletes and non-contact athletes. Results showed that male and female contact athletes demonstrated higher sensation seeking scores than male and female non-contact athletes. Castanier et al. (2010) made the link between risk taking and sensation seeking, stating that sensation seeking is often a means of regulating arousal levels and fulfils the need for

stimulation. Therefore, if contact athletes are sensation seekers, they may have similar characteristics to risk-taking athletes. Taken together, these findings suggest that athletes who engage in contact sports may have different characteristics to those who participate in non-contact, less risky activities.

In research that has specifically addressed pain, Tajet-Foxell and Rose (1995) measured personality alongside pain coping responses in dancers. They found that whilst dancers and non-dancers were not different from one another on introversion and extraversion scales, dancers had higher scores for neuroticism. Dancers also experienced pain more acutely than non-dancers but paradoxically were more willing to tolerate it, echoing results found by Pappas et al. (2005). This interaction between pain tolerance and pain perception suggests that dancers in this case may be more motivated to continue in pain and more willing to tolerate it, despite feeling it more intensely than non-dancers.

Raudenbush et al. (2012) measured aggression and competitiveness alongside pain tolerance in contact and non-contact athletes. They found that contact athletes (lacrosse players) were significantly more physically and verbally aggressive than non-contact athletes. However, there was no effect of aggressiveness and competitiveness on pain tolerance and threshold measures. Therefore, motivation and personality may mediate pain tolerance levels; however this explanation requires further investigation.

There has been some support for individual differences accounting for variations in pain reporting between athletes and non-athletes. Indeed, as none of the speculated differences have been tested satisfactorily, it is not possible to disregard this mechanism. As such, more research should be conducted to examine the personality differences between contact and non-contact athletes. This would clarify whether contact athletes are fundamentally different to non-contact athletes when they decide to engage in painful sports. Qualitative research could be carried out to explore how contact and non-contact athletes perceive themselves. Questions regarding physical and personality characteristics could be posed to determine if athletes view themselves as possessing unique traits required for their sports. Questionnaire-based studies could be conducted to examine personality differences between contact and non-contact athletes. In addition, research also could be carried out to determine if contact athletes become different to non-contact athletes as a result of playing painful sports. As such, longitudinal studies are required to examine whether participation in contact sports changes athletes over time.

Learning to cope with pain.

Learning to cope with pain as a potential mechanism has received the most attention in the literature. Athletes may learn more about pain via experience than non-athletes and therefore may evaluate it more realistically. As a result, athletes can understand what pain means to them, when to expect it and they may have developed effective coping strategies to deal with it (Ryan & Kovacic, 1966).

Self-efficacy has also been shown to mediate pain coping behaviours (Pen & Fisher, 1994; Baker & Kirsch, 1991). Pain-related self-efficacy is a predictor of future pain tolerance in non-sports related literature (e.g. Williams & Kinney, 1991). In sports settings, Weinberg, Gould, Yukelson and Jackson (1981) employed a leg extension task using participants who were previously identified as having either high or low self-efficacy regarding leg strength performance. Self-efficacy was manipulated by informing participants that they were to compete whilst doing the task, either against a varsity athlete who declared they were confident of winning (low self-efficacy condition), or an injured person who stated that they were not confident of winning (high self-efficacy condition). Results showed that those in the high self-efficacy condition with high pre-existing self-efficacy were able to keep their legs extended for longer than those with low self-efficacy. Participants with high self-efficacy also believed that they could keep their leg extended for longer than those with low pre-existing self-efficacy. The researchers concluded that self-efficacy can be modified with information about performance accomplishments. Therefore, if athletes learn to cope with pain involved with exertion, self-efficacy can be increased, which may in turn, enhance their ability to cope with pain.

Coping strategies.

Athletes use more mental strategies when coping with pain compared to non-athletes (Ord & Gijbers, 2003). Ord and Gijbers found that 16 of 20 trained rowers used coping strategies whilst in pain, while only 6 of 20 non-trained rowers did. A positive correlation was emerged between the number of pain coping strategies used and pain tolerance. The researchers also rated the quality of coping strategies and found that this was also positively correlated with pain tolerance. The trained rowers reported that they used the pain coping strategies during training as well as in competition, whereas the non-trained rowers did not. The trained rowers therefore had more experience of using these approaches that could have influenced pain tolerance.

Manning and Fillingim (2002) also assessed the use of coping strategies while in pain. They found that athletes used a competitive coping strategy and in some cases tried to “beat

the tests” when experiencing experimental pain. The athletes used coping self-statements during pain, felt more confident about controlling pain than non-athletes, and participants who demonstrated higher pain tolerance reported using a coping strategy. Jaremko et al. (1981) instructed participants to use a coping strategy in their study. They found that female athletes were able to use the coping strategy the most effectively, and they demonstrated higher pain tolerance than the other participants.

Many athletes, especially at elite level may have worked with a sports psychologist before and therefore may already use coping strategies to deal with pain in laboratory settings (DeRoche et al., 2011). Many coping strategies have been shown to help athletes to deal with painful situations. Driediger, Hall and Callow (2006) found that imagery was a useful method for injured athletes to use when undergoing rehabilitation. In particular, imagery helped athletes block out pain and served as a motivational tool. Whitmarsh and Alderman (1993), Ross and Berger (1996) and Naoi and Ostrow (2008) all reported that stress inoculation training (SIT) increased pain tolerance in athletes. In addition, Broucek, Bartholomew, Landers and Linder (1993) found that progressive relaxation increased pain tolerance in athletes. If athletes are already familiar with these techniques, they may employ these strategies either consciously or unconsciously in laboratory settings.

In addition to coping strategies, coping styles may also account for differences in pain tolerance. Direct coping as measured by the Sports Inventory for Pain (SIP15, Bourgeois, Meyers & LeUnes, 2009) reflects a tendency for athletes to view pain as necessary and something to be endured. Direct coping has been linked to mental toughness and resilience (Levy, Polman, Clough, Marchant & Earle, 2006) and is positively correlated with challenge states (Kopka-McDowell & LaChappelle, 2005). To date, no studies have examined direct coping as a mechanism for increases in pain tolerance, however Crust and Clough (2005) correlated mental toughness with physical endurance (which is linked to exertion related pain) by asking participants to suspend a weight from their arm for as long as possible. Participants with high mental toughness could endure the task longer than those with lower mental toughness. If direct coping is linked to mental toughness, it is suggested that direct coping would influence pain tolerance in the same way.

Catastrophizing.

Catastrophizing is a predictor of pain in both athletes and non-athletes (Olmedilla, Ortega, Boladeras, Abenza & Esparza, 2008). Catastrophizing refers to a negative and exaggerated perception of pain (Sullivan, Bishop & Pivik, 1995). Individuals who catastrophize direct more attention towards pain, report more severe pain and are less able to

use coping strategies (Sullivan et al.). This is important for performance, particularly in contact or endurance sports where pain is an integral part of participation.

Paparizos et al. (2005) measured catastrophizing behaviour in dancers and found that magnification of pain sensation was a significant predictor of pain in dancers. In non-dancers, helplessness and total catastrophizing were significant correlates and predictors of pain. Overall catastrophizing was a significant predictor of pain in non-dancers but not in dancers. Anderson and Hanrahan (2008) also examined dancers and found that the appraisal of pain as threatening predicted avoidance and catastrophizing coping styles. In one of the few studies to examine fear of pain and catastrophizing in laboratory settings, Geva and Defrin (2013) used triathletes and normally active controls during experimental pain modulation. Results indicated that the triathletes exhibited significantly less fear of pain and catastrophized about it less than the control group.

Fear of pain is an important factor in understanding pain related behaviours. Fear avoidance in chronic pain patients can result in individuals avoiding certain movements that are deemed to exacerbate pain (Crombez, Eccleston, Van Damme, Vlaeyen & Karoly, 2012). Individuals with a high fear of pain may report feeling more depressed, exhibit avoidance behaviours, catastrophize more and show poor physical functioning (Crombez, Vlaeyen, Heuts & Lysens, 1999). Indeed, fear of pain can be just as disabling as pain itself, particularly in chronic pain patients (Crombez et al., 1999). Athletes who suffer with long-term sports injuries may also exhibit pain related fear regarding returning to play which may result in them ceasing sports participation (Tripp, Stanish, Ebel-Lam, Brewer & Birchard, 2007). Athletes who fear sports related pain may therefore not engage in activities where pain is likely or may disengage from said activities.

Appraisal of pain.

Appraisal of pain may alter pain tolerance; for example, athletes who have regular exposure to pain, may appraise pain in a different way to non-athletes who have not experienced a great deal of pain (Ryan & Kovacic, 1966). Using interviews, Manning and Fillingim (2002) found that athletes defined pain differently to non-athletes. Athletes described pain as something to be overcome, whereas non-athletes were threatened by pain and defined it as a warning or a signal to stop: Manning and Fillingim suggested that this may alter tolerance to pain. Indeed, Unruh and Ritchie (1998) and Kopka-McDowell and LaChapelle (2005) both examined how pain was appraised in athletes and non-athletes. Results indicated that athletes tended to appraise pain as more of a challenge than a threat when compared to non-athlete groups, and that contact sport athletes appraised pain as more of a challenge than a threat when

compared to non-contact athletes. Kress and Statler (2007) also reported that cyclists perceived exertion pain as a positive challenge. They stated that cyclists thought that pain was part of the sport, was expected and because they knew it was finite they were able to cope with it and accept it.

Ryan and Kovacic (1966) suggested that athletes may be reducers and non-athletes augmenters for pain perception. Reducers typically diminish incoming stimuli (e.g. pain), whereas augmenters increase the intensity of the stimuli. Ryan and Foster (1967) tested this theory using contact and non-contact athletes and non-athletes who completed a simple augmentation/reduction test protocol using wooden blocks. Participants held a wedge shaped wooden bar in one hand and a standard width bar in the other. They were blindfolded and asked to move their hand along the wedge shaped bar until they believed that it was the same width as the standard bar. Results showed that contact athletes had the highest pain tolerance and non-athletes the lowest. In addition, whilst in pain, the contact athletes reduced their perception of the stimulation whereas the non-contact athletes enlarged their judgement of the width of the block. Augmenters have been shown to increase the intensity of their perceptions and therefore would report more pain (Ryan and Kovacic). Ellison and Freischlag (1975) found evidence for this notion when they reported that track distance runners and football linemen and backs exhibited the highest pain tolerance compared to other athletes. The athletes performed a muscular endurance pain task and those with the highest tolerance were found to underestimate the duration.

Experience and injuries.

Experience of pain may alter behaviour towards it in terms of perceptions of pain intensity. That is, regular exposure to pain may desensitise athletes to it. It also may alter cognitions regarding interpretation of pain. Wandner, Devlin and Chrisler (2011) questioned athletes with different amounts of experience. They found that athletes who had played their sport for more than ten years appraised pain more sympathetically and realistically than those who had played sport for less than five years. Griffith, Hart, Goodling, Kessler, and Whitmire (2006) reported similar results with BASE (buildings, antennas, spans and edges) jumpers. Likewise, Pappas et al. (2005) found that less experienced dancers catastrophized about pain more than those with over ten years' experience, indicating that length of time spent in a sport may have an effect on pain perception and coping. However, in an earlier study, Encarnacion, Meyers, Ryan and Pease (2000) found no significant differences in pain coping styles between professional, pre-professional and academy level dancers. In this study however, ballet dancers were allowed to self-assess their ability, meaning that they may have under or over-estimated

their skill level; a potential confound resulting in athletes placing themselves in the wrong group.

Athletes who have regularly experienced pain may not view it as a threat (Raudenbush et al., 2012). In their study, Raudenbush et al. correlated average pain ratings for past injuries with the amount of pain required before the athlete was willing to stop playing or practising their sport. Results showed that those with higher pain ratings for past injuries were more willing to play and practice whilst in pain. The authors also compared athletes with an injury history to those without and found that those with a history of injury were more willing to accept higher levels of pain before stopping playing or practising their sport. This indicates that willingness to tolerate pain is mediated by previous injuries. Therefore, in experimental studies athletes from contact sports and those with a history of injuries may be more willing to tolerate pain than those who have little experience of being injured.

In addition, Manning and Fillingim (2002) found that cold and ischemic pain tolerances were positively correlated with the number of injuries an athlete suffered. They suggested that this supports Rollman's (1979) adaptation level theory, which states that experimental pain is evaluated in terms of previous experience of pain. It seems plausible that someone who has experienced a great deal of pain in sport may evaluate laboratory based pain differently to someone who has limited experience of pain. As such, athletes who have not been exposed to a lot of pain may feel uncertain about experimental pain and therefore may not tolerate it for as long.

Experience and recall of pain may also influence responses to experimental pain. Babel (2016) reported that marathon runners underestimated both the intensity and unpleasantness of pain six months after they completed a marathon compared to their ratings immediately after completing the race. This suggests that positive, happy events (i.e. completing a marathon) may influence how someone recalls the intensity of pain later on. Individuals who underestimate the intensity and unpleasantness of prior pain may therefore continue to engage in painful activities. This may then influence the choice to participate in pain research and also painful sports.

Social and cultural influences.

Athletes may have different views of pain due to social and cultural experiences in their sport. Much sociological research has focused on the culture of "playing hurt" and of "toughing it out" in sports (e.g. Paparizos et al., 2005; Liston et al., 2006; Bird, 2011). Bird, for example, interviewed female football players and found that there was a culture of risk taking and playing with injury. Players said they did not want to let team mates down by not playing and saw

injury and pain as an occupational hazard. Malcolm and Sheard (2002) stated that in rugby, playing with injuries has become normalised and that pain is an integral aspect to the sport and something that is accepted. Likewise, Liston et al. reported that in rugby at both elite and amateur level, there is an ethos of continuing to play despite being in pain. This could mean that athletes are less willing to report pain during experimental research. This culture seems to pervade male and female sport at all levels (Bird) and in experimental settings this mind-set may remain.

Furthermore, athletes may normalise pain and be more motivated to accept it (Nixon, 1992). Nixon suggested that through sporting sub-cultures athletes may rationalise risks in sport and accept pain as part of the game. As a result of this, athletes accept pain and may feel obliged to withstand it. Nixon also suggested that in some cases coaches may reinforce the need to play hurt which can make athletes feel powerless. When pain is induced experimentally athletes may continue to feel this way and therefore are willing to tolerate pain for longer. Weinberg, Vernau and Horn (2013) found that willingness to play through pain, and a positive attitude towards injury was predicted by high athletic identity. High athletic identity has been linked to risk taking behaviours in sports, where athletes will continue to play despite injury due to fears of losing a place on the team, feeling alienated or the need to demonstrate masculinity (Gard & Meyenn, 2000). Therefore, it is possible that athletes with this disposition may be willing to endure more pain in experimental settings.

This mechanism has received the most attention, however further research is needed to examine some of the key aspects of learning. Specifically, appraisal of pain as a challenge or threat warrants further attention. Studies should examine cognitive appraisal in pain using contact and non-contact athletes. This research could go further and examine the impact that this has on performance. This is a fundamental question to answer and may provide insight into how contact athletes are able to maintain performance in painful situations. In addition, coping strategies appear to be important in how contact athletes approach pain. Research should aim to examine coping styles in different athlete groups in a range of settings. Quantitative research could examine how coping strategies are used during both experimental pain and sports related pain in the field. Qualitative research could explore how contact athletes in particular cope with painful situations. Finally, experience of pain also should be examined. Longitudinal studies could measure changes in pain reporting over an athletic season. All studies discussed above have been cross sectional in nature and therefore provide only a brief insight into how athletes experience pain. Measuring pain reporting over a season would help to establish whether pain responses change over time and whether learning takes place.

Attrition/Selection.

People who are more sensitive to pain, find it more unpleasant or have low pain thresholds may be more likely to avoid or discontinue painful activities such as sport (Manning & Fillingim, 2002). It has been suggested that those with an inability to disengage from pain may suffer from heightened anxiety and therefore may exhibit avoidance behaviour in relation to potentially painful situations (Bardel, Woodman, Perreaut-Pierre & Barizien, 2013). Therefore, when athlete groups are measured in the laboratory, we may only be measuring those people who have been willing to experience pain regularly, thus ignoring those who are not. In addition, athletes may be more willing to volunteer for pain based research and may want to learn about their pain tolerance. Consequently, any differences observed between athletes and non-athletes may be magnified.

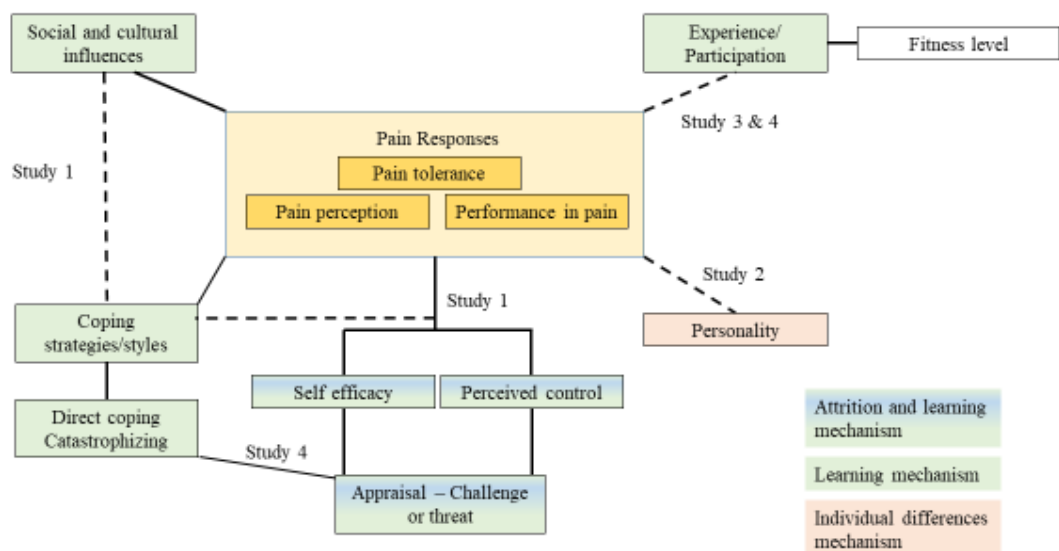
Indeed, Pen and Fisher (1994) stated that pain-related self-efficacy may predict whether someone approaches or avoids certain situations. For example, ignoring pain allows athletes to continue enduring it and to continue playing their sport, whereas catastrophizing behaviour has been reported to reduce involvement in sport (DeRoche et al., 2011). Accordingly, athletes may drop out of sport if they are not able to ignore pain, catastrophize about it or have low pain related self-efficacy. This theory has received little attention however, and there is scant evidence for this in the literature. In non-sports related research, findings have been a little more conclusive regarding mechanisms behind differences in pain responses. One such suggestion is that self-efficacy may mediate pain reports (Williams & Kinney, 1991). That is, those with higher pain coping self-efficacy may be more able to withstand pain than those low in self-efficacy. Individuals with low self-efficacy may drop out of sports as a result. As self-efficacy is developed through performance accomplishments (Bandura, 1977), this provides support for the proposed attrition and learning mechanisms, i.e. those who have successfully overcome pain in the past are more willing to tolerate it in lab settings.

In summary, whilst it is clear that athletes and non-athletes differ in their responses to pain, little attention has been given to the reasons behind these differences. Longitudinal studies should be conducted to establish how and why athletes adhere to or disengage from contact sports. This would aid in understanding why some athletes thrive in painful sports and others avoid them. Qualitative research could explore the reasons for non-participation in contact sports by interviewing athletes who do not engage in such activities. In addition, discourse with athletes who choose to participate in contact sports may provide an insight into their decision to put themselves in harm's way regularly.

In conclusion, the proposed mechanism of learning to cope with pain has received the most attention and appears to be a promising suggestion. Whether individual differences or attrition are responsible, at least in part, remains to be determined. Figure 1.1 illustrates a proposed model to explain the factors that may be related to pain responses. Solid lines indicate strong paths where evidence exists for relationships and interactions, dotted lines indicate paths that require more research or confirmation. To summarise, there is some evidence that learning and experience may influence pain responses. There is strong evidence that the social and cultural environment may cause athletes to under report pain or play while hurt (Liston et al., 2006). There is also evidence that coping styles, and in particular having a direct coping style can result in the willingness to partake in painful activities and view pain as a challenge (Kopka-McDowell & LaChapelle, 2005). Coping styles may be influenced by the environment or vice versa. In addition, linked to the attrition and the learning mechanism, there is evidence that high pain related self-efficacy can result in increased pain tolerance and this is linked to perceived control and challenge and threat perceptions (Williams & Kinney, 1991). Personality traits such as high neuroticism have been linked to reduced pain tolerance and heightened perceptions of pain, but this has not been examined widely in sport (Tajet-Foxell & Rose, 1995).

Figure 1.1

Model Showing the Mechanisms and their Proposed Inter-relationships



This thesis will examine the learning, attrition and individual differences mechanisms in the studies highlighted in fig. 1.1. This will address some of the key questions that remain to be answered regarding pain responses in athletes. Specifically, it is not known how athletes from a range of sports experience pain, how this may differ according to pain source and whether there are differences between athletes according to the amount of contact they experience. This will be examined in study one. It is also not clear how coping styles may differ among athlete groups and whether this changes according to the amount of contact experienced in sport; this will be examined in studies two, three and four. There is also some limited evidence that personality traits may influence pain reports, and this is examined in study two. If high contact athletes respond differently to pain than other groups, it is also important to understand how these differences develop and evolve. As such, in study three pain responses such as pain tolerance and coping styles will be examined longitudinally to understand how these may change over time. Finally, there is a paucity of research examining how pain may influence performance of motor tasks. In study four this is examined alongside manipulations of challenge and threat states to examine the role of cognitive appraisal during painful tasks. This should provide some insight into how pain impacts performance.

Future Directions and Implications

There is clearly a need to investigate the mechanisms behind the differences in pain response between athletes and non-athletes, and within intra-athlete groups. The only mechanism that has received much attention is that of learning to cope with pain. To examine this authors have focused on the use of mental strategies, appraisal of pain, experience of pain, injury and social and cultural influences on pain reporting. However, these studies have been cross-sectional so the process of learning has not been investigated; longitudinal studies are therefore needed.

The individual differences and attrition mechanisms require further investigation. For example, physiological reasons for differences between athletes and non-athletes are wholly speculative. Manning and Fillingim (2002) and more recently Geva and Defrin (2013) have suggested that nociceptive pathways may be altered as a result of exercise and this may alter perception of pain. However, this remains to be tested fully. Likewise, it has been suggested that personality may account for willingness to tolerate pain (e.g. Tjelt-Foxell & Rose, 1995); however this has not been explored in detail nor measured since. More psycho-physiological approaches should be used to assess both the mental and physical aspects of pain tolerance and perception.

In addition, researchers have not directly investigated the proposed mechanism of attrition. It is a difficult concept to measure but there are a number of ways it could be explored: Qualitative methods could be used to establish reasons for participation or non-participation in contact sports. This could provide an insight into the reasons why athletes choose certain sports and avoid others, and how motivation and persistence at high risk, painful activities is maintained. It could also explain why some people choose not to engage in sports or drop out. In addition, attentional processes suggested by Bardel et al. (2013) warrant further exploration. Namely, it would be worthwhile investigating attentional processes when in pain, not only in those who already engage in sports but also those who have avoided participating in sports.

The methods employed when investigating pain in athletes and non-athletes need to be considered in future studies. More needs to be done to examine the effects of pain on sports task performance using more ecologically valid methods: for example, it would be useful to examine ischemic pain stimuli and delayed onset muscle soreness (Dannecker & Sluka, 2011); along with realistic sports tasks in empirical, laboratory based research. This would allow results to be translated more readily to real world situations. Qualitative methods could be employed here to explore the reasons for any differences found between athletes and non-athletes.

There are a number of important reasons for investigating this area further. First, performance in pain could be maximised by the development of specific coping strategies. Second, participation in sport could be maintained by being able to identify those who are not effective at coping with pain. This could lead on to the implementation of interventions to improve coping. Finally, using questionnaires such as the Sport Inventory for Pain (SIP15) (Bourgeois et al., 2009) could highlight potential coping styles that are facilitative to certain sports or activities as a means to enhance sports performance.

Research examining pain in athletes has yielded some interesting findings but it is in its infancy. There does seem to be some agreement that athletes have a higher pain tolerance and that they view and respond to pain differently to non-athletes, yet there is no definitive answer as to how and why athletes respond differently to pain than other populations. Further research needs to be conducted to understand the mechanisms behind these differences and also to examine the role of contact in sport and how this may moderate responses to pain. In particular, comparisons should be made between high contact athletes and other athlete groups, such as non-contact athletes or non/low/medium contact athletes. Using a high contact – low/non-contact dichotomy will aid understanding of how contact within sports may influence pain reporting. In the past only a small number of studies have made this distinction. Many

studies examining athletes and pain have compared athletes to non-athletes (e.g. Geva & Defrin, 2013). Only four studies to date have accounted for contact in sport by distinguishing high contact athletes from other populations: Ryan and Kovacic (1966), Ryan and Foster (1967) and Raudenbush et al (2012) compared pain tolerance in high contact athletes and non-contact athletes and Leznicka (2016) compared pain tolerance in high contact athletes and non-athletes.

It is acknowledged that there are difficulties in classifying athletes according to the level of contact to examine pain experiences in sport. To gain a broad perspective of pain experiences, pain will be investigated according to source and a range of athlete groups will also be examined. It can be expected that all athletes at some time would feel pain in sport from exertion or injury however a rugby player or martial artist will experience more contact related pain than a tennis player. This reinforces the importance of exploring the source of pain rather than simply the amount of pain an athlete experiences. As the amount of contact may differ between sports (e.g. football compared to netball) it is potentially useful to examine the level of contact on a continuum ranging from non-contact sport (e.g. a triathlete) to high contact sport (e.g. martial arts). Within the thesis various definitions have been given to athletes to categorise them according to the amount of contact they experienced. In the first two studies, high (e.g. rugby player), medium (e.g. football player) and low (e.g. tennis player) contact athletes are examined. In study three (Chapter Four) participating and non-participating high contact athletes are studied. In the final study (Chapter Five), experienced and novice high contact athletes and non-contact athletes are compared. Examining a range of athletes will provide insight into pain behaviour based on the amount of contact experienced, the type of sport played and the length of time of engagement with a contact sport. This may go some way to explain why high contact athletes respond differently to pain compared to other populations.

1.3 Current PhD Thesis

There are therefore a number of unexplored areas of pain research using athletes as participants. Differences in pain responses between athletes and non-athletes and within athlete groups have been discussed along with potential mechanisms for such differences. The following section will discuss the rationale for this PhD thesis and will explain the methodologies chosen as well as the PhD aims and objectives.

In order to explore pain experiences of athletes, a range of methodological approaches will be adopted. A combination of qualitative and quantitative methods will be used to provide an in depth understanding of pain within sporting contexts. Some researchers have suggested

that positivist and constructivist paradigms are not compatible due to the epistemological and ontological differences between the two (e.g. Guba & Lincoln, 1988). However recently, some researchers have advocated that mixing approaches can be conducive to flexible and well informed research (Doyle, Brady & Byrne, 2009). Using mixed approaches can provide a detailed understanding of phenomena and can more clearly answer the research question (Gratton & Jones, 2010). Onwuegbuzie and Leech (2005) advocate that adopting a pragmatic approach to research can enhance and further knowledge within social and behavioural sciences. They suggest that epistemology should not dictate the methodology used to answer research questions. Researchers should instead use the strengths of both qualitative and quantitative research to understand phenomena and should not treat the two approaches as separate. Greene, Caracelli and Graham (1989) posited that using a mixed methods approach brings five key benefits to research. First, triangulation occurs by using multiple methods to examine the same phenomenon. Second, complementarity is achieved by seeking elaboration and clarification of results. Third, results from one approach can then be used to inform another. Specifically in this thesis, qualitative findings from study one will be used to inform subsequent chapters. Fourth, paradoxes and contradictions may arise, which may inform the research question. Finally, mixed methods approaches are expansive and can develop the scope of a study by examining the topic from different angles. As such, within this thesis a pragmatic approach has been adopted to address the research questions. This section will address each of these different methods utilised alongside the rationale for each approach used in the four studies included in this PhD thesis.

As stated in the literature review, qualitative research has focused mainly on the experience of playing hurt within sports or injury rehabilitation (e.g. Madrigal, Robbins, Gill & Wurst, 2015; Levy et al., 2009). Little research has investigated experience of pain within contact and non-contact sports, and there is a paucity of research that has differentiated between the different sources of pain. In addition, there is a dearth of quantitative measurement of pain responses in athletes beyond pain tolerance, perception or threshold measures. Therefore, a detailed exploration of pain responses and experiences in athletes from sports of differing contact levels will be conducted. This will build on the literature to date that suggests that high contact athletes appear to respond to and view pain differently to non-contact athletes.

The mechanisms for differences between athlete groups remains relatively unexplored and unclear. Individual differences, learning and attrition may be possible explanations but there has been no definitive answer beyond speculation. Qualitative research has highlighted

that learning to withstand pain through sporting culture may explain why high contact athletes respond to pain differently to other groups (Liston et al., 2006). Therefore, the first aim of this thesis is to qualitatively investigate pain experiences of a heterogeneous group of athletes, who experience different levels of contact (and therefore pain) within their sports. Qualitative research aims to understand the experiences of individuals and provides an in depth account of their thoughts and feelings regarding phenomena (Gratton & Jones, 2010). Therefore, this chapter will explore in detail the lived experience of pain within athletic groups and will examine the mechanisms for differences in pain responses. This will provide a rich account of how pain is viewed and will provide a platform for further examination of mechanisms for group differences in subsequent chapters. This study will employ template analysis as recommended by King (2007). Template analysis is a form of thematic analysis and is typically used with interview transcripts and involves the production of *a priori* themes based on literature (King). This then allows the researcher to develop the themes based upon the responses of the interviewees. This approach has been recommended as a method that can be used within a range of epistemological positions and is flexible in exploring new phenomena (King, 2012).

Some research has suggested that different sporting environments may influence attitudes and responses to pain (Nixon, 1992). Furthermore, tentative suggestions have been made that personality factors may also affect how one responds to pain (e.g. Tajet-Foxell & Rose, 1995). Combining these two factors, research has also indicated that personality may influence sports choice; for example team based athletes are more extraverted than individual athletes (Allen et al., 2011) and risk taking sports participants are also more extraverted than those who play less risky sports (Castanier, LeScanff & Woodman, 2010). Furthermore, coping styles may influence responses to pain. The SIP15 (Bourgeois et al., 2009) was designed to assess pain coping styles within athlete groups and has shown reasonable consistency across a number of studies (Bourgeois et al.). Pain coping styles may be learned or developed over time and it is not known whether athletes with positive coping styles choose painful sports or whether painful sports develop positive coping styles. With this in mind, the second aim of this thesis is to examine personality factors and pain coping styles in contact and non-contact sports participants. This will examine the mechanisms of individual differences and learning, by focusing on coping styles as a learned behaviour. This will be achieved through the use of personality and coping styles questionnaires administered within the field. Using questionnaires in the field can provide objective measures in an appropriate time frame (Gratton & Jones, 2010).

The next objective of this PhD will be to examine pain responses in new contact sports athletes using a longitudinal design. This aims to explore the mechanisms of attrition and learning and will help determine whether psychological factors and pain responses influence adherence to painful contact sports. This will be achieved by taking experimental pain tolerance and perception measurements over an athletic season. In addition, other measures will be taken, such as pain coping styles (using the SIP15), pain bothersomeness, feelings about the sport and attendance statistics. This will determine whether participating contact athletes have different responses and feelings towards pain than non-participating athletes. Measuring pain tolerance and perception in experimental conditions has flaws, as discussed earlier, however there is no other means of objectively determining how tolerant someone is to pain or how intensely they feel pain.

The final objective of this thesis will be to measure performance whilst in pain using high contact and non-contact athletes, whilst manipulating challenge and threat states. This will bring together the findings from previous chapters and relates directly to real sporting situations where pain is present and motor skills must be executed. Pain demands attention, and therefore has a detrimental effect on tasks that involve working memory (Attridge, Noonan, Eccleston & Keogh, 2015). There is a paucity of studies examining performance whilst in pain in athletes groups. Walker (1971) found that there were no differences between athletes and non-athletes when performing in pain; however, the participants were basketball players and therefore experienced relatively small amounts of contact. It is therefore not known how and why high contact athletes are able to maintain performance despite suffering sometimes extreme pain. To examine this, experimental pain will be induced whilst participants perform a motor task. Challenge and threat will be manipulated to examine whether athlete groups respond differently to instructions regarding the pain task. This will help to understand how different athlete groups respond to and perform in pain.

1.4 PhD aims and objectives

The current research aims to:

1. Develop an understanding of the pain experiences of different athlete groups, examining the proposed mechanisms of learning, attrition and individual differences (study 1, 2 and 3)
2. Compare high and low/non-contact athletes responses to pain (study 2 and 4)

3. Examine the role of challenge and threat states, performance in pain and pain responses in high and non-contact athletes (study 4).

To achieve aim one, a number of studies will be undertaken using a range of approaches. First, qualitative methods will be employed to explore how athletes experience pain. Second, questionnaires will be used to examine the mechanisms of personality and learning. Third, pain tolerance and perception measures will be taken to examine learning and attrition mechanisms. To achieve aim two, different athlete groups will be compared on a number of pain measures. The measures will include pain coping styles, pain tolerance and pain bothersomeness. To achieve aim three, experimental pain will be induced whilst challenge and threat states are manipulated.

In order to achieve the aims of the thesis, there are four key objectives:

- I. Explore pain experiences of a range of athletes (study 1)
- II. Investigate the role of personality and coping styles in high and low contact athletes (study 2)
- III. Investigate pain tolerance and perception over time in novice high contact sports participants (study 3)
- IV. Measure performance during experimentally induced pain whilst manipulating challenge and threat states (study 4).

Chapter Two: A Qualitative Exploration of Pain Experience in a Heterogeneous Sample of Athletes.

This chapter will address the first aim of the current thesis, which is to develop an understanding of the pain experiences of different athlete groups to examine the proposed mechanisms of learning, attrition and individual differences. This will be achieved by completing objective one of this thesis, which is to explore the pain experiences of a range of athletes. In doing so, this will provide a rich and detailed account of how athletes feel about, cope with and encounter pain within sports.

2.1. Introduction

Much of the research discussed in Chapter One was quantitative in nature. This research indicates that contact athletes respond to pain differently than other groups. Mechanisms for these differences require further investigation via qualitative means. This would allow researchers to understand how pain is experienced within sports. As concluded in the previous chapter, learning about pain appears to be the most plausible and the most researched explanation for athlete differences in pain reporting. Very little attention has been paid to the subjective experiences of athletes regarding different types of pain. Indeed, the sparse previous qualitative research available has focused either on pain coping strategies (e.g. Kress & Statler, 2007; Hare, Evans & Callow, 2008; Driediger et al., 2006), injury rehabilitation (e.g. Levy et al., 2009; Tripp, Stanish, Coady & Reardon, 2004) or coping with injury (e.g. Heil, 2012).

Qualitative research focusing on pain in sports is rather fragmented. There has been little discussion of how athletes view pain within different sports and there is a dearth of research into contact related pain. Research into contact sports has typically focused on the culture of such activities (e.g. Liston et al., 2006), rather than the actual experiences of athletes and the reasons for playing painful, risky sports. Some research has focused on exertion pain (e.g. Kress & Statler, 2007), and some on injury pain (e.g. Driediger et al., 2006), and these have provided some insight into coping methods for enduring these pain types. No study to date has attempted to examine the three types of pain in a qualitative manner, so little is known about how athletes experience pain, what it means to them and how they cope with it. It is also unclear how different types of pain are viewed and experienced in sports settings.

As discussed in Chapter One, pain is a common occurrence in sport through injury, exertion or through contact with other participants and/or objects. Differentiation between these main sources of pain has received little attention in the literature, with many researchers

using pain as one over-arching term. It is important to make distinctions between different types of pain as athletes may interpret each very differently. Injury related pain tends to be viewed as threatening and is out of the control of the athlete (Taylor & Taylor, 1998), exertion related pain is often viewed as a challenge and is in control of the athlete (Anderson & Hanrahan, 2008) and contact-related pain tends to be acute and is part of collision sports. Being able to withstand these types of pain is important to athletic success and could influence sport choice (Egan, 1987). How an athlete views different types of pain and copes with them could have an effect on performance and adherence; however, this has not been explored qualitatively. Exploring this via interviews will allow athletes to discuss how they feel about each type of pain and will increase understanding of how pain is experienced.

Most research into pain and athletic performance has been quantitative in nature, focusing on differences in experimental pain responses within groups of athletes and non-athletes. Typically, researchers have examined differences in pain threshold, tolerance and perception between athlete groups (e.g. Manning & Fillingim, 2002; Hall & Davies, 1991). Chapter One highlighted that athletes have higher pain tolerance and perceive pain as less intense than non-athletes (Tesarz, et al., 2012). In addition, high contact athletes have a higher pain tolerance than non-contact athletes (Ryan & Kovacic, 1966; Ryan & Foster, 1967; Raudenbush et al., 2012) and they report less pain intensity compared to non-contact athletes (Raudenbush et al.). Mechanisms for these differences have been suggested, but not widely empirically tested nor explored via qualitative means. Qualitative research methods can be useful to explore experiences of individuals (Gratton & Jones, 2010) and therefore might aid understanding of how athletes feel about sports related pain. There are at least three possible explanations for differences in pain reporting between athletes and non-athletes and amongst athlete groups: individual differences, learning to cope with pain and attrition. These will be discussed, briefly, in turn.

Individual differences refer to the idea that athletes may simply be different from non-athletes, either physically or psychologically. To date only a small number of studies have attempted to explore this view, usually by examining fitness levels (e.g. Anshel & Russell, 1994; Risch et al., 1993; Geva & Defrin, 2013). It has been suggested that training in stressful and painful environments might alter pain responses. On the other hand, it could be that athletes who choose to do so are inherently pain tolerant (Geva & Defrin, 2013). There has been no qualitative research to explore participation in painful sports from this standpoint.

Personality may account for differences in pain responses within athlete groups, though this has also received scant research attention. There is some evidence that are personality differences between athletes according to the sport they play (e.g. Allen, et al., 2013; Castanier et al., 2010). For example, high contact athletes exhibit higher sensation seeking behaviour than non-contact athletes (Schroth, 1995). High contact athletes may seek more stimulation to regulate arousal levels compared to non-contact athletes, indicating that high contact athletes may have different characteristics and motivations for playing sports. As such, high contact athletes might seek out risky activities and situations to regulate arousal levels. To date little research has examined this idea further and there has been no qualitative exploration of this in high contact sports.

In one of the few pain studies to measure personality traits in athletes, Tajet-Foxell and Rose (1995) found that dancers were more neurotic than non-dancers. Neuroticism has been linked to pain catastrophizing and has been shown to increase pain related distress (Newth & Delongis, 2004). However, paradoxically the dancers in Tajet-Foxell and Rose's study were more willing to tolerate pain, despite feeling it more intensely than the non-dancers. Thus, willingness to participate in painful sports may be a function of motivation or commitment to that activity. In summary, the mechanism of individual differences has received scant attention in the literature. There are suggestions that fitness levels or personality may moderate responses to pain, but more research is needed. Qualitative studies would be useful to develop an understanding of this.

Attrition as a mechanism has also received little research attention; it is possible that athletes who find pain unpleasant or have low pain thresholds may avoid or discontinue activities where pain is common (Manning & Fillingim, 2002). As discussed in Chapter One, there are two potential explanations for this. The first is that pain related self-efficacy might affect whether someone seeks out painful situations or avoids them (Pen & Fisher, 1994), because individuals with higher pain coping self-efficacy are more likely to be able to withstand pain than those with lower pain coping self-efficacy (Williams & Kinney, 1991). A second explanation is that anxiety may be increased in individuals who have the inability to disengage from, or ignore pain (Bardel et al., 2013). Therefore, when athlete groups are included in research, only those people who have been willing to experience pain regularly are being measured and those who are not are ignored. In addition, athletes may be more willing to volunteer for pain based research and may want to learn about their pain responses. Consequently, any differences observed between athletes and non-athletes may be magnified.

There has been little investigation or testing of these theories of attrition in athletic populations, and therefore more research is warranted. Specifically, qualitative research should focus on the reasons for participation and non-participation in contact sports.

The mechanism that has received the most attention is that of learning to cope with pain. There are a number of factors that might influence how an athlete learns how to manage pain. These include coping strategy use, pain related self-efficacy, appraisal of pain as a challenge or a threat, experience of pain (for example through injury) and social and cultural influences. When used well, coping strategies have been shown to enhance pain tolerance (Manning & Fillingim, 2002). Coping strategies refer to the specific cognitive or behavioural actions a person takes to cope with pain. These can be classified as adaptive, for example using imagery, or maladaptive, for example avoiding painful activity or catastrophizing (Azevedo & Samulski, 2003). Adaptive strategies are associated with positive approaches to pain and often result in better adjustment to pain, whereas maladaptive strategies result in the opposite (Tan, Jensen & DeBakey, 2008). Athletes and non-athletes use coping strategies differently, for example, Ord and Gijssbers (2003) found that highly trained rowers used more effective coping strategies than non-trained rowers. Coping strategy use was positively correlated with pain tolerance. Manning and Fillingim also found that athletes used competitive coping strategies whilst undergoing experimental pain whereas non-athletes did not. The athletes reported that they tried to “beat the tests” and compete against the pain. Athletes stated that they felt more in control of their pain than non-athletes, and as a result had higher pain tolerance. Taken together these findings suggest that using a coping strategy can enhance pain tolerance and that athletes appear to use these more than non-athletes.

Athletes also appraise pain differently to non-athletes. Experienced contact athletes often have a high direct coping style, which reflects a positive view of pain (Meyers, Bourgeois and LeUnes, 2001). Coping styles are a more general definition of pain coping and often combine a number of similar strategies (Cronqvist, Klang & Bjorvell, 1997). Direct coping is characterised by having a positive view of pain and accepting it as necessary for sport (Bourgeois, Meyers & LeUnes, 2009). In qualitative studies, athletes have reported that they view pain as something to overcome (e.g. Kress & Statler, 2007) they also view pain more as a challenge compared to non-athletes, who view pain as a threat (Kopka-McDowell & LaChapelle, 2005). In addition, athletes have reported that exertion pain, in particular, can be regulated: Kress and Statler interviewed cyclists and found that they viewed exertion pain as something to be mastered and controlled. They knew that the pain was finite and therefore were

willing to tolerate it. If non-athletes have never experienced this type of pain, they may therefore appraise it differently, as a threat.

As discussed in Chapter One, self-efficacy can influence how an athlete responds to pain. Self-efficacy can be modified via performance accomplishments; therefore, if athletes have achieved success despite pain, pain related self-efficacy will increase (Weinberg et al., 1981). In their study using a leg extension task to induce exertion related pain, Weinberg et al. found that athletes with high pre-existing self-efficacy, who were placed in a high self-efficacy condition via performance accomplishments, were able to withstand pain for longer. This suggests that prior success of coping with pain may foster increases in pain-related self-efficacy, thereby increasing pain tolerance and participation in contact sports. In a qualitative study examining mixed martial artists (MMA), Massey, Meyer and Naylor (2013) reported that MMA fighters increased their self-efficacy by deliberately inflicting pain upon themselves during training. The athletes stated that having the experience of pain before competitions made them feel more prepared and able to cope with the demands of their fights. Therefore, athletes who have more experience of pain may feel more able to cope with painful experiences in the future.

Indeed, it has been suggested that experience of pain may moderate appraisals and responses to it. Wandner et al. (2011) found that athletes with more experience in a sport appraised pain more realistically than those with less experience. They were able to decide whether pain was harmful or not more readily than those who were new to sports. This may also be a function of understanding the meaning of pain via experience. In some of the few qualitative studies to examine pain in sports, ultra-marathon runners reported that they were able to differentiate between harmful injury-related pain and “normal” pain experienced during a running event (Hanold, 2010). Thomas and Tarr (2009) found similar results following interviews with dancers. They reported that more experienced dancers were more able to determine whether they should stop dancing or not due to pain. They also were more aware of chronic injuries and were more likely to attend to pain than less experienced dancers. This may result in experienced athletes being more willing to tolerate perceived benign pain for longer compared to less experienced or non-athletes. In a similar study, Nemeth, von Baeyer and Rocha (2005) suggested that age and experience could explain how different athletes groups view pain. Interviews with gymnasts of various levels of experience suggested that older gymnasts could differentiate between threatening (i.e. injury pain) and non-threatening (i.e. pain associated with exertion) pain more readily than younger athletes. They also viewed

exertion pain more positively, because it was viewed as increasing “toughness”, therefore they were not deterred by this type of pain.

A final learning mechanism concerns the culture of sports. Sports culture has many definitions and covers a wide range of areas, including social customs, politics, identity and traditions (Jarvie, 2006). In terms of this thesis, sporting culture refers to the norms and social processes that occur within contact sports. Particularly in contact sports a culture of “playing hurt” or “taking one for the team” is prevalent (Liston et al., 2006). Athletes who participate in sports where such a culture is present may be socialised into accepting pain as part of the sport (Bird, 2011). Indeed, machismo and an unwillingness to show pain have been shown to permeate both male and female sports (Bird). Within rugby for example, enduring pain is seen as reaffirming masculinity and pain is often normalised (Pringle & Markula, 2005). Even within non-contact sports such as ultra-running (Hanold, 2010) and gymnastics (Cavallerio, Wadey & Wagstaff, 2016), pain is viewed as an essential part of the activity, is accepted and a culture of training and performing hurt is prevalent. In their ethnographic study examining the behaviours of coaches and gymnasts within a club, Cavallerio et al. reported that an ethos existed that reinforced the notion that pain was necessary. Athletes stated that they were ostracised by coaches and teammates for disclosing feeling pain or not adhering to the norms of performing hurt. Indeed it was expected that gymnasts would show “toughness” in order to feel part of the club. As such, athletes may feel compelled to participate in sports despite being in pain, risking further injury and during experimental pain they may still adopt this mind-set.

In other sociological research, Nixon (1994) explored the culture of risk within sports. Using media articles from Sports Illustrated, Nixon reported that athletes were socialised into accepting pain and risk as part of sport. Pain was often rationalised by coaches who put the needs of the team ahead of the welfare of the athlete. This can create a culture whereby athletes feel compelled to participate in sports despite feeling pain. In doing so, athletes often take risks and under-report injuries and pain (Cavallerio et al., 2016). Young, White and McTeer (1992) stated that masculinity is often reinforced by undergoing pain or injury. Via interviews, they identified four ways that male football and hockey players responded to pain. Hidden pain occurred when athletes felt the need to deny or conceal their pain from others. This often strengthened feelings of masculinity, as athletes felt they had “taken one for the team”. Disrespected pain referred to everyday aches that athletes tended to ignore despite the fact that this pain could develop into chronic injury later. This pain was not described as important to displaying masculinity. Unwelcomed pain was a result of injury that athletes would not want

to disclose, often due to fears about being left out of the team or ignored by others. Depersonalisation of pain occurred when athletes did not want to associate with injury and saw it as something alien to them. They would often refer to the injured site in the third person, rather than take ownership of the injury itself. Young et al. concluded that in male sports, pain was often ignored, reinforced masculinity and that playing hurt was commonplace. Consequently, male high contact athletes may take risks to continue to play sport and to bolster their masculinity.

Beyond these studies, there has been little exploration of the pain experiences of contact sports athletes. The mechanisms for their willingness to withstand pain and their reasons for choosing a risky sport have not been determined. In addition, there is little qualitative research exploring how non-contact athletes experience and feel about pain. There has also been little differentiation between the sources of pain and how these may illicit different feelings within athletes. The purpose of this study is to explore how athletes experience and cope with the three types of sports related pain. Based on the large body of quantitative research and the smaller corpus of qualitative research, template analysis will be employed. It is anticipated that this initial exploratory inquiry will raise questions regarding mechanisms for observed differences in the laboratory and provide directions for subsequent chapters. The template is based upon the three key themes to emerge from the literature review in Chapter One, i.e. Learning, Attrition and Individual Differences, which have been discussed above. Sub-themes have been added to the template to include self-efficacy, catastrophizing and various coping strategies, based on evidence from studies discussed previously.

2.2 Methods

Participants.

Using maximum variation sampling (Gratton & Jones, 2010), ten participants were invited to contribute to the study via a virtual learning environment in a higher education college. The only inclusion criteria were that the participants engaged in a sport or some form of exercise. The participants were both male (N = 6) and female (N = 4) with a mean age of 24.5 years (SD = 2.9 years). Participants were from a range of sports and were classified after analysis according to how much contact they experienced. High contact athletes (N =5) participated in kickboxing, judo, rugby and wrestling. Medium contact athletes (N=2) took part in football and low contact athletes (N=3) participated in athletics, gymnastics (Miss Fit) and exercise activities such as running, and weight or fitness training.

During analysis it became clear that the amount of contact experienced in sport differentiated the athletes. For the purposes of clarity the athletes were therefore grouped according to the type of sport played. High contact sports (H) were classified as those where contact is part of the sport, is essential to the sport and is allowed within the rules. Rugby, for example, involves tackles, rucks and mauls which involve collisions and contact with other players. In a sport such as football however a player who tackles someone to the ground from behind would be penalised for foul play. Whilst football does involve contact during tackles, the contact is not an essential part of the sport and excess contact is not allowed within the rules (The F.A.com, 2012). As such, football was classified as medium contact sport (M). Low contact activities were classified as those which do not involve coming into contact with anyone or any objects (L). As stated in the introduction, there are difficulties in classifying athletes according to the amount of contact they experience in their sport, however for the purposes of this study and due to the emerging themes during analysis, it was appropriate to consider how much contact each athlete was exposed to.

Participants were asked to provide demographic information as well as the amount of injuries they had suffered as part of their sport (see Table 2.1). Major injuries were classed as those that prevented the athlete from continuing the sport and kept them out of the sport for more than 2 weeks, for example a fracture, dislocation or sprain. Minor injuries were classed as those that did not warrant the athlete ceasing participation in the sport, such as bruises, scrapes and cuts.

Table 2.1

Participant Demographic Information

| Participant | Gender | Injuries | Sport | Years of experience |
|--------------------|--------|---|--|--------------------------------|
| H1, high contact | M | Major injuries: 10+ Minor injuries: 100's. | Rugby union, exercise (recreational) | 7 years |
| H2, high contact | M | Major injuries: 9 Minor injuries: 100's. | Mixed martial arts (MMA) (semi-professional) Pro-wrestling (professional) Rugby union (recreational) | 8 years 8 years 10 years |
| H3, high contact | F | Major injuries: 1 Minor injuries: 50 | Rugby (county) Netball (county) | 2 years 10 years |
| H4, high contact | F | Major injuries: 2 Minor injuries: 100's. | K1 kickboxing (recreational) | 8 years |
| H5, high contact | F | Major injuries: 0 Minor injuries: 5 | Judo (international) | 14 years |
| M1, medium contact | M | Major injuries: 3 Minor injuries: 100's. | Football, exercise (recreational) | 10 years |
| M2, medium contact | M | Major injuries: 5 Minor injuries – 20+. | Cricket, football, exercise (recreational) | 6 years |
| L1, low contact | F | Major injuries: 2 Minor injuries: 10 | Miss fitness, gymnastics (national) | 3 years |
| L2, low contact | M | Major injuries: 6 Minor injuries: 50 | Athletics (400m) (national) | 12 years |
| L3, low contact | M | Major injuries: 2-3 Minor injuries: 5-10. | Weight training (recreational) | 12 years |

Interview Schedule.

Each semi-structured interview took place in a quiet location and was recorded on a digital Dictaphone. In line with the recommendations of Howitt and Cramer (2005), the author conducted the interviews. The author has previous experience of studying pain in sports settings and also participates in regular sport or physical activity. As such it was felt that the researcher would have a degree of empathy with the participants.

Before interviews took place, participants were informed of the difference between injury related pain, contact pain and exertion pain, to ensure that they were familiar with terms used during the interview. A series of questions were asked of all participants during the semi-structured interview, using prompts where necessary to explore phenomena further or to encourage the participant to go into more detail (see appendix A).

The first set of questions referred to meaning and personal experience of the three types of pain. The aim of this section was to gain an understanding of what pain was like for the participants, thus achieving a key aim of qualitative research and enabling the researcher to interpret the meaning of that experience (Willig, 2009). The second set of questions addressed coping with different types of pain. The purpose of this section was to discover what athletes do while in pain to reduce its intensity or to be able to continue participating in pain. The final set of questions focused on different pain types as part of sport and exercise. The aim of this section was to gain an understanding of the link between sports participation and pain.

Ethical approval was sought and granted by the University Research Ethics Committee (see appendix A). Each participant was provided with an information sheet outlining what the investigation would entail and they were provided the opportunity to ask questions. They were then asked to sign an informed consent form and complete a brief demographic questionnaire. After the interview took place each participant was given a debrief sheet explaining the purpose of the study, the right to withdraw and where to seek further advice or help if they felt it was necessary.

Analysis.

Interviews were transcribed verbatim and reviewed concurrently with the original digital recording, following the recommendations of Willig (2009). Template analysis was employed by developing an initial template containing *a priori* themes deemed to be important to the data. Template analysis is typically used with interview transcripts and involves an initial

coding template using broad themes (King, 2007). This template can then be developed to fit with the data by adding, removing or merging themes. The final template should then reflect all of the transcripts and is the basis of the interpretation of the data.

The initial template was based upon the existing pain literature and contained the three main mechanisms that explain differences between high and low/non-contact athletes: Individual differences, attrition, and learning. The initial template can be seen in Figure 2.1.

Figure 2.1

Initial Template

1. Individual Differences
 - 1.1 Physical
 - 1.2 Psychological
2. Attrition
 - 2.1 Self-Efficacy
 - 2.2 Catastrophizing
3. Learning
 - 3.1 Control
 - 3.2 Appraisal
 - 3.3 Coping strategies
 - 3.4 Experience
 - 3.5 Social and cultural influences

Transcripts were read one by one, two to three days after the interview had taken place. Initial thoughts were made in the left-hand margin of each transcript. After reading and re-reading the transcripts and initial coding using NVivo software, the template was altered accordingly. Themes were organised and explored and their inter-relationships were examined. The transcripts were then read and re-read and the template was applied to each transcript in turn to check the nature of pain experience for all participants.

2.3 Results

The final template can be seen in Figure 2.2. On analysing the results, differences emerged between the athlete groups according to contact level. In addition, different comments were made according to the type of pain being discussed. The main differences between groups and pain types are considered throughout the results.

Figure 2.2

Final Template

1. Individual Differences
 - 1.1 Physical
 - 1.2 Psychological
2. Control & Self-efficacy
 - 2.1 Catastrophizing
 - 2.2 In control
 - 2.3 Not in control
3. Experience of pain/Bothersomeness
 - 3.1 Positive appraisal
 - 3.2 Negative appraisal
 - 3.3 Decision making (stop or continue activity)
 - 3.4 Attrition (stop or continue sport)
4. Coping strategies
 - 4.1 Goal setting
 - 4.2 Dissociation
 - 4.3 Self-talk
 - 4.4 Relaxation
 - 4.5 Arousal
 - 4.6 Social support
5. Social and cultural influences
 - 5.1 Team ethic
 - 5.2 Machismo

Individual differences.

This first order code refers to responses to pain that were deemed to be due to the participants' personality or physical makeup.

Physical.

Some participants referred to physical individual differences when discussing reasons for choosing or avoiding particular sports. Many athletes who participated in low or medium

contact sports referred to body size, shape and their strength when discussing why they avoided high contact, potentially painful sports such as rugby.

M1: *“I don’t think I’m built for rugby, I’m too small... I think that if I tried to play rugby I’d probably be injured most weeks, you know I’m just too small”*

Psychological.

Some participants referred to psychological individual differences when discussing the reasons why some people may choose or avoid painful sports. The participants referred to those who play high contact sports as somehow different to people who do not. In general, reference was made to contact sports participants being *“strong characters”*, *“confident”* and even *“sadistic”*. These comments came mostly from the high contact athletes rather than low or medium contact participants.

H1: *“Generally kind of most people that play rugby or contact sports they are quite, it’s like that character, like maybe they’re, well not outspoken, but they’re quite a confident person and they’ll look for that kind of...(I)...release and like everything that comes with it with rugby and contact sports like that and....well not a “lads’ lad”, it’s kind of hard to explain...”*

The high contact athletes in particular saw themselves as different to other athletes, and this was a reason they chose their sport and persevered with it. Some felt that not everyone was capable of doing their sport.

H2: *“To be a forward you have got to enjoy the physicality er, but like I say, especially with the MMA [mixed martial arts] and the wrestling, it is a certain type of person, I wouldn’t say crazy but beyond the norm...not the everyday person would do it.”*

One participant (H3) participated in both high and low contact sports and was able to compare the characters of the two athlete groups:

H3: *“...they just, they’re pretty strong characters all the women who play [rugby]...there is a big difference [between rugby and netball players]...er, netballers are a lot quieter and I’d say their pain threshold is lower than what rugby players are, as a generalisation.”*

Control and self-efficacy.

Many participants referred to whether pain was in their control and their perceived ability to cope with it. Participants referred to all three pain types here, with many stating that exertion pain was controllable but injury pain and sometimes contact pain were not. High contact participants also reported that they felt more in control of contact pain when compared to medium or low contact athletes.

Catastrophizing.

Some athletes reported feeling overwhelmed and consumed by injury pain. These tended to be athletes who had previous experience of serious injuries; they reported catastrophizing about the pain when thinking about injury severity and how it may affect future participation in the long term.

H1: *“I don’t know if it’s maybe just me, because of the injuries I’ve had, my initial thing is fear - if it’s my back or knee I’m like ‘shit, is that going to be a serious injury again? Am I going to be out for months?’”*

Interestingly, some of the medium and low contact participants seemed to be more concerned with the fact that injuries were limiting them in being able to do their sport at the present time, rather than the long-term consequences. Their catastrophizing appeared to be more about being able to continue in the short, rather than the long term.

M1: *“I think, ‘oh why can’t I do it [gym exercises]? Like what’s different about me?’ Cos [my friend] was doing fine and you could see that he really wanted to keep going with it...I did as well but...it was so sore in my groin I thought ‘oh why can’t I do it? I should be able to do it’. I thought to myself ‘well it might just be because I’ve never done it before’”*

All of the catastrophizing behaviour was in relation to injury pain. Athletes reported that this type of pain was detrimental to participation and long-term involvement in their sports. Some of this was linked to perceived control over the pain.

Control.

The participants were able to discuss their pain in terms of whether they felt in control of it or not. In general, exertion pain was perceived to be within the athletes’ control.

M2: *“I think with running, I know exactly what I am putting myself in. I know what pain I am going to get at the end of it, I know like I am in control of my pain so if it gets too much I can stop.”*

Some athletes felt that exertion pain was something that they chose to endure, and it was within their control to manage the intensity, not by stopping the activity but by training harder. This would then increase fitness levels, which in turn would reduce the amount of pain felt in the future.

H2: *“With the exertion pain it is more being angry at myself because, like I say, if I am knackered I find that I shouldn’t be knackered, you know what I mean, I need to be fit, I need to get fitter.”*

Some high contact athletes also reported feeling in control of the amount of contact pain they experienced during sports.

H3: *“...obviously you try and avoid it [contact pain], obviously you are going to get punched or kicked but obviously you have the option to move out of the way”*

Not in control.

In contrast to high contact athletes, the low and medium contact participants reported that contact pain was not in their control.

M1: *“Whereas in football where my pain is carried out by others I don’t know what is going to happen, sort of thing. So I think it is the whole not being in control of what can happen with my body, you know is the main pain that I go through.”*

When injury pain was discussed, most athletes reported that they did not feel in control of it. All participants who talked about this type of pain discussed it in terms of the unknown and how frustrating an injury could be.

L3: *“It’s frustrating because I can’t fix it. I can’t make it better...it’s because I can’t fix it, no matter what I do, no matter what I try, it just won’t go away and that’s the worst part of it.”*

Experience of pain/Bothersomeness.

The participants also discussed how much pain bothered them during sport. Bothersomeness was discussed in terms of how much pain interfered with their thoughts and

their behaviours. This appeared to be linked to experience. This was broken down into appraisal of pain as positive or negative and in terms of subsequent decisions made about the sport; i.e. whether to stop or continue.

Positive appraisal.

In general, exertion pain was appraised in a positive way. Most athletes reported that it reflected hard work, perseverance and meant that conditioning was taking place.

L2: *“The pain is almost like an indication of well done, that you’ve done it right and there’s no more you could have given”*

L3: *“I enjoy it. I like it. It’s good because it shows that I’ve worked hard”*

Most athletes reported that they enjoyed the feeling of exertion pain, sometimes during the pain but most of all after the exertion was over.

M1: *“It’s a bit of a sick pleasure”*

High contact athletes also appraised contact related pain in a positive manner.

H1: *“...that kind of pain [contact] that you experience is quite an enjoyable thing cos you know that’s part of the game, that’s why you play it... if you talk about maybe localised pain, and where it’s not a serious injury, so like you’re sore, you’re battered, you’re like bruised, you’re cut...people will say, they might write it on Facebook or they might text you like on a Monday saying... “I couldn’t get out of the bath” or whatever, or like “my legs are hanging off”, you will get messages like that. Or like the first couple of games of the season like, oh I’ve missed feeling like this on a Sunday. So yeah...like I said, you do feel like you’ve played a good hard game when you are sore.”*

Some even saw contact related pain as a “badge of honour” and something to celebrate, especially if the effects of the contact were visible to others.

H3: *“Well you have to laugh about it, like, you might get punched in the face and you know, you think ‘oh I’m going to get a black eye’ and you can feel it proper swelling. But then you don’t get one, so...(1)...you know you think, ‘oh I could have, you know, had a nice injury’ (laughs)...like to show everyone, look, I was punched by him.”*

The low and medium contact athletes did not report such feelings regarding contact pain. In terms of bothersomeness, most athletes reported that pain only bothered them if they

viewed it as negative or harmful. Some athletes generally accepted exertion and contact pain, but injury pain was different.

Negative appraisal.

The main negative comments were in relation to injury pain, especially in relation to its harmful effects and the consequences of being injured.

H1: *“I think because of my experiences in the past it’s always in the back of my mind that it’s a threat, er of the injury. I wouldn’t say it’s the threat of being sore and it hurts, it’s more of the consequences of not being able to play.”*

In addition, athletes commented on how injury can be devastating to competition schedules.

L1: *“...if you end up injuring yourself while you’re training prior to a competition and it’s quite a bad injury then you can’t compete...then that’s your whole years’ worth of training out of the window and you just have to wait until the next year to do it again. It can be frustrating, it can ruin everything”*

One high contact athlete appraised some particularly risky aspects of his sport in a negative way, potentially a function of the uniqueness of his sport and the fact it would be hard to train to withstand this type of pain.

H2: *“...with the wrestling we do a lot of the stuff where we get hit with things, like going through tables, coming off top ropes, getting hit with chairs and all that type of stuff, that’s the worst type of pain because...you cannot really train yourself to get hit with a chair or train yourself to get thrown through a table, you just have to do it and it’s that mental thing that you accept the hurt...but that is the worst pain because...there will come a point where I am going to get thrown through table and it is either I make a tit of myself and just stop the match and say ‘no I am not gonna do it’, but I just have to do it, and that is the worst pain.”*

In general, the high contact athletes appeared to appraise pain more realistically than the low and medium contact athletes did.

Decision making (stop or continue activity).

There was a clear distinction between high contact athletes and low and medium contact athletes when it came to making decisions about whether to continue with an activity if pain

was present. The high contact athletes were much more conservative in their approach to pain and would stop if they felt that the pain was harmful.

H2: *“but obviously with more serious injuries I find that I’ll just you know, although I do some stupid things especially with the pro wrestling, I will...say no, enough’s enough.”*

The high contact athletes also seemed to be more able to make the distinction between the importance of an event and whether it was worth continuing in pain. For example, one judoka stated that her decision making regarding whether to stop or continue a fight was based entirely on whether it was a training session or a competition. She was more willing to take risks for competition, but even then knew when to stop if it was serious.

H4: *“In training, if you are in pain...you start to take it easy and it doesn’t really matter as much, ...you can like stop...but in a competition you need to try and block it out to like continue in the fight, as long as it’s not serious.”*

The low and medium contact athletes, on the other hand, appeared to be more naïve about injury and would report trying “jog it off” or would try to “push through” injury pain, despite it being potentially serious.

M1: *“I think it was lack of understanding as to what’s going on [subluxation of knee]. I was experiencing the pain for 2 days and it was fine so I was like ‘oh I can carry on’”*

And later:

“At the back of my mind it’s like “well I shouldn’t be doing this but I’ve got to” sort of thing...but I’ll reduce the intensity just so I’m not putting the Achilles or what not through the same amount of pressure but ...(3)... it’s always at the back of my mind that I’ve got to keep on going, to push through it.”

Another low contact athlete reported taking pain killers to ensure she could compete in a Miss Fitness competition, despite having a serious hip injury.

L1: *“When I did my hip at the competition it was a case of ‘right I know that adrenaline is gonna kick in in a minute and the painkillers are gonna kick in’ so I’m not going to feel it so I’ll be able to do my routine again and that I’ll be able to get through it and it worked.”*

In summary, the high contact athletes appeared to be more cautious in their willingness to continue in pain compared to the other participants. They also appeared to be able to understand the meaning of injury pain better than the low and medium contact athletes. They seemed to be able to differentiate between harmful and benign pain and did not allow non-threatening pain to bother them.

Attrition (stop or continue sport).

Some of the high contact athletes reported that they would cease participation in their sport when they got older, an indication of being able to understand the meaning of pain.

H2: *“I am at that age where I’m young enough to be able to take it but maybe ten years down the line I don’t think I will be able to do the wrestling ten years down the line because obviously my body will be getting older, a lot more stiffer but with the likes of MMA and rugby, I think I will be able to do that a lot longer than what I will be able to do the wrestling.”*

Some of the low and medium contact participants reported dropping out of high contact sports because of pain and the threat of injury.

M2: *“I just don’t think that my body could cope with like people on top of me and that’s the only reason, like my dad, he never played football, he always played rugby and I used to go and watch him every weekend play rugby, I used to throw the ball around and kick it and that, maybe that’s why that put me off, I dunno, that he was always hurt.”*

However, no athlete said that pain would make them drop out of their sport. The main decisions to stop playing were based upon fitness, body shape and age.

Coping strategies.

Most participants reported using coping strategies to help them to endure pain. Many of the individual strategies employed were to cope with exertion and contact pain. Athletes tended to use social support from other people more for injury related pain.

Goal setting.

Athletes reported using goal setting for exertion pain to help them to maintain participation and involvement in the activity.

M1: “...just to keep me going through it sort of thing so I’ve got ...(2)... psychologically I’ll get myself through and I also know that I’ve got a goal to go towards...”

Dissociation.

A very common strategy for dealing with exertion pain was dissociation or blocking it out. Most athletes reported “*ploughing through*” this type of pain by ignoring it.

H5: “Just really to like keep on going, to try not to stop and just try and like keep on going, keep on fighting, keep on training and just like try and block the pain out so you’re not thinking about it.”

Self-talk.

Most athletes reported using self-talk when enduring exertion pain. This was mainly a motivational tool to maintain participation or to keep on training.

L3: “it’s self-talk as you would say ‘keep going’, ‘come on push, push just a little further’ and things like that. Dead simple but, you know, ‘just a couple more reps’ or ‘alright, alright I know you’re tired but come on just keep going, do 2 or 3 and then you can go home’, that kind of thing you know.”

Relaxation.

A small number of participants reported using relaxation strategies to help them to deal with contact pain or exertion pain when taking a break.

H1: “When you have had a big hit, just relaxing a bit, taking a few breaths sometimes makes it like, go away.”

L1: “Breathing, oxygen helps relieve it, having a couple of minutes break if you need it if you’re getting too tired and then try and do it again.”

Arousal.

Only high contact athletes reported using arousal levels to cope with pain. This was usually referred to being “*psyched up*” and ready to compete, often with references to using “*adrenaline*” to maintain performance levels.

H2: “I get a massive adrenaline rush sometimes, especially in pro wrestling... sometimes I don’t actually feel the bumps and bruises until after the match and I have calmed down especially with rugby, with MMA I have got to try and control the

adrenaline rush because it is controlled aggression, it is a game plan I have got to stick to but with the rugby and that I find that adrenaline just blocks it out for me sometimes.”

Many high contact athletes reported the delayed onset of pain, due to arousal or adrenaline during competition.

H4: *“...when it’s a fight, you don’t feel it. Even if you’re sparring you don’t because you’re thinking of your opponents next move, you’re not thinking of ‘oh he’s just hit me, my eye’s sore or he’s just kicked me in the ribs’ you’re just always thinking ahead...”*

Social support.

Athletes reported turning to team mates, coaches or friends and family for support especially for injury pain. They all stated that this strategy was very helpful to them when coping with injury pain.

L2: *“I talk to my mam a lot about it, she’s always on the phone because she knows what it means to me...she’s been there right from the start, right through all my injuries, when I dislocated my hips and stuff like that so she knows that it means a lot to me and she’s seen me cry when I’m not doing well...”*

Most athletes who had suffered with serious injury reported that having others around was a great source of support and comfort.

Social and cultural influences.

Participants, particularly team sports athletes, discussed how the culture could sometimes help them to cope with pain or make them want to continue whilst in pain. In addition, the participants stated that how their team mates viewed them was important in how they dealt with pain.

Team ethic.

Many of the team based athletes reported wanting to play in pain due to their team mates.

H1: *“Like, everybody else is running around, if you don’t get over to that ruck for example, your team mate’s going to get hurt or you’re going to lose the ball. So it’s just like, unless, you know, you’ve broke something, maybe then, it’s just like, get up and*

deal with it, cos that's just kind of the nature of that sport, you don't go off, or you don't just lie there because, obviously especially cos I play back row so you've got to be like, up and just keep going and its, think of your team mates"

This view was held by all of the athletes who played team sports and reflected the need to "take one for the team" (H1) or "stand together" (H2) with teammates.

Machismo.

In addition to wanting to "front up" for the team, some athletes reported that they did not want to appear weak or "soft" in front of others.

M1: *"there's a lot of lads there and they're sort of like 'get up, you're a girl', whatever, sort of thing, 'get up, on your feet, it's nothing, it's just a scratch'"*.

There was also a feeling amongst the footballers that if weakness was shown, it was a signal to the opposition that the player might be a "soft target", so there was reluctance to show pain in these situations.

2.4 Discussion

The aim of this study was to explore pain experiences within sports. Analysis of the transcripts using the initial template helped to develop an understanding of how pain was viewed amongst the participants. The initial template (Figure 2.1) was based upon the current literature focussing on pain in sports. The final template (Figure 2.2) contained additional themes that emerged from the data. The following section considers the initial template themes as well as those that emerged during the analysis.

The final template was developed from the three main themes in the initial template to make five final primary themes. The initial template was useful in examining the theme of individual differences, and this was not changed from initial to final template. The other themes within in the final template were developed as a result of merging or separating themes from the initial template.

Experience and bothersomeness.

The theme of attrition was moved to become a sub-theme of experience and bothersomeness. This reflected the comments from the participants that bothersomeness of pain and their previous experience of pain could be a factor in continuing or stopping a sport all together, or the activity itself in the short term. In addition, appraisal of pain was moved from

the original learning theme to experience and bothersomeness. This was because athletes reported that their appraisal of pain as positive or negative might also be explained by its bothersomeness and their experience of that pain. Whilst the template is presented hierarchically, it should be noted that control of pain is also related to appraisal of it.

Bothersomeness emerged as a theme containing appraisals of pain and decision making, though it was not part of the initial template. Bothersomeness is important in pain research but to the authors knowledge has not been investigated qualitatively in the sports literature. Bothersomeness is analogous to unpleasantness of pain and often the two words are used interchangeably to describe pain affect (Chapman et al., 2002). In quantitative studies, bothersomeness has been measured during experimental pain, usually using a visual analog scale (VAS) (Geva & Defrin, 2013). Athletes tend to find pain less unpleasant than non-athletes, but studies are few and bothersomeness was not the main measure taken (Hall & Davies, 1991).

Within the field of psychology, bothersomeness of pain has been shown to correlate positively with emotional distress (Grøvle et al., 2010), work-related absence (Dunn & Croft, 2005) and results in decreased physical function (Patel, Guralnik, Dansie & Turk, 2013). In sport, it therefore could be assumed that if someone finds pain bothersome, they may not perform well and may even cease participation. Indeed, DeRoche et al. (2011) reported that increased experience of pain can reduce how bothersome it is. Therefore, athletes with more encounters of pain can cope better with it and do not let it interfere with sports performance. In addition, this increased ability to cope with pain results in perseverance in painful sport activities and as a result, sustained performance levels. In this study, high contact athletes were not bothered by contact pain, yet the medium and low contact athletes were. This suggests that high contact athletes found this pain less bothersome, perhaps because of frequent exposure to contact related pain, coupled with a positive appraisal of it. The low and medium contact athletes were bothered by this pain due to lack of experience and a negative appraisal of it.

In contrast, most athletes reported that injury pain was bothersome and was appraised negatively. Athletes often feel that they cannot control injury pain (Taylor & Taylor, 1998), which results in feelings of helplessness, depression and frustration (Heil, 1993). Despite some athletes having quite serious injuries in the past, they still found injury pain bothersome, contradicting DeRoche et al. (2011), who stated that bothersomeness of pain is reduced according to experience. It therefore appears that it is not necessarily *exposure* to injury pain

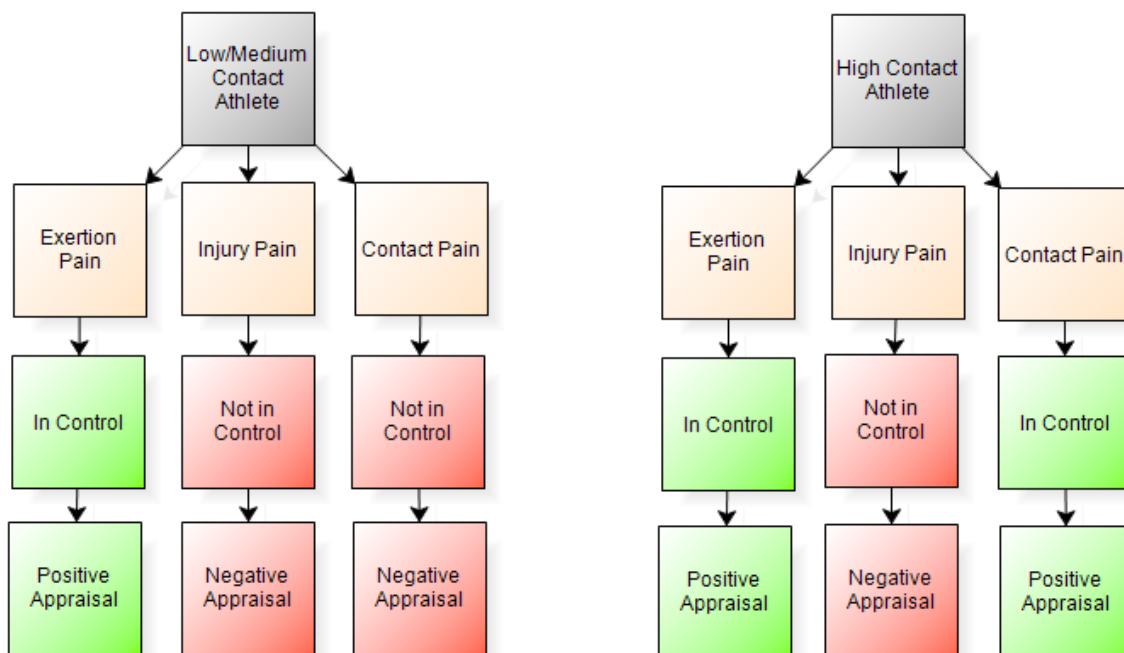
that reduces its bothersomeness, but the *appraisal* of that pain by the athlete. Negative appraisal appeared to result in higher bothersomeness. This has important implications for sports where injury pain may be frequent. If athletes appraise this risk negatively, it could result in reduced participation in the sport.

Athletes have reported that exertion pain is not bothersome because it is necessary for progression in sport, is in their control and is finite (Kress & Statler, 2007). In this study, all athletes stated that exertion pain was controllable and an accepted part of sport. Despite athletes stating that exertion pain may be unpleasant at the time, they viewed it as analogous to improvement and development within their sport.

Figure 2.3 shows how high and low/medium contact athletes appraised pain according to type of pain.

Figure 2.3

Appraisals of Exertion, Injury and Contact Pain by Athlete



Self-efficacy and control.

Self-efficacy and control were moved from the original themes of attrition and learning respectively and combined as one high order theme. This was because athletes stated that their feelings regarding pain were moderated by how much perceived control they had over it. It was

determined that perceived control over pain affected appraisal and catastrophizing, and therefore the two themes are linked to one another.

All comments relating to catastrophizing were in relation to injury pain. A key finding was that medium and low contact athletes appeared to be focused on the short-term consequences of injury rather than the long-term. Conversely, the high contact athletes appeared to be more conservative in their approach to pain and many of them seemed to think ahead about the consequences of playing while injured. This echoes the findings of Meyers et al. (2001) who found that high contact rodeo athletes had a greater sense of self-preservation compared to low contact and less experienced rodeo athletes. High contact athletes were more realistic in their appraisals of pain and were able to make more sensible judgements about continuing their sport. On the contrary, low contact and inexperienced athletes were much more willing to take risks and, at times, appeared naïve about their pain. This could be a function of experience and having knowledge of what pain means, which allowed high contact athletes to make more realistic judgements about pain. In addition, Griffith et al. (2006) and Pappas et al. (2005) reported that BASE jumpers and dancers respectively catastrophized less about pain as experience increased, due to having an understanding of pain. Taken together these results suggest that experience of pain may enable athletes to recognise what pain means, resulting in them making more reasoned decisions about continuing participation.

When discussing perceived control of pain, all athletes reported that they felt injury pain was not in their control, concurring with the findings of Taylor and Taylor (1998). Most athletes agreed that exertion pain was in their control. Kress and Statler (2007) interviewed cyclists and found similar results, reporting that they viewed cycling-related exertion pain as controllable and finite, meaning that they approached this pain positively. In addition, athletes have also reported that exertion pain is an indication of conditioning, meaning that it is accepted and is viewed as a sign that hard work is taking place (Anderson & Hanrahan 2008; Hanold, 2010). In the current study, athletes reported that they knew their exertion pain was part of their progress as an athlete and was something that they could control. Perception of control over pain and the meaning attached to it therefore appears to be important in how athletes approach pain.

Low and medium contact athletes did not feel in control of contact pain, often viewing it as a shock or as unexpected. In contrast, high contact athletes reported that whilst their contact pain could not be predicted sometimes, they did have control over it on other occasions. Some

high contact athletes blamed themselves for experiencing contact pain, because they felt they could always avoid it, for example by protecting themselves in a sparring match. Having perceived control over pain can enhance self-efficacy and therefore persistence at a task (Bandura, O'Leary, Barr Taylor, Gauthier & Gossard 1987). This may explain why high contact athletes continued to play their painful sports, and why the medium and low contact athletes chose not to engage in high contact activities. It is important to stress that it is the *perception* of control that is key to sustained involvement in sports. In Bandura's study, it was found that dummy pain killers were found to increase self-efficacy and control over pain, despite the use of a placebo. In this study, it is unlikely that high contact athletes had full control over their contact pain. Collisions, punches and tackles can be unpredictable despite being expected in contact sports. However as long as perceived control was present, self-efficacy was increased and involvement in the sport continued. Having less perceived control over pain can result in catastrophizing or avoidance behaviours (Bandura et al., 1987). Within the current study, some low contact athletes reported that they became anxious and uncertain about contact pain when it occurred, as they did not feel that they could control when and how it happened. Some also reported that they had tried contact sports but did not like the pain experienced, so ceased participation.

Social and cultural influences.

Social and cultural influences were also made a main theme in line with the many comments made by athletes regarding their experiences of team ethic and machismo within their sports. In general, all athletes accepted that pain was part of their sport. The high contact athletes accepted both contact and exertion pain as being an occupational hazard, which echoes the work of Liston et al. (2006). The low and medium contact athletes were willing to accept exertion pain as part of their sport but not contact pain. All of the athletes described feeling negatively about injury pain.

Understandably, the influence of the team ethic was discussed only by team based athletes. They reported that it was frequently expected that they continue to play hurt and they accepted this, as part of their team culture. Many studies have examined the role of culture and playing through pain and injury within contact and non-contact sports. For example, Liston et al. (2006) interviewed rugby players regarding their willingness to play through pain. Results indicated that the team ethic of standing up for the team and showing toughness in the face of pain were common reasons for continued participation in rugby. In non-contact sports such as

rowing, athletes also report that they continue to participate through pain to avoid letting the team down (Pike & Maguire, 2003). This team ethic was very evident in this study and reflected acceptance of pain as part of sport.

In addition, it was clear that the high contact athletes saw pain as part of their sport, and that contact pain, in particular, was viewed positively. This is indicative of a high direct coping style, suggesting that contact athletes saw this pain as important to their sport and something that should be “toughed out” (Bourgeois et al., 2009). Direct coping has been found to be higher in contact athletes compared to non-contact athletes (Meyers et al., 2001) and this study concurs with this finding. The high contact athletes reported that contact pain was necessary for their sport and they often described it in very positive terms. The low and medium contact athletes described contact pain negatively and did not approach it with confidence.

Machismo was added as a theme to illustrate masculinity and the need to appear tough and strong during sport. All high contact athletes within this study, regardless of gender referred to machismo when discussing their sport. This is a common theme within sports and has received attention in the literature, often referred to alongside the “sport ethic” (Madrigal et al., 2015). The sport ethic refers to the commonly held belief that a true athlete must be willing to do whatever is necessary to maintain participation in a sport, even if this means playing hurt or while injured. This ethic is often reinforced by teammates, coaches and spectators (Nixon, 1994). With this sport ethic comes feelings of masculinity and the need for athletes to “take it like a man” or to “act tough” (Madrigal et al.). Studies examining the sport ethic and machismo according to gender have found equivocal results. Some studies have reported that males have a stronger tendency to play hurt and act tough in sports (e.g. Nixon, 1996), whereas others have found no gender differences (Weinberg et al., 2013). Within the current study, there appeared to be no differences between genders when machismo was discussed, with both male and female high contact athletes expressing the need to demonstrate masculinity within their sports.

In summary, the findings suggest that there are differences in pain perception and coping according to the contact level of the athlete. High contact athletes saw themselves as different in personality to other groups and reported that certain characteristics were needed to be successful in their sport. Low/medium contact athletes felt that they did not possess physical attributes and traits such as aggressiveness and therefore chose not to compete in contact sports. Athletes were able to differentiate between the three types of pain and discussed each in

different terms. High contact athletes appraised pain more conservatively than athletes who experienced less contact. In addition, pain was viewed differently according to the source, with exertion pain being viewed positively and injury pain negatively. Contact pain was sometimes celebrated by high contact athletes, but was viewed as a shock by low and medium contact athletes. Sporting culture and experience both influenced how athletes felt about pain. How pain is perceived ultimately affects how athletes feel about it and how they respond to it. This has implications for coaches who work with athletes who may experience pain as part of sport. Coaches should be aware that pain perception might influence whether an athlete adheres to a sport or not. Coping strategies to alter pain perception could be used to aid enjoyment and adherence in contact sports.

There are limitations within this study. First, the sample used was heterogeneous and contained international competitors, county level and recreational athletes. This was to achieve a broad understanding of pain within a cross section of sports. More detailed research could aim to understand pain experiences within certain levels of sport (i.e. amateur and professional) or within certain sport types (i.e. team based or individual sports) to gain a more specific understanding of pain within these contexts.

Second, athletes were classified according to the level of contact experienced in their sport. Although there are problems with placing athletes into categories such as these, it was determined to be useful to explore responses according to contact level. It could be argued that each athlete would experience different levels of contact, and therefore pain in their sports. For example, in rugby a winger may not get involved in as many tackles, rucks and mauls as a prop. In addition, the purpose of contact in sports differ, which impacts on contact and pain experienced. For example, martial artists have a specific aim of hitting or contacting their opponent in a highly organised and specific way. A rugby player comes into contact with others at intervals during a match, but contact is not the sole purpose of the sport. Finally, in football contact is penalised but this does not mean that it never happens. It was difficult to classify football but as contact was not within the rules it was deemed to be a medium contact sport. These classifications were made to aid analysis, but it is acknowledged that there are difficulties in placing athletes into these categories.

Third, the study was limited to only ten participants, and therefore the research may not apply to other athletes. Further research involving more athletes from a varied range of backgrounds would develop understanding of pain experiences. Future research could involve

a mixed methods approach where psychological constructs such as bothersomeness and pain coping styles are measured alongside focus groups or interviews to explore differences between athlete groups.

In conclusion, this study aimed to explore the pain experiences of athletes from different sporting backgrounds, focusing on injury, contact and exertion pain. The objective was to explore the pain experiences of athletes from a range of sports. Results showed that athletes appeared to experience pain differently according to the amount of contact they endured within their sports. This chapter has therefore begun to help to develop an understanding of how athletes view and cope with pain in sports and thus provides a basis for the work reported later in the thesis. The template aimed to explore the proposed mechanisms for differences in responses to pain between athlete groups and highlighted five primary themes. The mechanism of individual differences was discussed when athletes talked about their psychological and physical composition. The mechanism of learning was explored when athletes discussed their experiences of pain and bothersomeness, social and cultural influences on pain, control over pain and coping strategies. Attrition was also covered when athletes talked about experience with pain and their decisions to stop or continue sports.

The most salient findings were that high contact athletes perceived pain differently to the other groups; they felt that they were different than the other athletes both physically and psychologically, and they appraised pain more realistically and as less bothersome than the other groups and reported seeing all but injury pain positively, reflecting a high direct coping style. The template has shown that there are key areas to examine further. Namely, more attention needs to be focused on the differences between high contact and non/low contact athletes responses to pain – in particular personality. The current chapter has highlighted that these groups may have different coping styles, personality and perceptions of pain. To examine these, quantitative methods will be employed in the next study to compare high contact athletes to low/medium contact athletes. The next chapter will focus on the mechanisms of individual differences and learning as well as pain coping styles and bothersomeness.

Chapter Three: Personality, Pain Coping Styles and Bothersomeness

According to Contact Level

The previous chapter showed that high contact athletes and low/medium contact athletes had different views about pain. Specifically, high contact athletes viewed themselves as different to other athletes, stating that only certain types of people could participate in their sport. In addition, high contact athletes appeared to have a positive view of contact pain and saw pain as necessary to sports participation. They also reported that they did not let contact pain bother them as it was an expected part of their sport. This chapter will examine personality differences and coping styles in relation to the three different sources of pain discussed in the previous chapter; exertion, contact and injury. Both high and low/medium contact athletes will take part from a range of team and individual sports. This is the same classification used in study one to maintain consistency of approach. This will cover, partially, the second aim of the thesis, to compare high and low/non-contact athletes' responses to pain. It will also achieve the second outcome of the thesis, to investigate the role of personality and coping styles in high and low/medium contact athletes.

3.1 Introduction

Athletes regularly experience pain through exertion, contact with external objects and injury, yet no research has made the distinction between the three types of sports related pain. However, as evidenced in Chapter Two athletes were able to distinguish between these sources of pain and spoke about how they viewed them differently. Being able to manage these different types of pain and maintain performance in sport is crucial to continued participation and contributes to success (Egan, 1987).

It has been made clear that athletes report experimental pain differently than non-athletes (Tesarz et al., 2012) and that contact sports participants tolerate more pain than non-contact athletes (Ryan & Kovacic, 1966). Pain tolerance differences have been noted between different types of sports: Egan (1987) examined cold pain tolerance in different types of athlete (karate, fencing, cross country skiing, football and boxing) plus a control group of non-athletes. Results showed that football players and cross-country skiers had significantly higher pain tolerance than fencers and karate participants. No other groups were significantly different. In addition, highly trained athletes have higher pain tolerance than recreational athletes (Scott & Gijbers, 1981) and better performing athletes tolerate more pain than less successful athletes

(Walker, 1971). Gaining an understanding of the mechanisms behind this may help the development of pain coping strategies and may increase participation in painful sports.

The reasons for the differences in pain responses remain unclear and relatively unexplored, as discussed in Chapter One. The most common suggestion is that athletes ascertain or develop ways to cope with pain effectively as a result of experience. Indeed, results from the previous chapter indicated that high contact athletes viewed pain differently to low and medium contact athletes. They were more realistic about their pain and could recognise when pain was harmful, indicating that experience of pain may alter how it is interpreted.

High contact athletes may also use different coping styles to athletes who participate in low or non-contact sports. Coping styles refer to a broad approach to dealing with pain and often combine a number of specific strategies (Koolhaas & DeBoer, 2008). Coping strategy use (for example, imagery) was discussed within Chapter Two but coping styles were not examined directly. However, there were indications that some high contact athletes adopted a direct coping style, defined as having a positive approach to pain. Athletes who have a high direct coping style tend to view pain as necessary and endurable (Bourgeois et al., 2009).

In the previous chapter, it was noted that high contact athletes found contact pain less bothersome than low or medium contact athletes. Bothersomeness refers to how much pain interferes with thoughts or behaviour (Chapman et al., 2002). This distinction may simply be a function of pain expectancy within contact sports. Athletes who deliberately decide to take part in contact sports expect a certain amount of pain via contact and therefore may accept it (Ryan & Kovacic, 1966). Regardless of the actual amount of pain experienced in sport, however, some athletes may simply find pain less bothersome than others. This may be due to learning to cope with pain as a result of experience (DeRoche et al., 2011).

As discussed in Chapter One, personality may also account for variance in pain reporting and sports choice. This has not been widely explored in athletic populations, however it has been suggested that neuroticism may explain different pain reports in dancers (Tajet-Foxell & Rose, 1995). In the previous chapter, high contact athletes reported that they viewed themselves as different to other athletes. They also suggested that certain characteristics were needed to successfully participate in high contact sports, such as being willing to accept and approach pain. This may explain why some people choose to engage in painful activities.

Within this chapter, three potential moderators of pain responses will be explored: Pain bothersomeness, coping styles and personality. Due to the paucity of research that has made

distinctions about different pain sources, studies are discussed here in terms of general pain unless otherwise stated.

Bothersomeness.

A topic that has not been widely explored is bothersomeness of pain in sports settings. Bothersomeness is associated with unpleasantness of pain and often is discussed in terms of chronic pain affect (Chapman et al., 2002). Bothersomeness of sports pain is distinct from intensity and unpleasantness because it also relates to how physically or psychologically limiting pain is to performance. In addition, sports pain tends to be episodic in nature and therefore may not accord with chronic pain definitions of bothersomeness. In the absence of a sports related definition of pain bothersomeness, for the purposes of this thesis bothersomeness is seen as being linked to behaviour. Without having specific equipment to objectively measure pain intensity or bothersomeness, researchers have typically used inventories or scales to ask participants to rate their pain. Usually pain intensity and unpleasantness are measured using Visual Analog Scales (e.g. Geva & Defrin, 2013) and on occasions the Borg Scale (e.g. Monnier-Beniot et al., 2006). Some studies have also examined how pain affects motor performance, to establish how bothersome athletes find it (Brewer et al., 1990). Research suggests that pain tends to inhibit performance of complex tasks and, therefore is bothersome to some individuals (Brewer et al.).

In many sports-related studies, researchers have measured intensity of pain, but not unpleasantness (e.g. Manning & Fillingim, 2002). Measuring bothersomeness of pain as well as pain intensity and unpleasantness is important, as the constructs are separate and provide information about different aspects of pain (Chapman et al., 2002). It is difficult for participants in studies to rate pain, which is a multivariate construct, using one number, especially when they have not received training in pain rating. Therefore, for pain measures to be accurate, they should address the multivariate nature of pain and should at least address intensity as well as bothersomeness (Chapman et al.).

In sports research, only one study has made the distinction between pain intensity and unpleasantness (Hall & Davies, 1991). Hall and Davies asked 14 athletes and 14 non-athletes to complete a cold pressor test. During the painful stimulus participants rated both pain affect and pain intensity using VAS. Results indicated that athletes perceived pain as less intense and unpleasant compared to non-athletes. Interestingly non-athletes perceived pain affect (i.e. how the pain felt) to be higher than pain intensity whereas athletes perceived pain intensity to be

higher than pain affect. This distinction is important because it suggests that whilst athletes perceived the cold pain as more intense, they did not find it as unpleasant. Conversely, non-athletes found the cold pain to be more unpleasant than it was intense. This may explain why athletes are able to tolerate more pain than non-athletes and suggests that unpleasantness and intensity may interact differently according to athletic status.

As stated earlier, as pain is such a subjective experience, it can be difficult to determine how intensely it is felt. Measuring how bothersomeness impacts on cognitive or physical functioning can be a useful means of establishing the effect it has on an individual. There has been little exploration of the physical and psychological impact of pain during sports activities. Therefore, the extent to which pain affects athletes while participating and how physically limiting different types of pain (i.e. exertion, injury and contact) are during sporting activity remain unknown.

Some studies have examined how physically bothersome pain is to performance of motor tasks; i.e. how limiting pain was on physical performance (Brewer et al., 1990; Walker, 1971; Evans & McGlashan, 1967). In the earliest study, Evans and McGlashan found that participants exerted more effort while in pain and, as a result, performance of a simple task improved. In contrast, Brewer et al. and Walker found that performance deteriorated while participants were in pain. Brewer et al. also reported that complex golf putting tasks (varying the distance and direction from the hole) were more inhibited by pain than simpler tasks. Therefore pain affected performance in an inverted U fashion, in a similar manner to arousal, and that more attentional resources were needed during the complex task performance. This explains performance improvements in Evans and McGlashan's study, because the task they used was relatively simple, involving displacing water by pumping a rubber bulb.

It is also not known whether pain bothersomeness is different according to athlete type. DeRoche et al. (2011) reported that pain bothersomeness was reduced according to experience. This resulted in perseverance in painful sport activities and consequently, sustained performance levels. Thus, it can be hypothesised that high contact athletes, who have had more experience of pain than low/medium contact athletes may have reduced bothersomeness of contact pain. With a lack of differentiation between pain types it is hypothesised that this would be the case for all three pain sources.

Coping styles and strategies.

Pain coping styles and strategies have been explored as mechanisms for higher pain tolerance in athletes. Coping strategies refer to the specific cognitive or behavioural actions a person takes to cope with pain, for example using imagery or avoiding painful activity (Azevedo & Samulski, 2003). Coping styles refer to a more general definition of pain coping and often combine a number of similar strategies (Cronqvist et al., 1997); for example, catastrophizing is a pain coping style that is maladaptive and includes strategies such as avoidance behaviours (Leung, 2012). There is debate as to whether coping styles themselves are personality traits or whether they are learned behaviours, and there is ambiguity regarding which personality traits correlate with certain coping styles (Connor-Smith & Flachsbart, 2007). Koolhaas and DeBoer (2008) argue that coping styles are a process and are situation dependent. An individual may learn about coping with certain situations depending on the context; for example, a contact athlete may learn or model coping styles on teammates based on team culture; for example if team mates regularly celebrate pain. As such, for the purposes of this study, coping styles are viewed as a learned behaviour rather than a personality trait.

Coping strategies.

Manning and Fillingim (2002) found that athletes used more competitive coping strategies compared to non-athletes while experiencing experimental pain. That is, athletes focused on overcoming the pain and wanted to “beat the tests”. Athletes also had a higher pain tolerance compared to non-athletes and were more confident in their ability to cope with pain. Participants who demonstrated higher pain tolerance reported using a coping strategy, indicating that learning of such approaches may alter pain responses. Further research has shown that athletes use mental strategies when coping with pain. For example, Ord and Gijssbers (2003) measured experimental pain tolerance and pain coping strategy use in rowers. The coping strategies were rated as “poor” if the strategy simply aimed to block out pain (e.g. counting down numbers) and “good” if the strategy actively focused on the pain (e.g. by thinking about the pain itself). Using this scale allowed the authors to quantify the quality of the strategies used, and to apply this to pain tolerance. Results demonstrated that trained rowers who reported using self-generated pain coping strategies during training and competition were able to tolerate more ischemic pain than those who did not. When the quality of the coping strategies were assessed, a positive correlation emerged between the quality of the strategy used and pain tolerance (Ord & Gijssbers).

As Ord and Gijbbers (2003) suggest, trained athletes may use coping strategies in their training and competition either consciously or unconsciously. Elite athletes, in particular, have probably worked with sports psychologists or may have read about psychological strategies to develop performance. Therefore, athletes who use pain coping strategies in the field may use these whilst under experimental conditions. Athletes who experience pain regularly in sport may simply have had the time and the need to refine coping strategies to continue participating. Many strategies have been shown to aid pain coping, such as imagery (e.g. Driediger et al., 2006), stress inoculation training (e.g. Naoi & Ostrow, 2008) and relaxation (e.g. Broucek et al., 1993).

Coping Styles.

In addition to coping strategies, coping styles have been highlighted as mechanisms for differences in pain response between athlete groups. Meyers, Bourgeois, Stewart & LeUnes, (1992) developed the Sports Inventory for Pain (SIP) that aimed to assess coping styles within painful sports. The original SIP assessed five coping styles; direct coping, cognitive, catastrophizing, avoidance and body awareness. Direct coping and cognitive scales measured positive dimensions of an athlete's coping style. High direct coping scores reflected the ability to see pain positively and accept it as part of sport. The cognitive scale measured whether any mental strategies were used by the athlete, with high scores reflecting use of mental techniques to help maintain performance. Catastrophizing measured how much an athlete ruminated about pain, with high scores indicating that the athlete despaired while in pain and essentially capitulated. The body awareness scale measured whether an athlete was hyper or hypo sensitive to pain with high scores indicating increased responsiveness to pain. The avoidance scale measured whether the athlete employed avoidant strategies when in pain, with high scores indicating that the athlete was less competitive when in pain. The initial SIP has since been refined into the SIP15 which assesses direct coping, catastrophizing and somatic awareness (Bourgeois et al., 2009). The somatic awareness scale assesses sensitivity to pain; the other scales are the same as outlined above.

Meyers et al. (2001) used the original SIP to examine pain coping styles in rodeo athletes of different abilities and disciplines. Top ranked rodeo athletes exhibited higher avoidance styles than lower ranked rodeo athletes. Higher ranked athletes may therefore have a greater need for self-preservation due to a desire to continue participation. Athletes competing in rodeo-style events with a high potential for injury (e.g. roughstock riding) exhibited lower

catastrophizing and higher body awareness than those who participated in less risky events (e.g. barrel racing). This suggests that those with less experience of injury may have less regard and concern for pain than those who have the potential to experience many injuries. Results showed that when compared to non-contact rodeo athletes, the high contact rodeo performers exhibited significantly higher direct coping styles and lower catastrophizing. Exposure to risk and pain therefore helped athletes to develop a greater ability to cope with and manage pain. Experience of pain may mediate responses to it by making athletes more aware of what it means. This would then allow athletes to refine coping mechanisms.

Griffith et al. (2006) also used the SIP to examine pain coping responses in BASE (bridges, antennas, spans and edges) jumpers. They found that more experienced jumpers were conservative in their approach to pain. Inexperienced jumpers were described as naïve and were willing to take more risks despite feeling pain. This indicates that experience of pain may result in a more measured and realistic approach to it. This accords with the results reported in Chapter Two that indicated that high contact athletes were more conservative in how they responded to injury pain. Therefore, there is evidence that athletes from different populations may use different pain coping styles and strategies for contact and injury pain, and that athletes in contact or risky sports may cope more positively with pain and catastrophize less about it.

In the only study to examine different pain types, Anderson and Hanrahan (2008) assessed pain coping styles in dancers according to whether they experienced performance (or exertion pain) or injury pain. Results showed that pain coping styles, as defined by the SIP, were not different for the two pain types. In addition, dancers viewed different sources of pain in a similar manner, which may be a result of an inability to distinguish between pain types. This was more a function of pain perception than the actual source of pain itself. If pain was perceived as a threat, dancers used more avoidance and catastrophizing coping styles regardless of the pain source. This could suggest that pain source is irrelevant and that it is the *perception* of pain that is important. That is, if an athlete views pain as a threat or is afraid, they will display avoidance and catastrophizing coping styles regardless of whether it is an injury or simply acute exertion related pain. It also suggests that it is particularly important for athletes to be able to distinguish between different pain types, because they may be catastrophizing over pain that is not harmful.

There has been little comparison of how different athletes cope with exertion pain; however, some studies have examined how athletes feel about this pain type. For example,

Kress and Statler (2007) found that cyclists saw exertion pain as something to be overcome and a challenge. Dancers also viewed exertion pain as positive due to its conditioning effect (Anderson & Hanrahan, 2008). Liston et al. (2006) found similar results with team based contact athletes. Exertion pain therefore, may be viewed positively by most athletes as it usually indicates that conditioning is taking place (Taylor & Taylor, 1999).

Evidence suggests that coping style differences may be apparent not only as a function of contact level, but also the source of pain. High contact athletes may cope more positively with contact and injury pain and catastrophize less as a result. Evidence for potential differences in responses to exertion pain is less clear, but individual studies have indicated that athletes may view this pain in the same way, regardless of sport type. In summary, coping styles may explain how athletes approach and view pain differently. However, more research is needed to determine how coping styles might differ according to pain source (i.e. contact, injury or exertion). Understanding how athletes cope with each of these pain sources could result in the development of effective pain coping strategies.

Personality.

Little attention has been given to individual differences as a mechanism for pain tolerance differences between athlete groups. Athlete groups may simply have different personalities to one another, which may account for pain tolerance differences. There has been brief speculation in the literature regarding the influence of personality on pain reporting. For example, Tajet-Foxell & Rose (1995) suggested that neuroticism may be linked to pain tolerance, though this was not directly measured in their study. Other than this, no studies have attempted to link personality to differences in pain reporting between athlete groups. Within clinical populations, neuroticism has been associated with reduced pain tolerance, higher pain ratings and the tendency to complain more of pain (Strachan et al., 2015). Moreover, positive personality traits such as agreeableness and optimism are protective against higher pain ratings and correlate with lower catastrophizing behaviour (Pulvers & Hood, 2013).

The Big Five personality dimensions provide one basis for examining personality (Kaiseler, Polman & Nicholls, 2012), however no studies have examined personality and pain responses in athletes. The broad dimensions of the Big Five are defined as follows: *Neuroticism* is an avoidance temperament and includes traits such as anxiety, impulsive behaviour, self-consciousness and moodiness. *Conscientiousness* refers to people who plan and strive with purpose towards goals. *Extraversion* is an approach temperament and conveys sociability,

dominance and assertiveness. *Openness to experience* includes flexibility, imagination, and curiosity. *Agreeableness* describes people who are friendly, empathetic and helpful (Buckworth, Dishman, O'Connor & Tomporowski, 2013).

Surprisingly, little research has focused on personality as a moderator of pain tolerance in sports settings. Medical studies have suggested that the Five Factor dimensions have an impact on pain tolerance. Neuroticism and measures relating to anxiety have been shown to have the most influence on experimentally induced pain (Vassend, Røysamb & Neilsen, 2013). Goubert, Crombez and Van Damme (2004) examined the role of catastrophizing and neuroticism in 122 patients with back pain. They found that neuroticism was a moderator in the relationship between catastrophic thoughts and pain severity. Neuroticism was associated with a reduction of the threshold at which pain was perceived as threatening. Threat was associated with catastrophizing thoughts and behaviours in the participants. Neuroticism is concomitant with negative feelings (Buckworth et al., 2013) and as such, those with this trait may attend to pain more and catastrophize about it.

The Big Five dimensions can influence coping with stressors. Neuroticism has been linked with maladaptive coping strategies whilst the other personality dimensions are associated with more adaptive strategies (Kaiseler et al., 2012). Personality factors can also influence appraisals of events as harmful or threatening, for example when experiencing pain (Suls & Martin, 2005). Individuals with high neuroticism tend to appraise events as more harmful or threatening whereas extraverted individuals have been associated with positive appraisals of coping resources and active coping responses (Kaiseler et al.).

Few studies have focused on the effects of personality on pain sensitivity in non-clinical populations (Vassend et al., 2013). In a study examining stressors in sports, Kaiseler et al. (2012) asked participants to rate the intensity of their stressor before completing a personality inventory measuring the big five dimensions. This study did not examine pain as a specific stressor, but it did focus on sports related, self-selected stressful events, one of which was injury. Results indicated that neurotic individuals perceived stressors to be more intense than less neurotic people. Neurotic individuals used less adaptive coping strategies and had lower perceived coping effectiveness. The other four personality dimensions were associated with more adaptive, effective coping strategies. This concurs with clinical studies, where agreeableness, openness to experience, extraversion and conscientiousness were found to be of critical importance to vigilance and sensitivity to pain (Goubert et al., 2004).

Moreover, personality may be one reason why some people choose to take up and maintain involvement in painful sports. Researchers have recently begun to explore personality differences between athletes and non-athletes as well as athletes from different types of sport (Allen et al., 2013). Studies have indicated that team based athletes have higher extraversion and lower conscientiousness than individual athletes (Allen et al., 2011). In addition, high risk takers in sport also have higher extraversion and lower conscientiousness than those who take fewer risks (Castanier et al., 2010). Some high contact athletes may be classed as risk takers due to the nature of their sports (Schroth, 1995). For example, combat sports are risky activities where the purpose is to defeat an opponent using physical force. Athletes who choose to partake in such sports are therefore risking injury and pain on a regular basis (Schroth). These findings suggest that the personality traits of extraversion and conscientiousness may be moderating factors in sport choice. Extraversion and conscientiousness appear to distinguish team and individual athletes as well as contact and non-contact participants. Emotional stability and neuroticism may identify people who are sensitive to pain and catastrophize about it (Kaiseler et al., 2012).

In conclusion, there has been little focus on the source of pain and how this might affect athletes. It is therefore unclear how and if athletes differentiate between pain types and how this may affect their performance and their mind-set. Research has indicated that there may be differences in pain coping styles and pain bothersomeness reporting between high and low/medium contact athletes, and findings in study one supported this. In addition, personality may influence the type of sport that an athlete chooses to play. More research is required however to explore differences between high contact athletes and others.

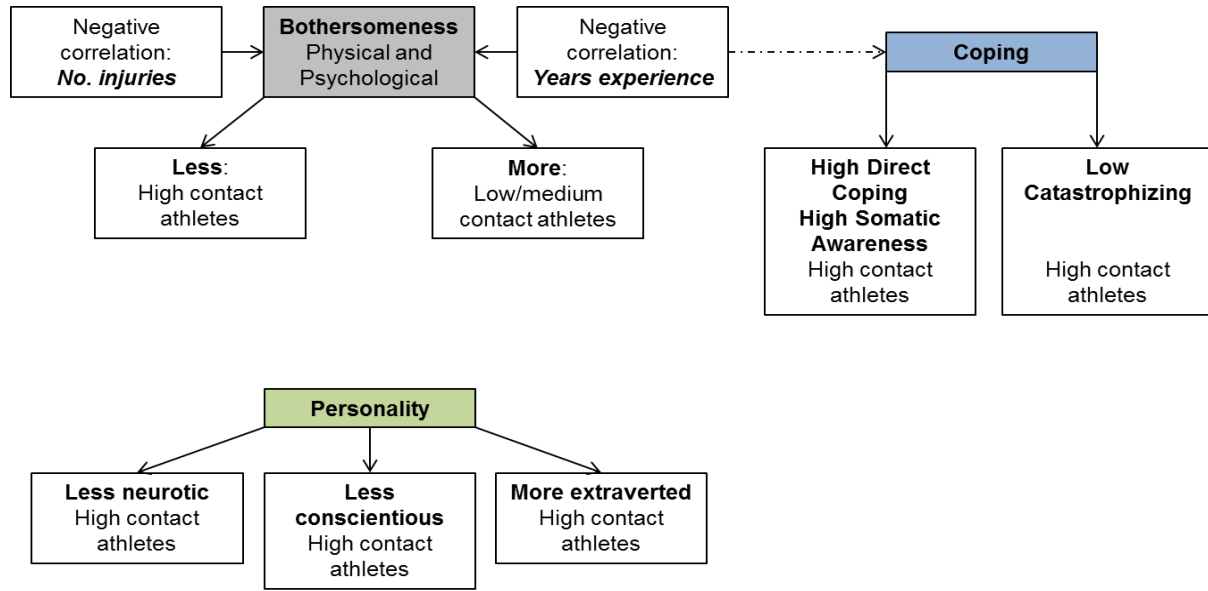
The current study.

The aim of this study is to assess the coping styles, pain bothersomeness and personality of high and low/medium contact athletes in the field. The objectives are to compare pain coping styles for three different types of sports related pain – exertion, contact and injury in high and low/medium contact athletes.

The hypotheses are as follows:

Figure 3.1

Hypothesised Results Based on Literature, Showing Inter-relationships between Variables.



H1: High contact athletes will find pain less physically and psychologically bothersome than low/medium contact athletes, for all three types of pain. This is based on research by DeRoche et al. (2011) who stated that bothersomeness may be reduced by exposure to pain.

H2a: High contact athletes will have higher direct coping scores than low/medium contact athletes for injury and contact pain. This is based on research by Meyers et al. (2001) who reported that high contact rodeo athletes had higher direct coping than rodeo athletes who experienced less contact and pain in their sport.

H2b: High contact athletes will have lower catastrophizing scores than low/medium contact athletes for injury and contact pain. This is also based on Meyers et al. (2001) who reported that high contact rodeo athletes catastrophized less about pain than those who experienced less contact and associated pain.

H2c: High contact athletes will have higher somatic awareness than low/medium contact athletes for injury and contact pain. This was also based on Meyers et al. (2001) who reported that high contact rodeo athletes had higher somatic awareness than those who experienced less contact and associated pain.

H3: With a lack of research into personality differences between high and low/medium contact athletes it is difficult to make a prediction about potential personality differences. It is

hypothesised however that there will be differences in personality subscales between high and low/medium contact athletes. It is hypothesised that high contact athletes will be more extraverted and less conscientious than low/medium contact athletes. This is based on work by Schroth (1995) who suggested that contact athletes may be risk takers who are characterised by higher extraversion and lower conscientiousness than other athletes. It is also predicted that high contact athletes will be more emotionally stable (i.e. less neurotic) than low/medium contact athletes, as reflected in clinical literature that indicates that those who approach pain positively tend to be less neurotic than those who avoid painful situations (e.g. Vassend et al., 2003).

H4a: The number of major injuries will be negatively correlated with psychological and physical bothersomeness for injury pain. This is based on the findings within the previous chapter that suggested that athletes who have experienced injuries may be less bothered by them as they may understand their meaning. This is also reflected in work by Nemeth et al. (2005) who suggested that experience of injuries may result in better understanding of the injury, which may reduce bothersomeness.

H4b: Years' experience will be negatively correlated with psychological and physical bothersomeness for all pain types. This is based on the suggestion by DeRoche et al. (2008) that experience of pain may reduce how bothersome it is for athletes.

3.2 Method

Participants.

Participants (n = 294; 188 male, 106 female, M age = 25.1 years, SD = 6.6 years) were recruited via University and College notice boards and by visiting local clubs and teams in the area. Inclusion criteria stated that athletes must participate at a competitive level in their sport. The participants were divided into two groups according to the sport played.

High contact athletes (N = 135) were drawn from sports where contact is part of the sport and allowed within the rules; these sports were karate, judo, mixed martial arts, jiu jitsu, kickboxing, wrestling, rugby union, rugby league and Gaelic football. Low/medium contact athletes (N = 159) were from sports where contact may occur in the sport, generally with objects (but could be with others), but is not integral to the nature of the sport, or sports where contact is not encouraged during the activity and if excessive would normally be penalised; these sports were dance, gymnastics, triathlon, golf, rowing, netball, cricket, hockey, basketball and football. Using an alpha level of $p < 0.05$, sample size (N = 294) was calculated based on

prospective estimates of power and effect size figures to achieve an acceptable power level of 0.8 and a large effect size of $\eta^2 = 0.138$ (Clark-Carter, 2008).

Ethical approval for the study was granted by the University Research Research Ethics Committee. All participants gave informed consent to participate (see appendix B).

Instruments.

Bothersomeness and demographic information.

The first questionnaire measured age, gender, years of participation in the sport, level of participation, point in the season when the questionnaire was completed, and number of major and minor injuries suffered in the sport. Participants were also given a bothersomeness questionnaire relating to each of the three types of pain (exertion, contact and injury). Questions regarding how bothersome pain was from a psychological and a physical point of view were posed using a five-point scale with anchors ranging from 1 = “not at all” to 5 = “extremely”. Participants were informed that psychological bothersomeness referred to pain interfering with psychological state during performance, whilst physical bothersomeness referred to whether pain interfered with any aspect of their physical performance.

The Sports Inventory for Pain (SIP15, Bourgeois, et al., 2009).

Participants were asked to complete this questionnaire three times, once focusing on contact related pain, once on injury pain and once on exertion pain. The wording in the questionnaire was adapted to reflect the pain types; for example, where the SIP15 states “I do not allow pain to interfere with my performance”, the word “contact”, “injury” or “exertion” was inserted before the word “pain” to allow participants to reflect on that pain type specifically. It was felt that this did not interfere with the psychometrics of the questionnaire and was essential to explore differences in response to each pain type.

The SIP15 was developed from the original Sports Inventory for Pain (Meyers et al., 1992). The original contained 25 questions and five subscales and received marginal support as a valid and reliable tool (Bartholomew, Edwards, Brewer, Van Raalte & Linder, 1998). Despite some support for the validity of the SIP (e.g. Encarnacion et al., 2000), it was felt that the inventory was too lengthy and that a revision of it was required. Bourgeois et al. produced the SIP15, a 15-item inventory that contained only three subscales – Direct Coping, Somatic Awareness and Catastrophizing. Direct Coping (through action) is a positive coping style in relation to pain and assesses the extent to which someone uses direct coping strategies to deal

with pain. People who score high on this scale tend to approach pain positively and are prepared to endure it. The Catastrophizing scale measures whether individuals ruminate on pain, feel it is unbearable or simply capitulate when in pain. The Somatic Awareness scale assesses whether someone is hyposensitive or hypersensitive to pain stimuli. The SIP15 yielded acceptable reliability values for direct coping ($\alpha = 0.87$) and catastrophizing ($\alpha = 0.76$), though somatic awareness was less reliable ($\alpha = 0.54$). Nevertheless, with the absence of other sports related inventories, the SIP15 has been used in several studies (e.g. Masten, Strazar, Zilavec, Tusak & Kandare, 2014; Griffith et al., 2006), has showed a sound factor structure and is a reliable tool where brevity is required when assessing in the field (Bourgeois et al.).

Ten Item Personality Inventory (TIPI, Gosling, Rentfrow & Swann, 2003).

This questionnaire assessed the Big Five personality traits of extraversion, conscientiousness, openness to experience, agreeableness and emotional stability. The inventory contained ten statements and required participants to state how much they agreed that the statement describes them. This was measured on a scale of 1-7 with 1 = *disagree strongly* and 7 = *agree strongly*. It was designed to meet the needs of researchers who require a short assessment tool in studies where personality is not the primary measure. It has diminished psychometric properties when compared to other longer personality inventories, but its brevity means that it can be used in the field and it has been shown to be more valid than other short measures of personality (Holmes, 2010).

Procedure.

All participants were provided with a questionnaire pack. The packs contained a definition of contact, exertion and injury pain, information sheet, consent form, the questionnaires as outlined above and a debrief sheet. Individual athletes were either posted the questionnaire pack with a stamped addressed envelope for returning the documents or were seen in person by the researcher. Where clubs were involved, the researcher attended a mutually convenient training session and distributed questionnaire packs to the group. Participants were allowed time to read the information sheet, sign the consent forms and were given time to ask any questions. They then completed the questionnaires and returned them to the researcher.

Data analysis.

Data were analysed using IBM SPSS statistics version 21. Differences between athlete groups for bothersomeness, coping styles and personality scales were analysed using

MANOVA and Discriminant Function Analysis (DFA). Initial analysis was conducted by comparing high contact athletes low/medium contact athletes. Correlations were performed to examine relationships between bothersomeness and some demographic variables.

Missing values appeared in the bothersomeness scales and within the SIP15 responses. The bothersomeness scales yielded missing values for both physical and psychological bothersomeness of contact and exertion pain. In each case, the participant had not answered these questions because they stated that they had not experienced these types of pain. In these cases listwise deletion was employed and a total of 11 cases were deleted. Some participants did not respond to whole pages of the SIP15 questionnaire. As such a large amount of data were lost, these cases were also deleted from the data set ($n = 19$). Therefore, data from 30 cases were deleted in total, leaving 264 participants. Of these 125 were high contact athletes and 139 were low/medium contact athletes.

Imputation using regression estimate was employed for SIP15 questions where the participant had missed only one question (Gelman & Hill, 2012). There was no pattern to the missed questions, as analysed using SPSS missing data pattern analysis. The data were therefore treated as missing completely at random, which meant that imputation was appropriate (Field, 2009). A total of 5 imputations were made across the SIP15 subscales. Despite the known problems of using imputation (such as increased standard error), it was felt that in this case the data would not be affected by imputing values for individual questions due to the small number of imputations required (Gelman & Hill). Effect sizes are reported as r throughout as recommended by Field.

3.3 Results

A total of 170 males (M age = 24.4 years, $SD = 5.7$ years) and 94 females (M age = 26.1 years, $SD = 7.9$ years) were included in the final analysis. Data were checked for normality, revealing that skewness was a problem. Where data could not be normalised through transformations using natural log and square root, non-parametric tests were conducted alongside the parametric equivalent. Results yielded were very similar for both tests; therefore, parametric results are reported here.

Research question 1: bothersomeness.

This question aimed to explore differences in psychological and physical bothersomeness of pain according to the amount of contact experienced within the sport.

All of the bothersomeness scales were significantly non-normal according to the Kolmogorov-Smirnov test, $p < 0.001$ (see appendix C). Data were thoroughly checked for skewness and kurtosis (see appendix D and E) and transformations applied where necessary, however transformations using square root and natural log did not normalise the data. All of the bothersomeness scales were checked for correlations (see appendix F). Where scales were correlated, the effect sizes were small to medium.

Box's test revealed that the assumption of homogeneity of covariance matrices was violated ($p < 0.0001$). Levene's test also revealed that homogeneity of variance was violated for physical bothersomeness of contact pain ($F_{(1,262)} = 16.42$, $p < 0.001$) and physical bothersomeness of exertion pain ($F_{(1,262)} = 6.68$, $p = 0.01$). No other scales were violated. Therefore, Pillai's trace has been used for analysis as a more robust statistic in this situation. When using large samples both Levene's and Box's test can be significant despite small deviances from homogeneity (Field, 2009). If Box's test is significant and data are not normally distributed, as in this case, it is prudent to check variances between groups. Hartley's F_{\max} or variance ratio was calculated for each group using 1.96 as the F_{\max} value threshold (Field). This revealed that the variances were equal on all bothersomeness scales apart from physical bothersomeness of contact pain ($F_{\max} = 3.44$) and psychological bothersomeness of contact pain ($F_{\max} = 2.04$). Outliers were then removed from these scales to attempt to normalise the variance, however this created more outliers and made the F_{\max} ratio even greater.

Hypothesis 1 stated that high contact athletes would find all three pain types less physically and psychologically bothersome than low-contact athletes. The independent variable was athlete type (high or low/medium contact) and the dependent variables were bothersomeness (physical or psychological) and pain type (contact, injury or exertion). A $2 \times 2 \times 3$ MANOVA revealed that there was a significant main effect of contact level on bothersomeness, $F_{(6,257)} = 2.6$, Pillai's trace (V) = 0.92, $p = 0.02$, $r = 0.10$. Univariate tests revealed that high contact athletes found contact pain significantly less physically bothersome than low/medium contact athletes, $F_{(1,262)} = 5.13$, $p = 0.02$, $r = 0.13$; they also found exertion pain significantly less physically bothersome than low/medium contact athletes $F_{(1,262)} = 0.31$, $p = 0.02$, $r = 0.03$.

Psychological bothersomeness of contact pain was approaching significance, with high contact athletes perceiving this to be less than low/medium contact athletes $F_{(1,262)} = 3.71$, $p = 0.05$, $r = 0.11$. The effect sizes for all observed differences were very small. No other significant effects were found. Therefore this hypothesis was partially supported.

DFA was also conducted alongside univariate tests to fully explore and understand the data (Field, 2009). The analysis was performed using bothersomeness scores as the dependent variable and contact level as the predictor variable. A total of 264 cases were analysed. Overall the discriminant function successfully predicted outcome for 58.7% of cases, with accurate predictions being made for 68% of high contact athletes and 50.4% of low/medium contact athletes, canonical $R^2 = 0.05$. A single discriminant function was calculated and this was significantly different for high and low/medium contact athletes, $\Lambda = 0.94$, $X^2 = 15.49$, $df = 6$, $p = 0.02$. The correlations between outcomes and the discriminant function suggested that physical bothersomeness of contact pain and exertion pain discriminated groups from each other. Physical bothersomeness of contact pain was positively correlated with the discriminant function value, ($r = 0.56$). Physical bothersomeness of exertion pain was also positively correlated with the discriminant function value, ($r = 0.56$). These findings suggest that high contact athletes are grouped by lower physical bothersomeness of exertion and contact pain. See Table 3.1.

Table 3.1
Physical and Psychological Bothersomeness Descriptive Statistics by Athlete Type and Pain Source

| Contact Pain | | | | |
|-------------------------------|--------------------|-----|------|------|
| Bothersomeness Type | Contact Level | N | M | SD |
| Physical Bothersomeness* | High contact | 125 | 1.9 | 0.06 |
| | Low/medium contact | 139 | 2.14 | 0.89 |
| Psychological Bothersomeness* | High contact | 125 | 1.85 | 0.92 |
| | Low/medium contact | 139 | 2.1 | 1.11 |
| Injury Pain | | | | |
| Bothersomeness Type | Contact Level | N | M | SD |
| Physical Bothersomeness | High contact | 125 | 2.59 | 1.07 |
| | Low/medium contact | 139 | 2.8 | 1.16 |
| Psychological Bothersomeness | High contact | 125 | 2.43 | 1.11 |
| | Low/medium contact | 139 | 2.61 | 1.23 |
| Exertion Pain | | | | |
| Bothersomeness Type | Contact Level | N | M | SD |
| Physical Bothersomeness* | High contact | 125 | 2.08 | 0.96 |
| | Low/medium contact | 139 | 2.35 | 0.99 |
| Psychological Bothersomeness | High contact | 125 | 2.04 | 1.01 |
| | Low/medium contact | 139 | 2.1 | 0.96 |

*p <0.05

Overall the results indicate that high contact athletes found contact and exertion pain less physically bothersome than low/medium contact athletes.

Research question 2: coping styles.

Research question 2 aimed to explore whether pain coping styles were different according to contact level. Normality was checked using the Kolmogorov-Smirnov test and all SIP15 subscales were shown to be significantly non-normal ($p < 0.005$, see appendix G). Skewness and kurtosis values were calculated using $z = 2.58$ as the threshold value (Field, 2009), this indicated that all subscales were normal.

Box's test revealed that the assumption of homogeneity of variance of covariance matrices had been violated ($p < 0.001$). The variances between high and low/medium contact

athletes for the SIP15 subscales were assessed using Levene's test and all but two subscales met the assumptions of homogeneity of variance; the somatic awareness scale for injury pain was significantly different between the two groups, $F_{(1,257)} = 4.67$, $p = 0.03$; as was the catastrophizing scale for exertion pain, $F_{(1,257)} = 7.73$, $p = 0.006$. Therefore, the variance ratio was calculated for these groups using Hartley's F_{\max} test. This showed that the F_{\max} variance ratio of 1.66 was not significant; therefore, homogeneity of variance can be assumed. Pillai's trace is reported in analysis, as recommended by Field (2009). The SIP15 subscales were also tested for reliability using Cronbach alphas. All scales were found to be reliable; direct coping $\alpha = 0.90$, catastrophizing $\alpha = 0.85$ and somatic awareness $\alpha = 0.77$.

Hypotheses 2a, b and c stated that high contact athletes would have higher direct coping and somatic awareness and lower catastrophizing scores than low/medium contact athletes for injury and contact pain. A 2x3x3 MANOVA was conducted using the SIP15 subscales (somatic awareness, direct coping and catastrophizing) and pain type (contact, injury, exertion) as dependent variables and athlete type (high or low/medium contact) as the independent variable. This revealed that there was a significant effect of contact level on the SIP sub-scales according to pain experienced, $F_{(9,254)} = 2.28$, $p = 0.01$; $V = 0.07$; $r = 0.09$. Univariate analysis revealed that high contact athletes had higher direct coping for contact pain than low/medium contact athletes, $F_{(1,262)} = 4.47$, $p = 0.03$, $r = 0.12$, with. Therefore, only hypothesis 2a was supported. Effect sizes were very small.

Further DFA was carried out to explore differences between high and low/medium contact athletes. A total of 264 cases were analysed. Overall the discriminant function successfully predicted the outcome for 61% of cases, with accurate classifications being made for 58% of high contact athletes and 63% of low/medium contact athletes, canonical $R^2 = 0.08$. A single discriminant function was calculated and this was significantly different for high and low contact athletes, $\Lambda = 0.92$, $X^2 = 20.46$, $df = 9$, $p = 0.01$. The correlations between predictor variables and the discriminant function suggested that direct coping for contact pain and catastrophizing for exertion pain classified contact level grouping. Direct coping for contact pain was negatively correlated with the discriminant function value, ($r = -0.45$). Catastrophizing for exertion pain was positively correlated with the discriminant function value, ($r = 0.25$). This suggests that high contact athletes are classified by high scores for direct coping for contact pain and low contact athletes are classified by high catastrophizing for exertion pain. See Table 3.2.

Table 3.2
SIP15 Subscales Descriptive Statistics by Athlete Type and Pain Source

| Injury Pain | | | | |
|-------------------|--------------------|-----|-------|------|
| SIP Subscale | Contact Level | N | M | SD |
| Direct Coping | High contact | 125 | 23.10 | 4.88 |
| | Low/medium contact | 139 | 23.10 | 5.45 |
| Catastrophizing | High contact | 125 | 13.26 | 3.20 |
| | Low/medium contact | 139 | 13.17 | 4.26 |
| Somatic Awareness | High contact | 125 | 8.80 | 1.99 |
| | Low/medium contact | 139 | 9.33 | 2.45 |
| Contact Pain | | | | |
| SIP Subscale | Contact Level | N | M | SD |
| Direct Coping* | High contact | 125 | 27.21 | 6.19 |
| | Low/medium contact | 139 | 25.64 | 5.86 |
| Catastrophizing | High contact | 125 | 10.61 | 4.44 |
| | Low/medium contact | 139 | 11.17 | 3.63 |
| Somatic Awareness | High contact | 125 | 9.64 | 3.04 |
| | Low/medium contact | 139 | 9.41 | 2.93 |
| Exertion Pain | | | | |
| SIP Subscale | Contact Level | N | M | SD |
| Direct Coping | High contact | 125 | 24.60 | 6.36 |
| | Low/medium contact | 139 | 25.56 | 5.51 |
| Catastrophizing | High contact | 125 | 12.52 | 4.15 |
| | Low/medium contact | 139 | 12.76 | 5.0 |
| Somatic Awareness | High contact | 125 | 8.81 | 2.69 |
| | Low/medium contact | 139 | 8.95 | 2.79 |

*p <0.05

Overall, the results indicate that high contact athletes had higher direct coping than low/medium contact athletes. In addition, DFA indicated that high direct coping for contact pain discriminated high contact athletes from low/medium contact athletes and that direct coping for exertion pain best classified low/medium contact athletes.

Research question 3: personality

Research question 3 aimed to examine whether there were personality differences amongst groups of athletes according to sport played. The Kolmogorov Smirnov test revealed

that all TIPI personality subscales were non-normal (see appendix H). Data were thoroughly checked for normality (see appendix I). Transformations using square root and natural log normalised some of the scales, but not all, as such the original data were used. Box's test was significant ($p < 0.0001$). Levene's test was also significant for the conscientiousness scale ($F_{(1,262)} = 6.12, p = 0.01$) and extraversion ($F_{(1,262)} = 4.28, p = 0.03$), Hartley's F_{\max} test was applied to these scales and it was shown that both scales were below the threshold ratio of 1.66, meaning that they could be treated as homogenous.

Hypothesis 3 stated that high contact athletes would be more extraverted, emotionally stable and less conscientious than low/medium contact athletes. A 2x5 MANOVA showed a significant effect of contact level (high or low/medium) on the personality subscales, $F_{(5,258)} = 4.62, p < 0.0001, V = 0.82, r = 0.13$. Univariate tests revealed that low/medium contact athletes were significantly more agreeable than high contact athletes, $F_{(1,262)} = 15.4, p < 0.0001, r = 0.24$. No other differences were found. Effect sizes for all measures were small. Therefore, this hypothesis was not supported. See Table 3.3.

Table 3.3
TIPI subscales Descriptive Statistics by Athlete Type

| TIPI Subscale | Sport Type | M | SD |
|------------------------|--------------------|------|------|
| Extraversion | High contact | 5.31 | 1.09 |
| | Low/medium contact | 5.39 | 1.34 |
| Agreeableness | High contact | 4.05 | 1.19 |
| | Low/medium contact | 4.61 | 1.11 |
| Conscientiousness | High contact | 5.29 | 1.41 |
| | Low/medium contact | 5.57 | 1.14 |
| Emotional Stability | High contact | 5.12 | 1.35 |
| | Low/medium contact | 5.01 | 1.43 |
| Openness to Experience | High contact | 5.24 | 1.16 |
| | Low/medium contact | 5.37 | 1.04 |

Research question 4: relationships between variables

This question aimed to explore any correlations between demographic variables and bothersomeness. Hypothesis 4a stated that the number of major injuries suffered would be negatively correlated with both physical and psychological bothersomeness, for injury pain. Psychological bothersomeness of injury pain was positively correlated with number of major

injuries ($r = 0.13$, $N = 264$, $p = 0.03$), though the effect size was small. There was no relationship between physical bothersomeness of injury pain and number of major injuries. Therefore, hypothesis 4a was not supported.

Independent t-tests were conducted to examine differences in major and minor injuries between high and low/medium contact athletes. High contact athletes reported having significantly more major injuries, $t_{(262)} = 1.94$, $p = 0.05$, and minor injuries, $t_{(262)} = 2.40$, $p = 0.02$, $d = 0.25$ compared to low/medium contact athletes. See Table 3.4.

Table 3.4
Number of Injuries Descriptive Statistics by Athlete Type

| Measure | Group | Mean | SD |
|----------------|--------------------|-------|--------|
| Major Injuries | High Contact | 5.18 | 5.60 |
| | Low/medium contact | 3.90 | 4.46 |
| Minor Injuries | High Contact | 83.46 | 149.73 |
| | Low/medium contact | 51.46 | 45.58 |

Hypothesis 4b stated that years' experience would be negatively correlated with both physical and psychological bothersomeness, for all pain types. This was partially supported: There was a significant negative correlation between physical bothersomeness of exertion pain and years' experience, $r = -0.17$, $N = 264$, $p = 0.005$. Psychological bothersomeness of exertion pain was also negatively correlated with years' experience, $r = -0.18$, $N = 264$, $p = 0.003$. There was a significant positive correlation between physical bothersomeness of injury pain and years' experience, $r = 0.25$, $N = 264$, $p < 0.001$ and psychological bothersomeness of injury pain and years' experience, $r = 0.18$, $N = 264$, $p = 0.003$. Effect sizes were small.

Independent t-tests were conducted to examine differences in years of experience between high and low/medium contact athletes. Low/medium contact athletes had significantly more years of experience than high contact athletes, $t_{(262)} = -2.37$, $p = 0.02$. See Table 3.5.

Table 3.5
Experience (years) Descriptive Statistics by Athlete Type

| Measure | Group | Mean | SD |
|------------|--------------------|-------|------|
| Experience | High Contact | 9.88 | 7.39 |
| | Low/medium contact | 11.86 | 6.10 |

Overall, the correlations revealed that psychological bothersomeness of injury pain and the number of major injuries were positively correlated. Psychological and physical bothersomeness of injury pain were both positively related to years' experience and psychological and physical bothersomeness of exertion pain were both negatively correlated with year' experience. The t-tests showed that high contact athletes had more major and minor injuries than low/medium contact athletes but had significantly less years' experience in the sport.

3.4 Discussion

The results indicated that high contact athletes experienced and viewed pain differently to the low/medium contact athletes, however most hypotheses were not supported or partially supported. See Table 3.6.

Table 3.6

Summary of Hypotheses and Major Findings

| Hypothesis number | Supported Y/N/Partially | Comments |
|---|-------------------------|--|
| 1: High contact athletes would find all three types of pain less psychologically and physically bothersome than low/medium contact athletes | Partially | No differences for injury pain |
| 2a: High contact athletes would have higher direct coping for contact and injury pain compared to low/medium contact athletes | Partially | No differences for injury pain |
| 2b: High contact athletes would have lower catastrophizing for contact and injury pain compared to low/medium contact athletes | No | |
| 2c: High contact athletes would have higher somatic awareness for contact and injury pain compared to low/medium contact athletes | No | |
| 3: High contact athletes would be more emotionally stable and extraverted and less conscientious than low/medium contact athletes | No | Low/medium contact athletes were more agreeable than high contact athletes |
| 4a: Major injuries would be negatively correlated with physical and psychological bothersomeness of injury pain | No | The relationship was positive |
| 4b: Years' experience would be positively correlated with physical and psychological bothersomeness for all pain types | Partially | Exertion pain was negatively correlated with experience. Injury pain was positively correlated with experience. No relationship between contact pain and experience. |

High contact athletes found contact pain and exertion pain less physically bothersome than low/medium contact athletes, though effect sizes were small ($r = 0.13$ and 0.03 respectively) (H1). They also reported that contact pain was somewhat less psychologically bothersome than low/medium contact athletes, however this was only approaching significance, with a small effect size ($r = 0.11$). There were no differences between groups for injury pain. High contact athletes had higher direct coping for contact pain than the low/medium contact athletes (H2a), and the effect size was small ($r = 0.12$). There were no other differences between groups for the other subscales. High contact athletes were less agreeable than low/medium contact athletes ($r = 0.24$) (H3), there were no other differences for any personality scales. Psychological bothersomeness of injury pain was positively correlated with number of major injuries ($r = 0.18$), though the effect size was small (H4a). Physical and psychological bothersomeness of exertion pain were both negatively correlated with years' experience ($r = -0.18$ and -0.17 respectively). However, physical and psychological bothersomeness for injury pain were positively correlated with years' experience ($r = 0.25$ and 0.18 respectively), effect sizes were also small (H4b). Each construct measured is discussed in turn below.

Bothersomeness.

High contact athletes found contact and exertion pain less physically bothersome than low/medium contact athletes. This result was expected because high contact athletes regularly experience pain and therefore are familiar with it (Hall & Davies 1991). In addition, high contact athletes expect to feel contact pain within sport, whereas low/medium contact athletes do not. As such, when contact pain occurs, low/medium contact athletes may be more physically bothered by it. Unexpected and under predicted pain has a detrimental effect on performance (Arntz & Hopmans, 1988) and therefore in the context of sports, if athletes do not expect to feel pain or it is more intense than they anticipated, it is likely to be more bothersome.

It is interesting that high contact athletes found exertion pain less physically bothersome than low/medium contact athletes. In Chapter Two it was noted that high contact athletes reported not feeling pain until the activity was over. This was due to concentrating and attending to the sport being played, which serves as a distraction (Brewer & Redmond, 2016). High contact athletes may have found exertion pain less physically bothersome due to attending to the activity and focusing on the next play or move. On the other hand, the experience of contact pain may act as a buffer to other pain types. Experiencing contact pain may prevent

athletes from noticing other forms of pain. Alternatively, athletes who are not bothered by contact pain may also find other forms of pain less bothersome. Furthermore, if pain is viewed as non-threatening, athletes tend to continue to participate in sport and view that pain as necessary (Paparizos et al., 2005). Therefore, if contact athletes are able to appraise contact pain realistically, as suggested by Meyers et al., (2001) they may also view exertion pain as crucial to their sport, meaning it is not bothersome.

Psychological bothersomeness of injury pain was positively correlated with number of major injuries. This indicates that athletes who suffered a great deal of injuries were more psychologically bothered by injury pain. Research examining rodeo athletes has indicated that previous experience of injuries might influence feelings about pain (Meyers et al., 2001). Injury prone rodeo athletes were more concerned about injury than those with less experience of being hurt, suggesting that previous injuries may not act as a buffer to bothersomeness of injury pain. Some researchers have suggested that habituation to pain may occur in sports (Ryan & Kovacic, 1966), but these results imply otherwise. It appears that high injury occurrence results in athletes being more psychologically concerned about injury pain. This could be a result of the consequences of injury and the fact that being injured can prevent participation in sport in the short and long term (Tracey, 2010). Contact pain or exertion pain on the other hand tend to be episodic, sometimes within the athletes control and are expected aspects of sport (Taylor & Taylor, 1998).

Psychological and physical bothersomeness for injury pain were also positively correlated with years' experience. This indicates that the more experience an athlete had in their sport, the more bothersome injury pain became. This could be a function of ageing and the fact that injuries become more common and harder to treat with age (Kallinen & Marku, 1995). It also may be due to an increase in athletic identity over time which results in more investment and engagement in the sport. The longer athletes participate in sport, the more potential there is for them to closely identify themselves with that sport (Weinberg et al., 2013). If participation is halted due to injury, worry, anxiety and even depression can occur (Johnston & Carroll, 2000). Therefore, over time athletes may become more bothered by injury pain physically and psychologically.

In contrast, physical and psychological bothersomeness for exertion pain were negatively correlated with years' experience. This is likely to be a function of fitness and conditioning in the sport. Exertion pain refers to fatigue and therefore is linked to fitness levels

(Taylor & Taylor, 1998). It follows that as athletes spend more time playing their sport that they would become more able to deal with the physical exertions required. It is also likely that self-efficacy might increase as a result of prolonged participation and therefore increased exposure to exertion pain. Bandura (1977) stated that performance accomplishments are essential components of increased self-efficacy. Thus, as athletes continually accomplish the task of overcoming fatigue, their self-efficacy increases. This rise in self-efficacy may then reduce bothersomeness.

Coping Styles (SIP15).

The hypotheses regarding coping styles of high and low/medium contact athletes were also only partially supported. The only difference was that high contact athletes had higher direct coping scores than low/medium contact athletes for contact pain. Direct coping refers to being able to “tough out” and endure pain (Bourgeois et al., 2009). High contact athletes have been shown to accept contact pain and sometimes celebrate it (Liston et al., 2006). They also view contact pain as necessary to their sport and therefore are willing to endure it (Meyers et al., 2001). The high contact athletes reported contact pain as less bothersome than low/medium contact athletes. Having a high direct coping style may reduce pain bothersomeness or vice versa. However, more research is required to investigate this further.

Personality.

The only personality difference found was that low/medium contact athletes were more agreeable than high contact athletes. Agreeableness denotes traits such as friendliness, empathy and helpfulness (Buckworth et al., 2013). It has been suggested that athletes with low agreeableness may be more aggressive than those with high agreeableness (Kaiseler et al., 2012). High contact team sports such as rugby may involve conflict and aggression (Gard & Meyenn, 2000), and thus, being less agreeable may be an asset for these sports. In contrast, high contact individual sports are usually combat activities associated with martial arts. These activities often focus on spirituality, discipline and self-control (Lakes & Hoyt, 2004) and are associated with decreases in mood disturbance, anger and tension (Focht, Bouchard & Murphey, 2000). It is therefore unclear whether certain personalities may be drawn to different contact sports. However, it has been reported that high contact athletes generally may be more aggressive and willing to hurt others in comparison to low/medium contact athletes (Raudenbush et al., 2012), meaning that they may be less agreeable and empathetic. Agreeable individuals are more likely to avoid confrontation, meaning they might avoid contact situations

where conflict may occur, such as contact sports (Kaiseler et al.). It is surprising that no differences were found for other personality traits, however it should be noted that the TIPI is a very brief measure of personality and using more comprehensive inventories may have yielded different results. As such, personality cannot be discounted as a mechanism for differences between athlete groups. Indeed, differences in agreeableness were found here, using a short questionnaire. Therefore, future research should aim to examine personality as a mechanism using more robust instrumentation such as the Five Factor Inventory (Costa & McRae, 1992).

Most hypotheses were only partially supported and despite having a relatively large sample size, effect sizes for all measures were small or medium. The TIPI and SIP15 were the only instruments used that had previously been validated. Both are classed as valid and reliable measures of personality and pain coping styles respectively. However, the TIPI is a very concise personality measure and was used for its brevity. Other inventories could have been used to assess personality in more detail. The bothersomeness scales used and the self-report measures of injury occurrence and experience have not been validated and as such may have not been appropriate measures.

In addition, the SIP15 was adapted and presented three times to participants, requiring them to comment on injury, exertion and contact pain. As a result, participants may have not discriminated between the three types of pain effectively, despite receiving instructions about their meaning. The questionnaire packs were rather large and took on average around 10 minutes to complete. It is therefore possible that participants did not read fully the definitions of each type of pain or they hurried their responses.

Self-report measures alone cannot determine how athletes respond to pain. Future research should aim to combine qualitative and quantitative approaches to explore pain coping during sports. In addition, more work should be carried out with personality as a main focus to determine if high contact athletes are indeed different to low/medium contact athletes. Further, bothersomeness as a construct should be measured more within experimental research settings. Rather than simply taking threshold and tolerance measures, researchers should also aim to distinguish between pain intensity and bothersomeness whilst examining participation in contact sports.

Finally, it should be noted that the nature of the athlete groups may have impacted on the results. The low/medium contact group contained athletes who may have experienced some

degree of contact pain (e.g. footballers). As such, any differences between this group and the high contact group may be under estimated. Future research should aim to compare non-contact athletes (such as track and field participants, cricketers or swimmers for example). Doing so would eliminate any potential confounds in relation to the amount of contact experienced with sports.

In summary, high contact athletes viewed contact pain as less physically bothersome than low/medium contact athletes. This is possibly associated with higher direct coping for contact pain, which they saw as something to endure and “tough out”. This agrees with previous literature indicating that high contact athletes have a more positive view of pain and are therefore willing and able to tolerate it (Ryan & Kovacic, 1966). High contact athletes were less agreeable than low contact athletes. This accords with other studies that found that high contact athletes may be more willing to face conflict and be assertive compared to low/medium contact athletes (Kaiseler et al., 2012; Castanier et al., 2010).

The key findings reflect that high contact athletes found contact pain less bothersome than low/medium contact athletes and that they had a higher direct coping style for this type of pain. It is not clear if on the one hand, high contact athletes are able to develop a direct coping style and experience reduced pain bothersomeness over time due to participation in contact sports. Or conversely, high direct coping and reduced pain bothersomeness may be present at the outset of playing a contact sport. To examine this potential learning mechanism further, studies are required to determine whether direct coping and indeed other pain related markers, such as tolerance or perception, are modified over time or whether they are present at a particular level at the beginning of participation in contact sports.

Further research needs to be conducted using longitudinal designs and more robust instrumentation to further examine differences between athlete groups. In addition, longitudinal research should focus on attrition in contact sports to determine whether individuals who participate in contact sports are different from those who disengage. This will be examined in the next chapter.

This study demonstrates that coaches and athletes should be aware of pain appraisals and how they might affect both performance and adherence to sports. It also indicates that sports choice may be determined by how pain is viewed. With further research, examining pain appraisals, it would be possible to identify people who are at risk of disengaging from contact sport or who are prone to negative appraisals and then implement interventions accordingly.

Chapter Four: A Longitudinal Exploration of Pain Tolerance and Participation in Contact Sports

The previous chapter showed that high contact athletes reported less pain bothersomeness and had higher direct coping than low contact athletes. The current chapter will further examine coping styles and bothersomeness and will measure pain tolerance in athletes who are new to contact sports. Measurements will be taken over a whole athletic season to observe any differences between athletes who participate in the sport and those who cease participation. This will cover the second aim of the thesis, to compare high and low/non-contact athlete's responses to pain. It will also achieve the third outcome of the thesis, to investigate pain tolerance and perception over time in novice high contact sports participants.

4.1 Introduction

As discussed in Chapter Three, there is evidence that athletes and non-athletes differ in their responses to pain (Hall & Davies, 1991; Sullivan et al., 2000). There are many plausible reasons for the differences in pain reporting according to athletic status. The first is that alterations to endogenous inhibitory processes may occur due to exposure to fatiguing training (Tesarz et al., 2012). It has been postulated that engaging in regular, vigorous physical activity may alter pain perception and tolerance, (Tesarz et al.; Rhudy, 2013). Such activity may improve or alter endogenous inhibitory processes thereby reducing pain. Thus, athletes may perceive and process pain differently to non-athletes as a result of repeated exposure to exhausting training (Tesarz et al., 2013). This has been demonstrated in studies indicating that more experienced athletes have higher pain tolerance than less experienced athletes (e.g. Scott & Gijsbers, 1981)

Further studies have suggested that a combination of psychological factors and participation in high intensity training may explain higher pain tolerance in endurance athletes (Geva & Defrin, 2013). In their study, Geva and Defrin reported that reduced catastrophizing and less fear of pain were linked to higher pain tolerance. They suggested that psychological factors and perceptions of control over pain may mediate pain responses. Therefore, athletes with low tolerance to pain may increasingly catastrophize when exposed to pain within sports; this in turn may reduce their participation in sports or may discourage them from participating in the first place.

Other researchers have suggested that individual differences such as personality factors may account for variances in pain tolerance and perception (Tajet-Foxell & Rose, 1995).

Neuroticism has been associated with reduced pain tolerance and higher pain intensity reports (e.g. Boggero, Smart, Kniffin & Walker, 2014). Highly neurotic individuals have been shown to catastrophize more about chronic pain (Goubert et al., 2004), however there has been little exploration of how personality links to episodic sports-related pain. It is also unclear whether personality traits predict participation in painful contact sports.

In Chapter Three it was reported that high contact athletes were less agreeable than low or non-contact athletes. There were no other differences between the groups; as such the possibility that personality traits may influence sports choice cannot be discounted. However, there were no other differences between the groups. More research is required to examine whether personality traits impact on sports adherence and choice. The TIPI employed in study two was used for its brevity and therefore further research would be required to fully examine personality traits in high contact and non/low contact athletes.

Contact athletes may learn to tolerate pain through psychological factors such as use of coping strategies (Geva & Defrin, 2013). Pain tolerance and use of coping strategies have been positively correlated (Manning and Fillingim, 2002; Ord & Gijssbers, 2003). In clinical pain research, it is widely reported that use of coping strategies can be a positive way of managing both chronic and acute pain (Fernandez & Turk, 1989). Furthermore, positive coping styles such as direct coping as measured by the SIP15 may result in athletes approaching pain and viewing it as a necessary part of sport (Bourgeois et al., 2009). This style has been linked to resilience and therefore may be present in athletes who are able to cope with stressors easily (Bourgeois et al.).

Perhaps the most plausible explanation for high contact athletes having a high pain tolerance is that it is developed through experience, as suggested by Ryan and Kovacic (1966). In laboratory studies, repeated exposure to pain has resulted in task interference habituation, indicating that in controlled environments, the recurrent experience of pain may reduce its intensity and detrimental effects on performance (Crombez, Eccleston, Baeyens & Eelen, 1997). In studies conducted in less controlled settings, associations have been made between experience of pain and tolerance. For example, in studies examining battlefield pain, soldiers who had previously suffered severe injuries demonstrated higher pain tolerance than those who had light injuries (Dar, Ariely & Frenk, 1995). Further, in studies examining labour pain, nulliparous women have reported greater pain during childbirth than multiparous women (Sheiner, Sheiner & Shoham-Vardi, 1998). Accordingly, athletes who have had greater

exposure to pain may feel it less intensely than others who have limited experience of sports pain. This may have an impact upon both adoption of, and adherence to, contact sports.

Conversely other research has reported that increased exposure to pain may result in sensitisation due to pain-related anxiety (e.g. Saisto, Kaaja, Ylikorkala & Halmesmaki, 2001). Individuals with high levels of pain anxiety have been shown to catastrophize more about pain and report higher pain intensity (e.g. Sullivan et al., 2000). Those with high pain related anxiety who report pain as intense, may therefore avoid painful contact sports altogether. It is unclear how or if the experience of sports-related pain would interact with pain tolerance and if pain tolerance predicts sports participation.

There has been little exploration of continued participation in painful contact sports; however, injury rehabilitation research has shown that individuals with high pain tolerance adhere better to treatment programmes (Byerly, Worrell, Gahimer & Domholdt, 1994). In addition, exercise adherence literature suggests that approximately 50% of people who begin an exercise programme will drop out (Buckworth et al., 2013). The intensity of activity, injury risk and exercise mode predict adherence to exercise (Buckworth et al.), however little research has examined the determinants of participation in contact sports. Injury risk as a predictor of adherence to sports may be an important factor in high contact activities where injury risk may be higher. This may also be true of other activities such as endurance sports where overuse injuries may be common.

This study is the first to examine multiple mechanisms for differences in pain responses in contact sports. Participation in contact sports over an athletic season will be measured alongside cold and ischemic pain tolerance, pain bothersomeness and coping styles. Further, the study will aim to test the competing hypotheses that contact athletes are more pain tolerant at the outset of playing, i.e., individual differences account for differences, or that pain tolerance increases in participating contact athletes during the first season, i.e., they learn to cope with the pain experienced.

Hypotheses.

In order to test the following hypotheses, data were collected at three points over an 8 month period. Participating contact athletes were compared with those who stopped participating, following cluster analysis.

H₁: Cold and ischemic pain tolerance would differ at each point in the season according to whether athletes participated in the sport or stopped participating. It was hypothesised that participating contact athletes would increase pain tolerance over the season.

H₂: Pain intensity ratings would differ at each point in the season according to whether athletes participated or stopped participating in the sport. It was hypothesised that pain intensity ratings would reduce over the season for participating athletes.

H₃: Bothersomeness of pain would differ at each point in the season according to whether athletes participated or stopped participating in the sport. It was hypothesised that bothersomeness would reduce over the season for participating athletes.

H₄: Participating athletes would demonstrate a higher direct coping style than non-participating athletes.

4.2 Method

Participants.

A total of 102 pain free student athletes, 47 males (mean age = 23.6 years, SD = 6.0 years) and 55 females (mean age = 20.5 years, SD = 3.6 years), who were new to both post-compulsory education and voluntary contact sports were recruited via university notice boards, direct contact with local clubs and through social media. The participants had all recently begun taking part voluntarily in a contact sport (rugby, n = 62; American Football, n = 15; mixed martial arts (MMA), n = 11; and kickboxing, n = 14). Participants were classed as new to contact sports if they previously had no experience of engaging in sports where contact is allowed within the rules. Using an alpha level of $p < 0.05$, sample sizes were calculated based on prospective estimates of power and effect size figures to achieve an acceptable power level of 0.8 and a large effect size of $\eta^2 = 0.138$ (Clark-Carter, 2008). Ethical approval for the study was granted by the University Research Ethics Committee (see appendix J).

Materials.

Demographic questionnaire.

Participants were asked to state the number of injuries they had suffered, previous sports played as well as age and gender. The participants were also asked three questions about their feelings regarding beginning their new sport, which were responded to on a five-point Likert scale: how much they were looking forward to the sport (1 = *not at all*, 5 = *extremely*); how much they thought they would enjoy the sport (1 = *not at all*, 5 = *extremely*); and how

they thought they would feel about any pain experienced in the sport (1 = *dislike it very much*, 5 = *like it very much*).

Sports Inventory for Pain (SIP15; Bourgeois et al., 2009).

Participants completed three adapted versions of the SIP15 questionnaire that were altered to account for three different pain types; contact pain, exertion pain and injury related pain. The reliability of the SIP15 was discussed in the previous chapter.

Bothersomeness questionnaire.

Participants were asked to rate bothersomeness of the three types of pain in terms of physical bothersomeness (how much the pain interfered with physical performance of their sport) and psychological bothersomeness (how much the pain interfered with psychological states during performance). This was measured on a five-point scale of 1 = *not at all*, 5 = *extremely*.

Participants were also asked to rate how enjoyable they found the sport (1 = *not at all*, 5 = *extremely*) and how they felt about any pain experienced in the sport (1 = *dislike it very much*, 5 = *like it very much*). They were also asked whether they had any injuries or physical reasons for not playing their sport (such as being ill) that had prevented them from attending for at least 1 week.

Attendance.

At the 4 month and 8 month points, coaches supplied attendance data for each athlete in the form of training registers. This was converted to a percentage of attendance at all possible training sessions and competitive matches. This was taken to establish at the end of the season, whether the participants were classed as participating in the sport or whether they had disengaged from it. Most of the sports had two training sessions per week plus one competitive match. The MMA and kickboxing athletes had two training sessions per week and competitions once every two weeks. The duration of training sessions for rugby and American football was 1.5 hours. The martial arts training sessions were 1 hour in length. The duration of rugby matches was 80 minutes, American football matches could be between 2 and 3 hours. Martial arts competitions varied in length from 5 minutes to 30 minutes. It should therefore be noted that the sports differed in duration both in training and competition. In addition, the exposure to pain and the intensity of the activity also differed. For example, American football players are not active for the whole game, and a rugby player may not get involved in many tackles depending on his or her position. It was therefore not possible to standardise the amount of exposure to pain in each sport whilst maintaining ecological validity.

Pain Tolerance.

Both pain tolerance measures were performed in isolation from other participants and the athletes were asked not to share their experiences or results with anyone else.

Cold pressor.

A tank containing iced water was used, with the water circulated using a pump and kept at 2-3°C. Participants were asked to place their dominant hand in the water up to the wrist and were instructed to keep it there for as long as possible. Pain tolerance was measured as time to withdraw in whole seconds, using a stopwatch. A ceiling time of 5 minutes was imposed, though participants were blind to this. At 1 minute intervals participants were asked to rate the intensity of pain on a visual analog scale (VAS), consisting of a 10 cm horizontal line with anchors at each end indicating the severity of the pain, these ranged from 0 (*no pain*), to 100 (*the most pain imaginable*). A measurement was then taken, in millimetres, from the no pain end of the scale to the mark made by the participant. Such scales have proved to be reliable and valid for measuring the intensity of acute pain (Bijur, Silver & Gallagher, 2001).

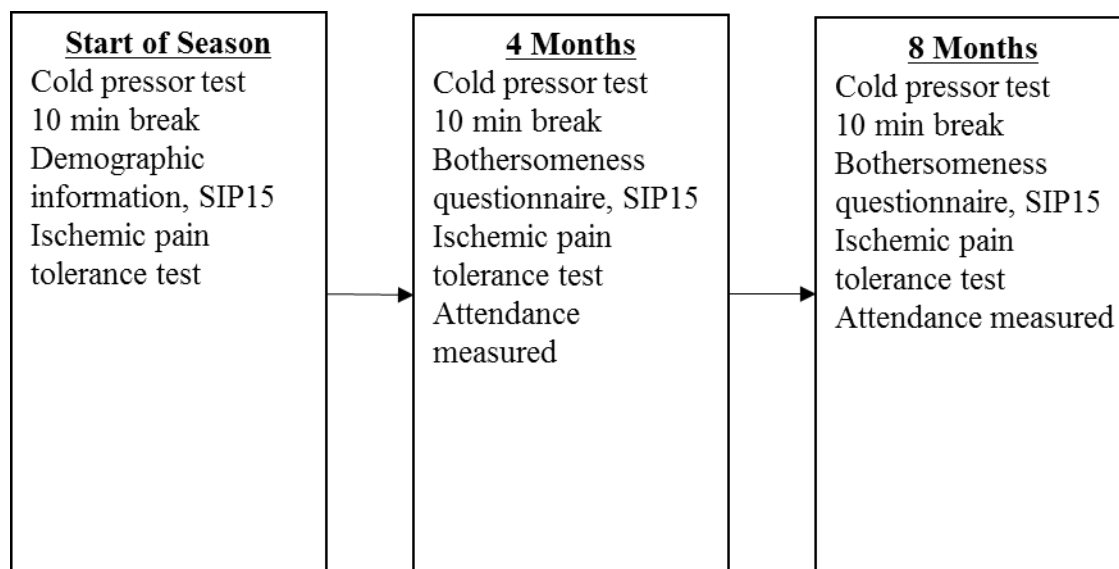
Ischemia.

Pain was induced using a sphygmomanometer and a handgrip dynamometer, following the submaximal effort tourniquet protocol outlined by Manning and Fillingim (2002). Participants initially performed three maximal hand-grip exercises using a hand grip dynamometer. Their mean hand-grip score was calculated and was used to establish 50% of their maximum hand-grip. Participants were then asked to raise their non-dominant arm above their head for 30 seconds, after which a blood pressure cuff was placed round the upper arm and inflated to 230mm Hg at a rate of 40mm Hg per second. Full cuff inflation was taken as time 0 and participants rated on the VAS the intensity of their pain at this point. Participants then lowered their arm to the horizontal position and performed 20 handgrip dynamometer exercises at 50% of their maximum grip strength for a period of one minute. One exercise counted as a 2 second grip, followed by a 2 second rest. VAS ratings were then taken at minute intervals to a blind ceiling time of 5 minutes or when the participant asked for the test to be stopped. When the test stopped, the cuff was gradually deflated as recommended by Bae and Lee (2014) to allow the volume of blood to gradually increase in the limb.

Procedure.

Figure 4.1

Study Design over the Season



Participants were tested at three data collection points (see Figure 4.1). At point one, the start of the season, participants first gave informed consent to participate, then completed a cold pressor test on the dominant hand and wrist. They then had a 10 minute break in which they completed a demographic questionnaire and the SIP15. Following this, they were tested for ischemic pain tolerance using the tourniquet protocol on the non-dominant arm.

At subsequent data collection points, at month four and month eight, the same procedure was followed, with the addition of a bothersomeness questionnaire administered in the ten-minute break. All participants returned for data collection at the mid-point of the season. A total of 17 participants did not return for the final data collection phase, meaning that data were available for 85 participants at all three collection points. Participants who had left the sport and did not return for final testing were contacted by telephone or email to state why they had stopped participating in the sport. Seven stated that they had other commitments that prevented them from continuing, and 10 stated that they did not enjoy the sport anymore.

Data Analysis.

The aim of the analysis was to compare those who participated in contact sports to those who disengaged on measures of cold and ischemic pain tolerance, bothersomeness, and intensity as well as direct coping. Data were analysed using IBM SPSS statistics version 21. MANOVA, mixed ANOVAs and t-tests were used to explore differences between the two

groups of athletes and the measures taken over the season. Effect sizes were calculated as r , as recommended by Field (2009).

Missing values appeared in the VAS where participants withdrew after the 5-minute ceiling time. As recommended by Field (2009) arbitrary values were entered to denote missing figures. There were also missing values for participants who did not return for the final data collection phase ($n = 17$); the same method was applied to them using missing values to indicate that they did not attend.

To categorise participants as participating or non-participating at the end of the season, hierarchical cluster analysis was employed as recommended by Clark-Carter (2008). A total of 102 cases were included in the analysis. The variables used were percent attendance at the 4 month and 8 month points of the season. Between group linkage method was used, using a range of clusters from 2-4. Two clusters emerged and as a result, 47 participants were placed in a “participating” cluster (mean age = 23.0 years, SD = 6.34 years, male $n = 27$, female $n = 20$) and 55 were placed in a “non-participating” category (mean age = 21.0 years, SD = 3.5 years, male $n = 20$, female $n = 35$), see Table 4.1. Participating athletes were those who were regularly attending training and competition, non-participating athletes were those who had either dropped out of the sport all together or who did not have regular attendance at training and as such were often not the coaches’ first choice for competition. Following cluster analysis coaches were asked to comment on each athlete and state whether they thought athlete was indeed participating or non-participating. 100% of the cases were agreed by the coaches.

Independent samples t-tests for attendance at both time points revealed that the participating group had significantly higher attendance than the non-participating group ($p < 0.0001$); characteristics of the sample can be seen in Table 4.1 and attendance figures can be seen in Table 4.2.

Table 4.1

Sample Characteristics for the Overall Sample and Participating and non-Participating Athletes

| | Overall sample | Participating Athletes | Non-Participating Athletes |
|---|--------------------------|-------------------------|----------------------------|
| Sport played before taking up contact sport | Netball n = 10 | Netball n = 3 | Netball n = 7 |
| | Cricket n = 6 | Cricket n = 5 | Cricket n = 1 |
| | Football n = 11 | Football n = 3 | Football n = 8 |
| | General exercise = 42 | General exercise n = 21 | General exercise n = 21 |
| | None n = 33 | None n = 15 | None n = 18 |
| Current contact sport | MMA n = 11 | MMA n = 7 | MMA = 4 |
| | Rugby n = 62 | Rugby n = 30 | Rugby = 32 |
| | Kickboxing n = 14 | Kickboxing n = 8 | Kickboxing = 6 |
| | American Football n = 15 | American Football n = 8 | American Football n = 7 |
| Injuries or illness that prevented attendance for at least 1 week | Injury n = 11 | Injury n = 5 | Injury n = 6 |
| | Illness n = 8 | Illness n = 4 | Illness n = 4 |

All data were checked for normality using the Kolmogorov-Smirnov test. Where data were found to be non-normal, transformations using square root and natural log were conducted, however these did not normalise data, as such original data have been used in the following analysis. Non-parametric tests were also conducted where data could not be normalised and results were the same as parametric tests. All information regarding these can be located in the relevant appendix as outlined below.

4.3 Results

Attendance and enjoyment.

Attendance at the 4 and 8 month points of the season was compared between the two groups. At both times the participating athletes had significantly higher attendance than the non-participating athletes; at 4 months, $t_{(100)} = 15.75$, $p < 0.0001$, $r = 0.84$, and at 8 months, $t_{(100)} = 37.10$, $p < 0.0001$, $r = 0.96$, see Table 4.2.

The participating athletes enjoyed their sport significantly more than the non-participating athletes at the 4 month point, $t_{(100)} = 4.16$, $p < 0.0001$, $r = 0.38$, and also at the 8 month point, $t_{(83)} = 5.58$, $p < 0.0001$, $r = 0.52$. They also felt significantly more positive about the pain they endured at 4 months, $t_{(100)} = 2.78$, $p = 0.006$, $r = 0.26$ and at 8 months, $t_{(83)} = 4.51$, $p < 0.0001$, $r = 0.44$.

Table 4.2

Average Percentage Attendance (mean [M] and standard deviation [SD]) for Sport (training sessions and competition) and Minimum and Maximum Attendance Percentages for Participating and Non-participating Athletes at 4 and 8 months

| Group | 4 Months M (SD) | Min/max % at four months | 8 Months M (SD) | Min/max % at eight months |
|-------------------|-----------------|--------------------------|-----------------|---------------------------|
| Participating | 84.1 (13.8) | 52%/100% | 81.3 (14.1) | 40%/100% |
| Non-participating | 42 (13.1) | 12%/72% | 2.2 (6.7) | 0%/30% |

Scores for attendance, enjoyment and feelings about pain were examined for normality and non-parametric tests were conducted where needed (see appendix K).

At the start of the season the groups did not differ for the question “how much are you looking forward to starting this sport?” and “how much do you think you will enjoy the sport?”, $p > 0.05$. However for the question “how do you think you will feel about any pain you experience in the sport?” the non-participating athletes reported that they would dislike it more than the participating athletes, $t_{(100)} = 4.11$, $p < 0.0001$, $r = 0.38$.

Correlations were performed to examine relationships between variables across all groups, regardless of whether the athletes participated or not. There was a significant correlation between attendance and enjoyment at 4 months, $r = 0.55$, $p < 0.0001$. There was also a significant positive correlation between attendance and enjoyment at 8 months, $r = 0.631$, $p < 0.0001$. This accords with the results at four months, with a larger effect size.

Correlations were also performed to examine the relationship between attendance and feelings about pain. There was a significant positive correlation between feelings about pain and attendance at 4 months, $r = 0.52$, $p < 0.0001$. There was also a significant positive correlation between these two variables at 8 months, $r = 0.56$, $p < 0.0001$, this accords with 4 months findings, with a slightly larger effect size.

Correlations were performed to examine relationships between enjoyment and feelings about pain. There was a significant positive correlation between enjoyment and feelings about pain at 4 months, $r = 0.57$, $p < 0.0001$. These findings were echoed at 8 months, $r = 0.69$, p (two-tailed) < 0.0001 . This indicates that as feelings about pain became more positive, enjoyment increased, with a large effect size.

Taken together these correlations demonstrate that enjoyment and feelings about pain were related to attendance in sport: High scores for positivity regarding pain were related to higher participation levels within the sport.

Cold pressor.

Data were checked for normality using the Kolmogorov-Smirnov test. The non-participating group’s pain tolerance was found to be normally distributed at the mid and end season points ($p = 0.2$). All other pain tolerance measures were significantly non-normal ($p < 0.001$, see appendix L). A 2x3 mixed ANOVA was conducted to examine differences between participating and non-participating contact athletes in cold pressor tolerance at the start of the season and at 4 and 8 months. Mauchly’s test of sphericity was significant ($X^2(2) = 30.4$, $p < 0.0001$), as such the Greenhouse-Geisser statistic is reported for the ANOVA (Field, 2009). Levene’s test was not significant ($p > 0.005$), meaning that the data can be treated as homogenous.

There was no significant main effect of point in season on cold pressor tolerance regardless of engagement group (participating or non-participating), $F_{(126, 1.56)} = 2.97$, $p = 0.06$, $r = 0.81$. However there was a significant interaction effect of engagement group on cold pressor tolerance, $F_{(2, 1.52)} = 7.93$, $p = 0.002$, $r = 0.91$, see Table 4.3.

Table 4.3

Descriptive Statistics, Cold Pressor Tolerance in Seconds for Participating and Non-participating Athletes at the start of the Season and at 4 and 8 months

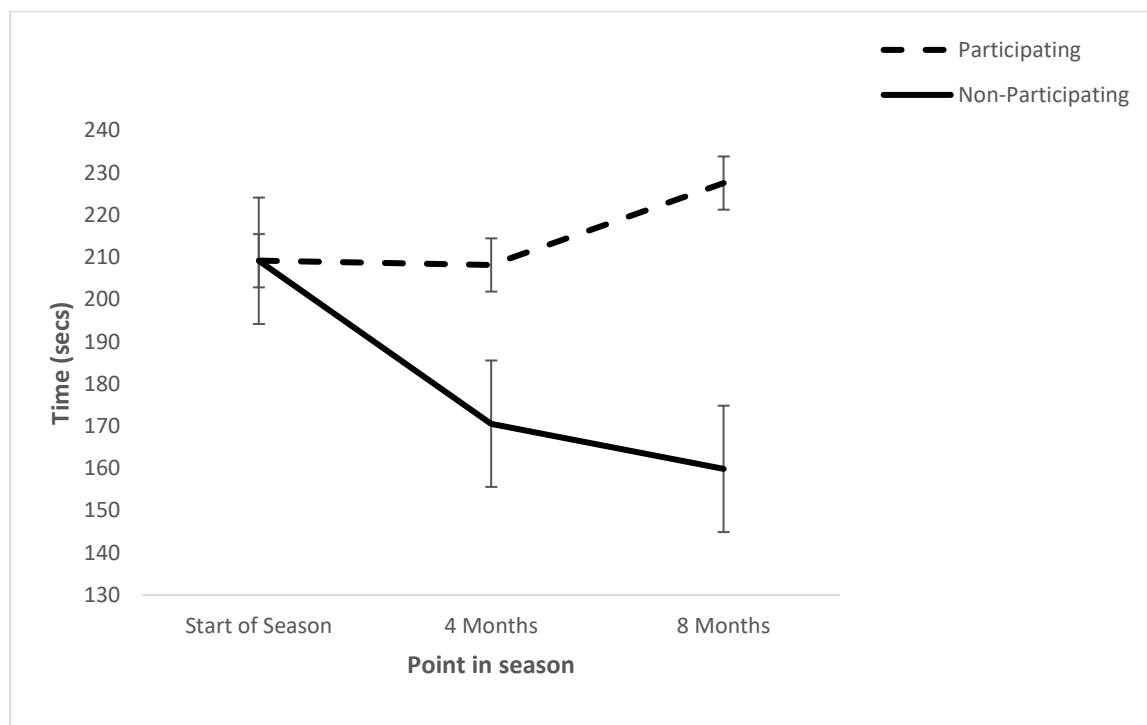
| Point in season | Engagement Type | Mean (s) | Std Deviation (s) |
|-----------------|-------------------|----------|-------------------|
| Start | Participating | 209.21 | 95.6 |
| | Non-participating | 209.23 | 82.5 |
| 4 months | Participating | 208.3 | 92.9 |
| | Non-participating | 170.6 | 84.5 |
| 8 months | Participating | 227.6 | 77.3 |
| | Non-participating | 159.9 | 79.3 |

Independent samples t-tests using a Bonferroni adjusted alpha of $p < 0.016$, showed that participating athletes had significantly higher pain tolerance than the non-participating athletes at 8 months, $t_{(83)} = 3.91$, $p < 0.0001$, $r = 0.39$, but not at the start of the season, $t_{(100)} =$

1.18 $p = 0.23$, $r = 0.11$ or at the 4 month point, $t_{(100)} = 2.15$, $p = 0.03$, $r = 0.21$; see Figure 4.2. Therefore hypothesis 1 was partially supported.

Figure 4.2

Cold Pressor Tolerance (time in seconds) at the Start of the Season, at 4 months and at 8 months for Participating and Non-Participating Athletes.



A repeated measures ANOVA was conducted to examine pain tolerance differences only within the participating athlete group at the three different points in the season. Mauchly's test of sphericity was significant ($X^2(2) = 17.7$, $p < 0.0001$) as such the Greenhouse-Geisser statistic is used in the following analysis. There were no significant differences in pain tolerance at the start, 4 month or 8 month points in the participating group, $F_{(1.5, 69.3)} = 1.47$, $p = 0.24$, $r = 0.14$. To test the hypothesis that pain tolerance would increase in participating contact athletes, a paired samples t-test was conducted to compare cold pressor tolerance at the start of the season to 8 months. This revealed that there was no significant difference in pain tolerance at the start of the season compared to 8 months, $t_{(46)} = -1.31$, $p = 0.19$, $r = 0.16$.

The same test was conducted only for non-participating athletes; Mauchly's test of sphericity was significant ($X^2(2) = 12.7$, $p = 0.002$), accordingly the Greenhouse-Geisser statistic is used for subsequent analysis. There was a significant main effect of cold pressor

tolerance over the season, $F_{(1.5, 56.9)} = 11.95$, $p < 0.0001$, $r = 0.41$. Paired samples t-tests using a Bonferroni adjusted alpha of $p < 0.016$, revealed that the non-participating group were significantly more pain tolerant at the start of the season compared to 8 months, $t_{(37)} = -3.99$, $p < 0.0001$, $r = 0.54$. There were no other significant differences between time points.

Hypothesis 2 stated that pain intensity would reduce over the season for participating athletes. Data for cold pain VAS scores at minute 1 were checked for normality, deleting cases listwise. The Kolmogorov-Smirnov test revealed that the VAS scores at each time point in the season were all normally distributed ($p = >0.05$). Levene's test revealed that the VAS scores at the start of the season violated the assumption of homogeneity of variance, ($F_{(1,83)} = 7.7$, $p = 0.007$). Hartley's F_{\max} ratio was calculated using 2.4 as the threshold for violation of this assumption. The F_{\max} ratio was 2.3, meaning the data can be treated as homogenous (Field, 2009).

Mauchly's test of sphericity was significant, ($X^2(2) = 20.1$, $p = <0.0001$), as such the Greenhouse-Geisser is reported. VAS scores at minute 1 were compared using a mixed 2x3 ANOVA. There was no significant main effect of cold pain intensity over the three time points, $F_{(1.64, 136.3)} = 2.78$, $p = 0.07$, $r = 0.14$. There was no interaction effect, meaning there were no significant differences between participating and non-participating athletes over the season, $F_{(1.64, 136.3)} = 1.54$, $p = 0.21$, $r = 0.11$. Therefore hypothesis 2 was not supported. See Table 4.4.

Table 4.4

Descriptive Statistics for Visual Analog Scale in mm for Cold Pressor for Participating and Non-participating Athletes at the start of the Season and at 4 and 8 months

| Point in Season | Engagement Type | M | SD |
|-----------------|-------------------|------|------|
| Start | Participating | 59.1 | 22.5 |
| | Non-participating | 67.6 | 14.2 |
| 4 months | Participating | 64.7 | 20.9 |
| | Non-participating | 71.9 | 16.2 |
| 8 months | Participating | 57.1 | 22.5 |
| | Non-participating | 71.6 | 18.2 |

Ischemic pain.

Data were checked for normality and transformations carried out where necessary, along with non-parametric equivalents (see appendix M). A 2x3 mixed ANOVA was

conducted to examine differences in ischemic pain tolerance across the season according to whether the athlete adhered to the sport or stopped. Mauchly's test of sphericity was significant ($X^2_{(2)} = 9.4, p < 0.009$), as such the Greenhouse-Geisser statistic is reported for the ANOVA. There was no significant main effect of point in season on ischemic pain tolerance, $F_{(1.8, 149)} = 0.62, p = 0.52, r = 0.06$. However there was a significant interaction effect of engagement group on ischemic pain tolerance, $F_{(1.8, 149)} = 8.36, p = 0.001, r = 0.23$, see Table 4.5.

Table 4.5

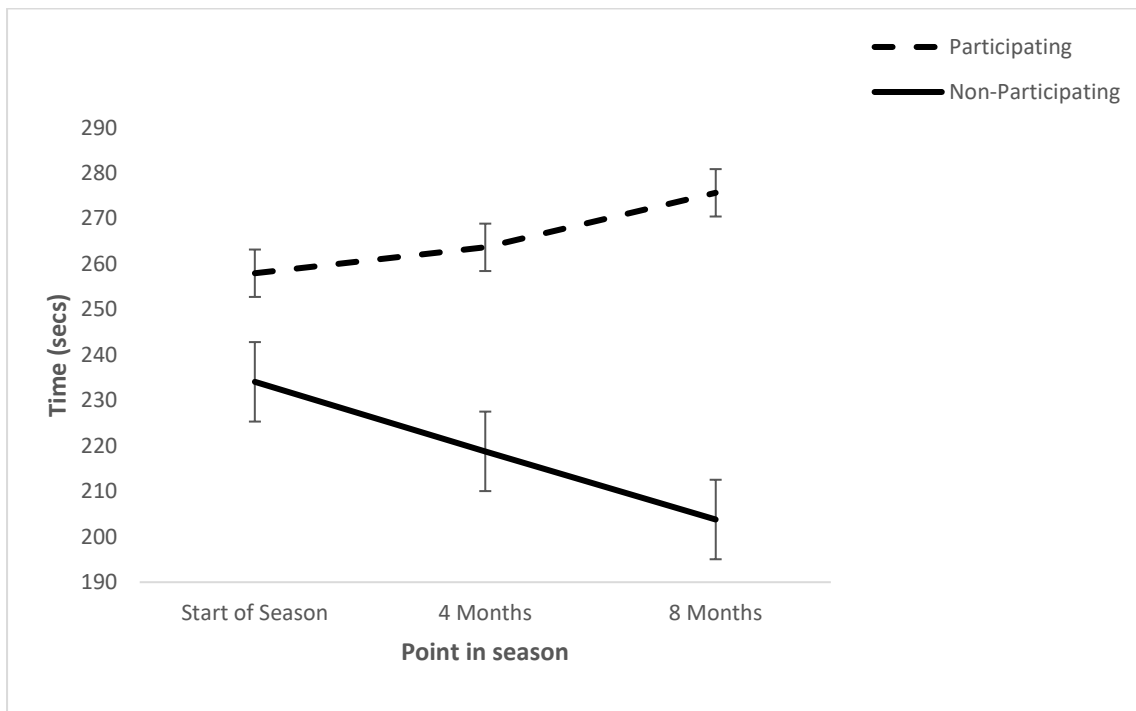
Descriptive Statistics for Visual Analog Scale in mm for Ischemic Pain for Participating and Non-participating Athletes at the start of the Season and at 4 and 8 months

| Point in season | Engagement Type | Mean (s) | Median | Std Deviation (s) |
|-----------------|-------------------|----------|--------|-------------------|
| Start | Participating | 258.1 | 280 | 53.3 |
| | Non-participating | 234.1 | 229 | 50.7 |
| 4 months | Participating | 263.7 | 270 | 39.5 |
| | Non-participating | 218.8 | 221.5 | 63.6 |
| 8 months | Participating | 275.7 | 290 | 27.4 |
| | Non-participating | 203.8 | 201.5 | 71.6 |

Independent samples t-tests were conducted to explore differences between groups at the three time points in the season, using a Bonferroni corrected alpha of $p < 0.016$. The participating athletes had higher pain tolerance than the non-participating athletes at the start of the season, $t_{(100)} = 2.83, p = 0.05, r = 0.27$, a small effect size. Participating athletes also had higher ischemic pain tolerance than the non-participating group at 4 months, $t_{(100)} = 4.57, p < 0.0001, r = 0.41$, and at 8 months, $t_{(83)} = 6.33, p < 0.0001, r = 0.57$. Taken together these results suggest that the participating athletes were more tolerant of ischemic pain throughout the season compared to the non-participating group (see Figure 4.3); accordingly, hypothesis 1 was supported.

Figure 4.3

Ischemic Pain Tolerance (time in seconds) at the Start of the Season, at 4 months and at 8 months for Participating and Non-Participating Athletes.



A repeated measures ANOVA was conducted to examine whether ischemic pain tolerance differed only within the participating athlete group at the three different points in the season. Mauchly's test of sphericity was significant ($X^2(2) = 7.2$, $p = < 0.027$) as such the Greenhouse-Geisser statistic is used in the following analysis. There were no significant differences between pain tolerance at the start, 4 month or 8 month points in participating athletes, $F_{(2, 92)} = 2.79$, $p = 0.07$, $r = 0.17$. However, to test the hypothesis that pain tolerance would increase in participating contact athletes, a paired samples t-test was conducted to compare ischemic pain tolerance at the start of the season to 8 months. This revealed that pain tolerance was significantly higher at 8 months compared to the start of the season, $t_{(46)} = -2.05$, $p = 0.04$, $r = 0.28$.

The same test was conducted only for the non-participating athletes. Mauchly's test of sphericity was not significant ($p = 0.126$). There was a significant main effect of ischemic pain tolerance over the season, $F_{(2, 74)} = 5.61$, $p < 0.05$, $r = 0.25$. Paired samples t-tests using a Bonferroni correction revealed that non-participating athletes were significantly less pain tolerant at 8 months compared to the start of the season, $t_{(37)} = 2.90$, $p = 0.006$, $r = 0.43$, a

medium effect size. This indicates that non-participating athletes became less tolerant of ischemic pain as the season progressed.

Hypothesis 2 stated that pain intensity ratings would reduce over the season for participating athletes. Data for ischemic pain VAS scores at minute 1 were checked for normality, deleting cases listwise. The Kolmogorov-Smirnov test revealed that the VAS scores at each time point in the season were all normally distributed ($p > 0.05$). Levene's test revealed that the VAS scores at the start of the season violated the assumption of homogeneity of variance ($F_{(1,82)} = 9.1, p = 0.003$), as did VAS scores at 4 months ($F_{(1,82)} = 7.8, p = 0.006$). Hartley's F_{max} ratio was calculated using 2.4 as the threshold for violation of this assumption. The F_{max} ratio was 2.5 for the start of the season and 1.7 for 4 months, meaning the data can be treated as homogenous at 4 months but not at the start of the season (Field, 2009). The assumption of sphericity was met, as Mauchly's test was non-significant. A 2x3 mixed ANOVA revealed that there was no significant main effect of ischemic pain intensity over the three time points, $F_{(2,164)} = 1.33, p = 0.26, r = 0.08$. There was also no interaction effect, $F_{(2,164)} = 0.99, p = 0.37, r = 0.07$; there were no VAS differences according to whether the athlete participated in the sport or disengaged from it. Therefore, hypothesis 3 was not supported, see

Table 4.6

Descriptive Statistics for Visual Analog Scale in mm for Ischemic Pain for Participating and Non-participating Athletes at the start of the Season and at 4 and 8 months

| Point in Season | Engagement Type | M | SD |
|-----------------|-------------------|------|------|
| Start | Participating | 44.8 | 16.5 |
| | Non-participating | 63.5 | 10.1 |
| 4 months | Participating | 44.4 | 16.5 |
| | Non-participating | 61.2 | 11.2 |
| 8 months | Participating | 40.8 | 13.5 |
| | Non-participating | 62.2 | 10.7 |

Bothersomeness.

Physical and psychological bothersomeness data were checked for normality and all measures were found to be significantly non-normal using the Kolmogorov-Smirnov test ($p < 0.0001$, see appendix N and O respectively). Non parametric equivalent tests were conducted where necessary and yielded similar findings to parametric tests.

A 3x2x2x2 (pain type, bothersomeness type, time in season, engagement group) mixed ANOVA was conducted to examine differences between participating and non-participating athletes for physical and psychological bothersomeness of injury, contact and exertion pain at 4 and 8 months, (see Table 4.7). Levene's test revealed that all scales met the assumption of homogeneity of variance. Mauchly's test of sphericity was significant for pain x bothersomeness and pain x time in season, as such the Greenhouse-Geisser statistic is reported for the ANOVA for these factors, as recommended by Field (2009).

There was a significant 4-way interaction effect of pain type x time point in the season x bothersomeness x engagement group, $F_{(2, 166)} = 3.14$, $p = 0.04$, $r = 0.44$, indicating that the three types of pain were different according to whether the person participated in the sport or not, the time point in the season and according to whether they found the pain psychologically or physically bothersome.

At 4 months, participating athletes found exertion pain more physically bothersome than the non-participating athletes, $t_{(83)} = 2.68$, $p = 0.009$, $r = 0.28$, a small effect size. In addition, at 8 months, participating athletes found contact pain to be significantly less physically bothersome compared to non-participating athletes, $t_{(83)} = -3.79$, $p < 0.0001$, $r = 0.38$, a medium effect size.

At 4 months, participating athletes found exertion pain significantly more psychologically bothersome compared to non-participating athletes, $t_{(83)} = 2.36$, $p = 0.02$, $r = 0.25$, a small effect size. At 4 months participating athletes also found contact pain to be significantly less psychologically bothersome than non-participating athletes, $t_{(100)} = -1.96$, $p = 0.05$, $r = 0.19$, a small effect size. In addition, at 8 months participating athletes found contact pain significantly less psychologically bothersome compared to non-participating athletes, $t_{(83)} = -5.41$, $p < 0.0001$, $r = 0.51$, a large effect size.

Participating athletes found contact pain to be less physically bothersome at 8 months compared with four months, $t_{(46)} = 5.49$, $p < 0.0001$, $r = 0.60$, a large effect size. They also found contact pain significantly less psychologically bothersome at 8 months compared to 4, $t_{(46)} = 3.93$, $p < 0.0001$, $r = 0.5$, a large effect size. Injury pain was also more physically bothersome at 8 months compared with 4 months, $t_{(46)} = 2.65$, $p = 0.01$, $r = 0.36$, a medium effect size, but there were no differences for psychological bothersomeness at the two time points. Exertion pain was significantly less physically bothersome at 8 months compared with 4 months, $t_{(46)} = 3.19$, $p = 0.003$, $r = 0.42$, a medium effect size, and also less psychologically

bothersome at 8 months compared with 4 months, $t_{(46)} = 4.07$, $p < 0.0001$, $r = 0.51$. Taken together these results indicate that all pain types were significantly less physically and psychologically (apart from injury pain) bothersome by the 8 month point for the participating athletes, supporting hypothesis 3.

Physical bothersomeness of exertion pain was not significantly different between the 4 and 8 month points of the season in non-participating athletes, ($p = 0.16$). However, contact pain was significantly more physically and psychologically bothersome at 8 months compared to 4 months, $t_{(37)} = -2.13$, $p = 0.03$, $r = 0.32$ and $t_{(37)} = -2.97$, $p = 0.005$, $r = 0.43$ respectively, a medium effect size. Injury pain was also significantly more physically bothersome at 8 months compared to 4 months, $t_{(37)} = -2.48$, $p = 0.01$, $r = 0.37$, a medium effect size, but there were no differences for psychological bothersomeness. Taken together these results suggest that contact pain, in particular, became more bothersome, both physically and psychologically as the season progressed for the non-participating group.

Table 4.7

Descriptive Statistics for Physical and Psychological Bothersomeness for Participating and Non-participating Athletes at 4 and 8 months

| Bothersomeness Measure | Time Point | Engagement Group | M | SD |
|-----------------------------|------------|-------------------|-----|-----|
| Contact Pain Physical | 4 months | Participating | 2.2 | 0.9 |
| | | Non-participating | 2.3 | 0.9 |
| | 8 months | Participating | 1.8 | 0.8 |
| | | Non-participating | 2.5 | 0.9 |
| Injury Pain Physical | 4 months | Participating | 2.7 | 0.9 |
| | | Non-participating | 2.4 | 1.0 |
| | 8 months | Participating | 2.5 | 0.9 |
| | | Non-participating | 2.7 | 0.9 |
| Exertion Pain Physical | 4 months | Participating | 2.1 | 0.9 |
| | | Non-participating | 1.6 | 0.6 |
| | 8 months | Participating | 1.8 | 0.7 |
| | | Non-participating | 1.5 | 0.5 |
| Contact Pain Psychological | 4 months | Participating | 2.0 | 0.9 |
| | | Non-participating | 2.4 | 0.8 |
| | 8 months | Participating | 1.7 | 0.8 |
| | | Non-participating | 2.7 | 0.8 |
| Injury Pain Psychological | 4 months | Participating | 2.5 | 0.9 |
| | | Non-participating | 2.5 | 0.8 |
| | 8 months | Participating | 2.5 | 0.9 |
| | | Non-participating | 2.7 | 0.8 |
| Exertion Pain Psychological | 4 months | Participating | 2.1 | 0.8 |
| | | Non-participating | 1.7 | 0.6 |
| | 8 months | Participating | 1.7 | 0.8 |
| | | Non-participating | 1.6 | 0.5 |

The bothersomeness scales at month 4 and 8 were tested for reliability using Cronbach alphas and the results are displayed in Table 4.8

Table 4.8

Cronbach alphas for Physical and Psychological Bothersomeness Scales

| Bothersomeness Measure | Overall α | α by engagement group | |
|-----------------------------|---------------------|------------------------------|-------------------|
| | | Participating | Non-participating |
| Contact Pain Physical | 0.82 | 0.89 | 0.79 |
| Injury Pain Physical | 0.83 | 0.90 | 0.76 |
| Exertion Pain Physical | 0.79 | 0.79 | 0.72 |
| Contact Pain Psychological | 0.84 | 0.90 | 0.73 |
| Injury Pain Psychological | 0.85 | 0.89 | 0.80 |
| Exertion Pain Psychological | 0.82 | 0.82 | 0.81 |

SIP15.

All SIP15 subscales were assessed for normality using the Kolmogorov-Smirnov test, and non-parametric tests were conducted where necessary. In addition, Mauchly's and Levene's tests were used to assess the assumption of sphericity and homogeneity of variance respectively (see appendix P). A 2x3 MANOVA (engagement group, SIP15 subscale) was conducted using the SIP15 subscales as dependent variables. There was a significant main effect of engagement group on SIP subscales, $F_{(27,57)} = 10.57$, Pillai's trace (V) = 0.83, $p < 0.0001$, $r = 0.39$. Each subscale is discussed below. Pillai's Trace statistics are reported where scales did not meet the assumption of homogeneity of variance, as recommended by Field (2009). The SIP15 subscales were also assessed for reliability using Cronbach alphas, and all scales were found to be reliable; direct coping $\alpha = 0.91$, catastrophizing $\alpha = 0.85$, somatic awareness $\alpha = 0.77$.

Direct coping.

Hypothesis 4 stated that participating athletes would have a higher direct coping style than the non-participating athletes. There was a significant main effect of engagement group on direct coping, $F_{(9,75)} = 13.77$, $V = 0.62$, $p < 0.0001$, $r = 0.39$. Univariate tests revealed that participating athletes had higher scores than the non-participating athletes at the following time points: at the start of the season for injury pain, $F_{(1,83)} = 26.47$, $p < 0.0001$, $r = 0.49$ and also for contact pain, $F_{(1,83)} = 43.5$, $p < 0.0001$, $r = 0.58$. At 4 months, participating athletes also had

higher scores for injury pain, $F_{(1,83)} = 36.5$, $p < 0.0001$, $r = 0.55$ and contact pain, $F_{(1,83)} = 23.5$, $p < 0.0001$, $r = 0.46$. At 8 months participating athletes continued to have higher scores than non-participating athletes for injury pain, $F_{(1,83)} = 64.78$, $p < 0.0001$, $r = 0.66$ and also for contact pain, $F_{(1,83)} = 56.38$, $p < 0.0001$, $r = 0.63$. There were no significant differences for exertion pain. These results indicate that the participating athletes exhibited higher direct coping for contact and injury pain than non-participating athletes at all three time points across the season. This supports hypothesis 4, see Table 4.8.

Repeated measures ANOVAs were conducted to examine any differences within each group for direct coping. There were no differences over the season for direct coping in both groups for all three types of pain, $p > 0.05$.

Catastrophizing.

There was a significant main effect of engagement group on catastrophizing, $F_{(9,75)} = 15.83$, $V = 0.65$, $p < 0.0001$, $r = 0.41$. Univariate tests revealed that the participating athletes had lower catastrophizing scores than the non-participating athletes for injury pain at 4 months, $F_{(1,83)} = 60.55$, $p < 0.0001$, $r = 0.64$ and at 8 months, $F_{(1,83)} = 83.37$, $p < 0.0001$, $r = 0.71$.

Repeated measures ANOVAs were carried out within each athlete group to establish if there were any differences in catastrophizing scores across the season. Mauchly's test was significant for the participating group ($X^2(2) = 72.21$, $p < 0.0001$) therefore the Greenhouse-Geisser corrected tests are reported, $\epsilon = 0.55$. There was a significant change in catastrophizing for injury pain over the season in the participating athlete group, $F_{(2,1.11)} = 52.74$, $p < 0.0001$, $r = 0.98$. Bonferroni tests revealed that catastrophizing was significantly reduced at months 4 and 8 compared to the start of the season, $p < 0.0001$, but there were no differences between month 4 and 8.

Mauchly's test was significant for the non-participating group ($X^2(2) = 16.44$, $p < 0.0001$), therefore the Greenhouse-Geisser corrected tests are reported, $\epsilon = 0.73$. The non-participating athletes catastrophized significantly more as the season progressed for injury pain, $F_{(2,1.46)} = 22.93$, $p < 0.001$, $r = 0.71$. Bonferroni tests revealed that catastrophizing was higher at 4 and 8 months compared to the start of the season, $p < 0.0001$, and it increased from month 4 to 8, $p = 0.03$.

There were differences for exertion pain within the participating group: Mauchly's test was significant ($X^2(2) = 15.87$, $p < 0.0001$), therefore the Greenhouse-Geisser corrected tests are reported, $\epsilon = 0.71$. There was a significant effect of catastrophizing over the season, $F_{(2,1.54)}$

= 4.27, $p = 0.02$, $r = 0.85$. Bonferroni tests revealed that participating athletes had reduced catastrophizing for exertion pain at 8 months compared to 4, $p = 0.002$. There were no other significant differences.

There were no differences for exertion pain within the non-participating group. There were no significant differences for contact pain over the season in both groups.

Somatic Awareness.

Box's test revealed that the assumption of homogeneity of covariance matrices was not violated. Levene's test revealed that all scales met the assumption of homogeneity of variance. There was no significant main effect of engagement group on somatic awareness, $F_{(9,75)} = 0.48$, $\Lambda = 0.94$, $p > 0.05$.

Table 4.9

Descriptive Statistics for SIP15 Subscales for Exertion, Contact and Injury Pain at the start of the Season, at 4 months and at 8 months for Participating and Non-participating Athletes.

| Scale | Engagement Group | Pain Type | Start Season <i>M(SD)</i> | 4 months <i>M(SD)</i> | 8 months <i>M(SD)</i> |
|-----------------|-------------------|-----------|------------------------------|--------------------------|--------------------------|
| Direct coping | Participating | Injury | 25.1(3.9) ^a | 25.5(2.9) ^b | 25.8(2.8) ^c |
| | | Contact | 26.2(3.8) ^d | 25.6(3.3) ^e | 26.2(3.2) ^f |
| | | Exertion | 24.4(2.9) | 25.0(3.0) | 25.4(3.1) |
| | Non-participating | Injury | 21.4(2.1) ^a | 21.8(2.5) ^b | 21.1(2.5) ^c |
| | | Contact | 21.7(2.0) ^d | 22.5(2.3) ^e | 21.5(2.2) ^f |
| | | Exertion | 24.6(2.4) | 24.9(3.1) | 24.3(3.1) |
| Catastrophizing | Participating | Injury | 17.7(2.8) | 12.8(3.5) ^g | 12.5(3.2) ^h |
| | | Contact | 12.3(3.8) | 12.9(3.3) | 12.5(3.2) |
| | | Exertion | 12.0(3.6) | 13.2(3.9) | 12.0(3.0) |
| | Non-participating | Injury | 17.3(2.5) | 18.6(3.2) ^g | 19.1(3.3) ^h |
| | | Contact | 13.1(2.5) | 13.0(2.4) | 13.4(1.9) |
| | | Exertion | 12.5(2.7) | 12.1(2.8) | 11.8(2.6) |
| Somatic | Participating | Injury | 8.7(1.2) | 9.2(1.3) | 9.6(1.4) |
| | | Contact | 8.8(2.0) | 8.9(1.9) | 8.9(2.0) |
| Awareness | Participating | Exertion | 8.5(2.0) | 9.0(1.9) | 9.1(1.8) |
| | | Injury | 8.7(1.0) | 9.2(1.4) | 9.3(1.3) |
| | Non-participating | Contact | 8.6(1.7) | 8.5(2.2) | 8.5(2.2) |
| | | Exertion | 8.3(1.6) | 8.3(1.7) | 8.5(1.8) |

Superscript letters indicate significant differences between participating and non-participating athletes, $p < 0.05$

4.4 Discussion

The aim of this study was to examine pain tolerance, bothersomeness and coping styles over a season, whilst accounting for participation in contact sports. A total of 47 athletes were classed as participating and 55 were classified as non-participating. Results indicated that participating athletes were more pain tolerant than non-participating athletes after 8 months for both pain measures. They also found pain less bothersome and had higher direct coping than those who disengaged from contact sports. Whilst the participating athletes did not become significantly more pain tolerant of cold pain, they were more tolerant of ischemic pain at 8 months compared to the start of the season. In contrast and surprisingly, the non-participating athletes became significantly less pain tolerant over the season for both measures.

Pain tolerance.

Pain tolerance differences were found between participating and non-participating athletes; hypothesis 1 was partially supported for cold pressor as participating athletes had higher cold pain tolerance than non-participating athletes only at the end of the season. Hypothesis 1 was fully supported regarding ischemic pain, as the participating group had higher tolerance than the non-participating group at all three time points, though it should be noted that at the start of the season the difference was small ($r = 0.27$). In addition, the participating athletes had significantly higher ischemic pain tolerance at month 8 compared to the start of the season.

The slight differences in pain tolerance results for ischemia and cold pain may be a result of the protocol, and the gradual build-up of ischemic pain (Bhalang, Sigurdsson, Slade & Maixner, 2005) compared to the intense immediate pain felt using cold pressor (Addison, Kremer & Bell, 1998) which can then subside (Rainville, Feine, Bushnell & Duncan, 1992). Studies have shown that cold and ischemic pain differ in their intensity and unpleasantness (Janal et al., 1994) and therefore it is recommended that a number of stimuli are used to determine pain sensitivity (Bhalang et al., 2005). Such differences in responses to cold and ischemic pain have been found in other studies using athletes (e.g. Jaremko et al., 1981). It has been suggested that athletes learn about certain types of pain and therefore view and respond to them differently (Jaremko et al.). It has been posited by Addison et al. (1998) that ischemic pain is similar to exertion pain and that cold pain is experienced by some athletes in the form of ice packs or baths. How these pain types are perceived by athletes may influence pain tolerance. For example, in study one it was highlighted that exertion pain (similar to ischemic pain) was seen as necessary and a sign of hard work within sports. Accordingly, some athletes

may have seen this type of pain as something to be endured and overcome. On the other hand, cold pain, for some athletes may have been associated with being hurt, as ice packs are often used in the acute phase of injury. Therefore, athletes may have viewed the two pain modalities differently.

The changes in pain tolerance over time for the participating athletes are interesting, as this group maintained cold pain tolerance and showed increased ischemic pain tolerance at the end of the season compared to the start. This suggests that these athletes may have learned to cope with ischemic pain particularly well. It should be noted that at 8 months 38% of this group reached the 5 minute ceiling time for the ischemic stimulus. 36% reached the ceiling time of 5 minutes for cold pressor. It therefore cannot be discounted that ceiling effects are present, and had the participants been able to continue, differences in tolerance may have been noted over the whole season for both measures.

The results suggest that participation in contact sports may not be solely dependent upon pain tolerance at the outset; rather a combination of physical and psychological factors may help athletes cope with pain and thus foster adherence. It is possible that participation in the sport may have produced a learning effect on the participating group, supporting Geva and Defrin's (2013) suggestion that participation in regular exercise may moderate responses to pain. Indeed, fear of pain has been shown to be inversely related to hours spent training, indicating that the more one engages with painful activity, the less one fears it (Geva & Defrin). As such, fear of pain could explain the decline in pain tolerance in the non-participating group. Perhaps due to exposure to pain in the form of contact sports, this group became more fearful of it, echoing research suggesting that pain related anxiety has been shown to reduce pain tolerance over time (Saisto et al., 2001). This links to the finding that the non-participating group catastrophized more about pain than the participating group. A further suggestion, though not directly measured, is that the non-participating group had low pain related self-efficacy, which has also been shown to reduce tolerance to pain (Bandura et al., 1987) or that negative affect regarding the sport (reflected in their low enjoyment ratings) increased their sensitivity to pain (Gedney & Logan, 2006).

As participation in contact sports decreased, the non-participating group may have lost their point of reference for pain. That is, the less they played the sport, the more distant from contact pain they became, meaning that they may have had nothing to compare the experimental pain to. This may have resulted in a reduction in pain tolerance. Having a point of comparison for pain can be useful in obtaining pain ratings from patients in clinical settings (Swift, 2015). Over time, pain memories and ratings can become distorted, sometimes

resulting in lower pain tolerance and higher pain intensity ratings (Walentynowicz, Bogaerts, Van Diest, Raes & Van den Bergh, 2015; Babel 2016). For example, 3 months after undergoing dental pain, Kent (1985) reported that some patients found it difficult to compare their previous pain to their current pain levels. These participants typically reported pain as more intense. This suggests that the ability to compare current pain to previous pain may degrade over time. The non-participating athletes may have reduced pain tolerance as a result of this.

Pain perception.

There were no differences in pain intensity between groups or time points using VAS after one minute of pain, meaning hypothesis 2 was not supported. Therefore, even though the groups differed for pain tolerance, they both perceived the initial pain to be of a similar intensity. This finding supports previous studies that have found that pain intensity (as measured by VAS) is often independent of pain tolerance (e.g. Lee, Watson & Frey Law, 2010). This therefore raises the question as to why participating athletes tolerated more pain, yet still reported the same pain intensity as the non-participating group. Participating athletes may have employed coping strategies (Manning & Fillingim, 2002) or they may have felt differently about pain compared to the non-participating athletes (Taylor & Taylor, 1998). As such, they may have approached the pain tests more positively. Indeed, participating athletes felt more positive about pain and had higher direct coping and lower catastrophizing scores for contact pain compared to non-participating athletes. It also cannot be discounted that the non-participating athletes may have lacked motivation to partake in the pain tasks. The participant information and consent forms for the study highlighted that the focus of the research was on contact sports participants; as these athletes had reduced their participation, they may not have felt that they were important to the research.

The result that participating athletes did not show any significant changes in pain ratings over the season (as measured by VAS) accords with other research that has found that pain perception does not necessarily change as a result of repeated exposure to pain (Maeoka, Hiyamizu, Matsuo & Morioka, 2015). Therefore, experience of pain within sports may not influence pain perception per se and significant decreases in perceived pain intensity may not be necessary for continued participation in contact sports. On the other hand, significant reductions in pain tolerance may result in reduced engagement in sports as demonstrated by the non-participating athletes' results. Collectively the pain tolerance results suggest that participating athletes may have learned how to adapt to pain, whereas the non-participating group may have failed to do so within the sport and the pain tasks presented.

Bothersomeness.

Participating athletes found contact pain both physically and psychologically less bothersome than non-participating athletes at 8 months, supporting hypothesis 3. In addition, the participating athletes found all three types of pain less bothersome at 8 months compared to 4 months. This suggests that either conditioning may have taken place, or that these athletes simply learned to cope more effectively with pain. In addition, better endogenous pain inhibition (Rhudy, 2013) or reduced fear of pain and catastrophizing as a result of experience may be responsible (Geva & Defrin, 2013).

The non-participating athletes found contact pain to be significantly more psychologically and physically bothersome at 8 months compared to at 4 months. They also found contact and injury pain to be more physically bothersome at 8 months. This may explain their lack of engagement and reduced enjoyment in their sport. It has been suggested that pain-related self-efficacy may predict whether someone approaches or avoids situations (Pen & Fisher, 1994). Athletes with low pain related self-efficacy may reduce involvement in sport, whereas those who are able to ignore or cope with pain may continue participation (DeRoche et al., 2011).

The participating athletes found exertion pain more physically and psychologically bothersome than non-participating athletes at 4 months, however their attendance at this point was significantly higher. Thus, despite being more bothered by exertion pain, the participating athletes continued to engage with the sport. Exertion related pain is often viewed positively and is seen as a necessary part of developing as an athlete (Kress & Statler, 2007); therefore, participating athletes may have accepted this pain despite its bothersomeness. This could be a result of using coping strategies more effectively (Scott & Gijssbers, 1981) or a function of motivational and self-efficacy factors (Johnson et al., 2011).

SIP15.

The SIP15 results supported hypothesis 4 that participating athletes had higher direct coping scores than non-participating athletes for injury and contact pain throughout the season. The participating group therefore viewed this pain more positively and were willing to endure it (Bourgeois et al., 2009). It is interesting that participating athletes had higher direct coping than non-participating athletes at the start of the season as well as at the other two time points. This suggests that participating athletes had a different pain coping style from the outset. High direct coping has been linked to resilience and is characterised by the ability to face and overcome stressors (Bourgeois et al.). It is therefore possible that the participating athletes were

more resilient to pain to begin with. Resilience has also been linked to habituation to pain (Smith, Tooley, Montague, Robinson, Cosper & Mullins, 2009), which may explain the maintained pain tolerance in the participating group.

It should also be noted that direct coping scores did not change significantly over time within either group. This suggests that the presence of high direct coping at the outset may differentiate participating and non-participating athletes, rather than participation being responsible for building direct coping. This lends some weight to the argument that coping styles may be a reflection of personality and that the presence of certain coping styles can be linked to inherited traits (e.g. Connor-Smith & Flachsbart, 2007). As part of this thesis, direct coping has been treated as something that can be developed over time, and therefore linked to learning. However, the results of this study suggest that direct coping does not change over an athletic season and that it is important for direct coping to be present at the start if participation is to be maintained. This may be a temporal issue in that direct coping may take longer than a season to develop. More research is warranted in this area to establish this.

Participating athletes also felt more positive about the pain they experienced compared to the non-participating group. The non-participating group, with significantly lower direct coping scores, did not view injury or contact pain as something to “tough out”. Indeed, they catastrophized significantly more about injury pain at 4 months compared to participating athletes. In addition, the participating athletes catastrophized less about injury pain at 4 and 8 months compared to the start of the season. Injury pain is not usually within the control of the athlete and can cause stress and anxiety (Taylor & Taylor, 1998) however coping strategy use has been shown to reduce fear and anxiety in athletes with injury pain (Driediger et al., 2006). Athletes who feel in control of their pain and do not find it stressful may have higher pain tolerance than those who ruminate about pain (Geva & Defrin, 2013). Catastrophizing has been shown to reduce pain tolerance (Driediger et al.), which also accords with these results.

Although this study adds to the athletic pain literature there are some limitations: First, laboratory induced pain can never reflect the real world of sporting collisions, unexpected injuries and fatigue. In addition, participants were aware that the pain stimulus was finite and safe. The pain stimuli were different in nature, resulting in a discrepancy between pain tolerance results, with ischemic pain yielding differences between groups at all three time points, whereas cold pain did not. More research therefore is required using a variety of pain stimuli to fully explore differences between participating and non-participating athletes.

Second, psychological factors such as motivation may have influenced results. As the study required participation at three different time points, testing fatigue may have been present (which is also reflected in the drop-out rate). In addition, order effects may have existed in the repeated pain tolerance testing. Whilst athletes were not informed of their exact tolerance time so they could not try to better it, they may have experienced increased anxiety or on the other hand, familiarity with the protocol.

In addition, to achieve an appropriate sample size, athletes were drawn from four different contact sports. It was not possible therefore to examine athletes who all had the same experiences of pain. Further, both team based and individual sports were used and due to the differences in sample size (77 team based athletes compared to 25 individual athletes) it was not possible to make comparisons between different sports types. Further research should aim to examine specific sports, as the nature of the sport may have an impact on results.

No control group using healthy non-athletes was included due to previous research findings indicating that athletes and non-athletes respond differently to pain (Tesarz et al., 2012). Future studies should however aim to include a control group to examine whether non-participating contact athletes and healthy non-contact athletes respond in the same way to experimental pain over 8 months. It would be interesting to examine whether there are any differences between those who drop out of contact sports and those who play non-contact sports or those who choose to avoid sport all together. Given the different direction of results for participating versus non-participating athletes it seems that exposure to pain can result in sensitisation (in the case of non-participating athletes) and potential habituation (in the case of the participating athletes).

Future studies should attempt to measure pain responses over a longer period of time and explore the mechanisms behind differences within athletic groups. This study focused only on one athletic season; it is therefore unknown beyond this time frame how athletes respond to pain. More detailed questions via qualitative methods should also be asked about how athletes feel about pain experienced within sports over time.

This longitudinal study is the first to suggest that commitment to high contact sports is linked to maintained or increased experimental pain tolerance and decreases in pain bothersomeness over an athletic season. In addition, having a high direct coping style for injury and contact pain at the start of a season is important for participation in contact sports. Reductions in pain tolerance over time in the non-participating group suggest that other factors are responsible for engagement in sport and not just pain tolerance at the outset. For example, individuals who catastrophize about pain or have a low direct coping style may choose to drop

out of contact sports. In addition, finding pain bothersome may also influence attrition rates. As pain intensity (as measured by VAS) did not differ between participating and non-participating athletes, it could be suggested that participating athletes perceived pain in the same way as non-participating athletes, but they did something different to cope with and endure it. Higher direct coping and reduced catastrophizing were demonstrated by participating athletes, suggesting that their view of pain was indeed different to non-participating athletes. Participating athletes also enjoyed their sport more and felt more positively about the pain they experienced. It is postulated that the participating group learnt to cope with pain and adapted to it over the season (Smith et al., 2009). A likely reason for significant reductions in pain tolerance in the non-participating group is a decrease in motivation and a lack of interest in the testing protocols. Though not directly measured, fear of pain (Byerly et al., 1994), or low pain related self-efficacy (Baker & Kirsch, 1991), or negative affect (Gedney & Logan, 2006) may account for these results.

Taken together these results suggest that those who adhered to contact sport tolerated more experimental ischemic pain as the season progressed. Participating athletes also found pain less bothersome, catastrophized less about injury pain over time and had a high direct coping style at the start of the season. This study has shown that experience of pain may alter pain responses. It also seems that direct coping and bothersomeness may influence pain responses. It is unclear however, how these variables might interact and impact upon performance in pain. This is a fundamental question to answer, given that contact sports athletes regularly play whilst in pain. As such, the next chapter will examine motor performance in experienced and novice high contact athletes, whilst manipulating their approach to experimental pain. Direct coping and bothersomeness will also be measured, alongside measures of pain tolerance and intensity.

Chapter Five: Performance in Pain, Challenge and Threat Manipulations and Coping Styles

This current chapter examines performance in pain when challenged and threatened in contact and non-contact athletes. Coping styles and bothersomeness will be measured alongside pressure pain tolerance and perception. This will cover the third aim of the thesis, to examine the role of challenge and threat states, performance in pain and pain responses in high and non-contact athletes. It will also achieve the fourth outcome of the thesis, to measure performance during experimentally induced pain whilst manipulating challenge and threat states.

Preceding chapters have indicated that athletes who differ in their response to pain may do so as a function of experience. Study three demonstrated that athletes who participated in contact sports were more tolerant of ischemic pain over a season compared to those who dropped out. In addition, participating athletes were more tolerant of ischemic pain by the end of the season compared to the start. There were no differences in pain reporting at the start of the season for cold pain, and non-participating athletes became less tolerant of both stimuli over the season. The mechanisms for this remain relatively unexplored, however participating athletes possessed a higher direct coping style and found pain less bothersome than non-participating athletes, indicating that psychological factors may have moderated pain reporting. Indeed, study two suggested that athletes who participated in high contact sports found contact related pain to be less bothersome than those who played low contact sports. High contact athletes also had a higher direct coping style for contact pain compared to low contact athletes. Qualitative data from study one also suggested that high contact athletes saw pain as something to be “toughed out” or “pushed through”, which is indicative of a high direct coping style (Bourgeois et al., 2009). Whether high direct coping develops as a result of experience of painful activities or whether it is present initially in people who choose to play high contact sports has yet to be fully determined. Study three suggested that the latter may be the case: High direct coping was present in participating contact sports athletes at the start of the season, indicating that this style may exist in those who choose to play contact sports at the outset. Taken together these results suggest that responses to pain such as tolerance and bothersomeness may develop over time, but psychological factors such as high direct coping may need to be present at the outset for athletes to participate in painful sports.

5.1 Introduction

Athlete groups.

It is widely agreed that athletes have a higher pain tolerance than non-athletes (Tesarz et al., 2012; Geva & Defrin, 2013). Research within athlete groups has also demonstrated that some athletes report pain differently to others. For example, high contact athletes can tolerate more pain and report less pain intensity than low or non-contact athletes (Ryan & Kovacic, 1966; Ryan & Foster, 1967); and highly trained athletes have higher pain tolerance than club or non-athletes (Scott & Gijssbers, 1981). This suggests that sporting endeavours that are inherently painful may produce a learning or habituation effect, resulting in certain athletes exhibiting superior pain tolerance and reporting lower pain intensity than other groups (Hall & Davies, 1991). It is therefore important to examine athletes who have experienced a great deal of pain in their sports alongside those who have experienced less pain. As stated in previous chapters, there are issues with using a contact – non-contact dichotomy and it cannot be ruled out that athletes in non-contact sports never experience pain. For the purposes of this study high contact athletes (i.e. rugby players, martial artists) will be compared to athletes who play sports where no contact is allowed at all (e.g. tennis). This will make the distinction between athlete groups clear.

In non-sports research, experience of pain has been shown to affect pain reporting (Dimova et al., 2013). Some studies suggest that exposure to pain can result in adaptation; for instance, soldiers who experienced severe injuries had a higher pain tolerance than those with lighter wounds (Dar et al., 1995) and patients who suffered chronic lower back pain were less sensitive to experimental pain than healthy controls (Peters & Schmidt, 1992). Other research however has suggested that increased experience of pain results in sensitisation (O'Neill, Manniche, Graven-Nielsen & Arendt-Nielsen, 2007). These discrepancies may be a result of using different pain stimuli and methods to assess sensitisation or adaptation, and further research is needed to determine how pain and psychological factors affect cortical and subcortical processes (Roussel et al., 2013).

Moderators of pain reporting: Challenge and threat.

Despite conflicting results in chronic pain literature, the scant research focused on sports suggests that contact athletes report less pain than non-contact athletes (e.g. Ryan & Kovacic, 1966). This may be a result of a combination of factors, one of which is cognitive appraisal of the situation, such as a challenge or a threat. The Biopsychosocial Model (BPS) of

challenge and threat (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996) states that demand and resource appraisals will determine whether a challenge or threat state occurs. Challenge states occur when an individual evaluates their coping resources and determines that they are sufficient to meet task demands; however, when coping resources are perceived to be insufficient, a threat state occurs (Seery, 2011). The BPS model has been used to develop a sports specific model, the Theory of Challenge and Threat States in Athletes (TCTSA, Jones, Meijen, McCarthy & Sheffield, 2009). The TCTSA posits that additional factors such as self-efficacy and perceived control also contribute to challenge or threat states. In addition, cardiovascular responses can indicate a challenge or threat state. Specifically, a challenge state results in increased sympathetic adreno-medullary activity along with increased cardiac activity and reduced peripheral vascular resistance. Threat states are also characterised by an increase in sympathetic activity and smaller increases in cardiac activity. However, a threat state results in either an increase or no change in peripheral vascular resistance (Jones et al.). Performance in sport can be predicted by these physiological indexes (Blascovich, Seery, Mugridge, Norris & Weisbuch, 2004) and challenge states are often associated with enhanced performance compared to threat states (e.g. Moore, Wilson, Vine, Coussens & Freeman, 2013; Turner, Jones, Sheffield & Cross, 2012).

Threat appraisals have been shown to reduce tolerance of experimental pain (Jackson et al., 2012; Wang, Jackson & Cai, 2016). Jackson et al., for example, reported that cold pressor tolerance was higher in individuals who perceived low threat and demonstrated pain acceptance. Qualitative research indicates that high contact athletes such as rugby players do indeed accept pain as part of their sport and they see pain as an occupational hazard (e.g. Liston et al., 2006), as such they may feel that they have the resources to cope with experimental pain, resulting in a challenge state. It should be noted however that challenge and acceptance are separate constructs, but they may have similar effects on pain responses. Acceptance refers to the welcoming of events, experiences and emotions in relation to pain and often results in higher pain tolerance and decreased stress when a pain stimulus is presented (Braams, Blechert, Boden & Gross, 2012). Challenge, as defined above relates to the belief that task demands can be met. To date there have been few studies that have focused on challenge and acceptance of pain.

Assessing challenge and threat.

Challenge and threat states can be manipulated via the provision of instructions about coping resources (e.g. Turner et al., 2012). According to TCTSA, instructions should provide information regarding self-efficacy, control over the situation and goals (Jones et al., 2009). For a challenge state to occur, instructions should focus on the ability and resources the person has to complete the task, perceived control over the situation and mastery oriented goals, with an overall aim to make the person feel competent. To induce a threat state, the opposite of these instructions should be provided (Jones et al.).

Both psychological and physiological measures can be taken to determine whether an individual is in a challenged or a threatened state. Challenge and threat states have typically been assessed using self-report measures; however, these do not reflect actual states due to social desirability and other biases when responding (Paunonen & LeBel, 2012). It has therefore been suggested that more objective measures of challenge and threat states are taken using cardiovascular response measurements. Turner et al. (2012), for example, used a Bio-Impedance cardiograph integrated system to measure cardiovascular reactivity. In the absence of such equipment, other measures can be used to track underlying haemodynamic responses associated with challenge and threat states. One such measure is heart rate variability (HRV; Thayer, Ahs, Fredrikson, Sollers & Wager, 2011). HRV reflects the influence of the autonomic nervous system on heart rate (Dishman et al., 2000). It is often defined as the standard deviation of the intervals between R waves of the cardiac cycle. It is indicative of the nervous systems that modulate heart rate, often expressed using a frequency spectrum. Low frequency is mediated by both the parasympathetic and sympathetic nervous systems whereas high frequency is mediated mainly by the parasympathetic nervous system (Dishman, et al.). High frequency indicates the dominance of parasympathetic, vagal activity, whereas low frequency indicates sympathetic activity (Berntson et al., 1997). Lower high frequency power is associated with increased anxiety, panic and worry. Therefore, lower resting HRV is linked to higher stress and poor cardiovascular health and indicates poor adaptation to stress (Chalmers, Quintana, Abbott & Kemp, 2014). Conversely, high HRV is indicative of an ability to adapt to the environment, show resilience and self-regulate (Beauchaine, 2001). Trained athletes have been shown to have higher HRV than sedentary controls, indicating that experience of athletic training can influence HRV (Dixon, Kamath, McCartney & Fallen, 1992). It has been suggested that lower HRV can indicate a threat state whereas high HRV can indicate a challenge state (Laborde & Lautenbach, 2015).

Vagal tone has been proposed to indicate challenge and threat states, and is positively correlated with HRV (Laborde, Mosely & Thayer, 2017). The main measure used to indicate HRV is the root mean square of successive R-R intervals (RMSSD), which reflects vagal tone. This measure is highly correlated with high frequency HRV (Laborde et al.). Sheinkopf et al. (2007) examined vagal tone in children under non-stressful challenge conditions. Results indicated that children with high vagal tone showed resilience and adaptive behaviours when presented with a challenging task. Children with low vagal tone did not adapt well and exhibited maladaptive behaviours. This suggests that there is an association between cardiovascular responses and behaviours during challenging conditions. Specifically, high vagal tone or HRV may result in positive adaptations to the environment, which is indicative of challenge states (Sheinkopf et al.). Cocia, Uscătescu and Rusu (2012) examined the role of attention bias in threatening conditions using a spatial cueing task. Results indicated that individuals with high HRV were less threatened during the fearful task. This suggests that participants with low HRV were more hypervigilant to the threat stimulus than those with high HRV. This accords with other research that indicates that high HRV can act as a buffer to threatening situations (Miskovic & Schmidt, 2010).

In a further study, O'Brien, Wingfield and Rohleder (2011) examined threat perceptions in adults by manipulating feedback during a stress test. Participants were asked to make moral judgements about scenarios and were then provided with positive or negative feedback. Cardiovascular measures were taken continuously throughout. Results indicated that low HRV was a predictor of increased threat perceptions when negative feedback was provided. However, those with high HRV had little change in their threat perceptions even when given negative feedback. This suggests that individuals with high HRV may be more resilient to negative instructions and that HRV may predict threat responses. These results are echoed in a study by Hansen, Johnsen and Thayer (2009), who had participants perform cognitive tasks under threatening or non-threatening conditions. Participants were divided into high and low HRV groups based on median baseline measures. Results indicated that participants with high HRV outperformed the low HRV group on the cognitive task regardless of whether the instructions were threatening or not. Therefore, individuals who are able to adapt to the environment and have high HRV may perform better in threatening situations compared to those with lower HRV. In summary, there is evidence that HRV is an index of challenge and threat (e.g. Laborde & Lautenbach, 2015); however more research is needed, in particular when pain is induced.

To date, few studies have examined challenge and threat manipulations while participants experience experimental pain. Wang et al. (2016) used the cold pressor test to induce challenge or threat states. Before the pain task, a high threat group was informed about frostbite, a low threat group was told about the safety of the pain test and a challenge group was encouraged to show persistence in the face of pain. Results showed that the high threat group had lower pain tolerance and catastrophized more during the test than the other two groups. In an earlier study, Tomaka, Blascovich, Kibler and Ernst (1997) had participants complete a mental arithmetic task whilst undergoing cold pressor pain. The results showed that participants who reported high pain levels perceived the mental arithmetic task to be more threatening compared to participants who reported less pain, lending further support to the influence of psychological variables on cognitive appraisal. No study has yet attempted to examine the relationship between cognitive appraisals of experimental pain, challenge and threat conditions and performance in a motor task.

Performance in pain.

Regardless of sporting experience, most researchers agree that pain demands attention, and therefore has a detrimental effect on tasks that involve working memory (Attridge et al., 2015). In cognitive tasks, pain decreases performance and the ability to multi-task (Keogh, Moore, Duggan, Payne & Eccleston, 2013). In addition, pain also alters perceptions of the strategies and processes used to complete tasks, even if performance is not affected (Keogh et al.). Pain also weakens performance in complex motor tasks (Brewer et al., 1990). In a review of the effects of pain on the motor system, Bank et al. (2013) concluded that pain affects many elements of motor processing and that acute experimental pain alters motor control, resulting in compensatory or protective behaviours. Therefore, pain affects not only working memory but also task performance.

There is a paucity of research focusing on how pain affects motor performance using athletes as participants. In the only published study to compare athletes to non-athletes in pain, Walker (1971) found no performance differences of a novel neuromuscular task between groups. In a study in preparation for review, Sheffield, Thornton and Jones (2017) compared performance of a novel motor task in high contact athletes, low contact athletes and non-athletes whilst undergoing cold pressor pain. Results showed that high contact athletes performed better in pain compared to low contact and non-athletes. In addition, low contact and non-athletes performed significantly worse in pain compared to when they were not in

pain, whereas high contact athletes maintained performance during the pain tasks. This suggests that experience of pain within sports may influence attentional processes and the ability to function effectively in painful situations.

Contact sports are inherently painful and present many occasions where athletes may have to withstand pain from fatigue, contact with others and injury. It is unclear how and why high contact athletes are able to withstand often intense pain yet can still attend to the fluid situation before them, often using complex scanning and decision making abilities to achieve success in their sport. The most plausible explanation is that experience of pain alters the perception of it (Hall & Davies, 1991). That is, experience of pain over time may result in reduced pain intensity reporting (Ryan & Kovacic, 1966). This could influence a number of variables such as cognitive appraisal and bothersomeness of pain and therefore, ultimately performance.

In addition, direct coping styles may predict those who choose to persevere at contact sports, and this appears to differentiate athletes even at the start of a contact sport career. Therefore, a combination of learning via experience and having a high direct coping style may distinguish those with high pain tolerance from those with low pain tolerance (e.g. Crombez et al., 1997; Smith et al., 2009; Bourgeois et al., 2009). This also may discriminate between those who perform well in pain and those who do not.

Exposure to experimental pain results in poor task performance because anxiety can shift attention towards task irrelevant stimuli (Eysenck, Derakshan, Santos & Calvo, 2007). This, according to Attention Control Theory (ACT; Eysenck et al.), is known as attentional bias, a phenomenon whereby individuals focus their attention on threat related stimuli (for example, pain) rather than the task at hand. ACT states that attention is regulated by both a top-down goal driven system and a bottom-up stimulus driven attentional system. The goal directed system is governed by knowledge, current goals and expectations whereas the stimulus directed system focuses more on salient stimuli in the environment. According to ACT, anxiety affects the balance between the two systems, with the stimulus driven system becoming more influential than the goal driven system (Eysenck et al.). This affects the execution of motor tasks, and results typically, in poorer performance. Research into attentional bias has been equivocal, with some researchers reporting that attention is drawn towards experimental pain stimuli (e.g. Crombez, Van Ryckeghem, Eccleston & Van Damme, 2013), and other researchers reporting that the opposite occurs (e.g. Lautenbacher et al., 2009). It is suggested

that these discrepancies may be due to how pain is interpreted. That is, if pain is viewed as a threat, individuals may over-attend to it, or catastrophize, whereas if pain is accepted or seen as a challenge, the opposite may occur (Todd et al., 2015). This may also be the case for direct coping; that is, individuals with a high direct coping style may view pain as a challenge (Kopka-McDowell & LaChapelle, 2005), and therefore may be able to more easily direct attention towards task relevant factors. As such, athletes who are not threatened by pain may perform better than those who are, during experimental pain conditions.

It is therefore suggested that measuring where attention is directed (for example, towards pain) only addresses part of the question regarding how people respond to pain (Crombez, Heathcote & Fox, 2015). This is because self-report measures of attentional focus can be unreliable, and because technology has now advanced so that physical measures can be taken (for example eye tracking) to assess attention. In addition, as pain is a dynamic construct, multiple approaches should be taken to assess how individuals feel about pain. It is recommended that researchers should also examine the interpretation and meaning of pain, for example whether a painful situation is viewed as a challenge or a threat. This would help to explain some of the ambiguous findings within attentional bias research and would provide a more in-depth understanding of pain responses (Crombez et al.). It could be suggested that athletes who have had a great deal of experience of pain may view that pain as a challenge rather than a threat (Meyers et al., 2001).

In a study that attempted to measure attentional focus, Vine, Freeman, Moore, Chandramanan and Wilson (2013) investigated performance of a novel motor task, while challenge and threat appraisals were created by manipulating pressure to complete the task. Gaze was measured using a mobile eye tracker to examine the role of attention in performing the task. Results showed that challenge situations resulted in better performance and better visual control, lending support to the notion that challenge states result in better attentional control compared to threat states. This suggests that challenge states should result in better performance than threat states.

Bothersomeness.

Bothersomeness may also change as a result of experience of pain (DeRoche et al., 2011). High pain bothersomeness results in poor physical functioning and individuals who report high pain bothersomeness may perform ineffectually during experimental pain (Patel et al., 2013). They may also choose not to engage in, or drop out of painful contact sports.

Reduced pain bothersomeness can result in longer involvement in combat sports, meaning that as experience increases so does exposure to pain (DeRoche et al.). It has been suggested that pain tolerant individuals may be “toughened up” by repeated exposure to pain in this way, resulting in reduced pain bothersomeness and the drive to seek out painful situations (Seguin, Pihl, Boulerice, Tremblay & Harden, 1996). As pain is often experienced in a motivational context (Karsdorp, Ranson, Nijist & Vlaeyen, 2012), these findings suggest that if pain bothersomeness is low, individuals may approach painful situations and perform well due to motivational factors. This might create a cyclical or reciprocal situation whereby pain is sought out and experienced, thus reducing bothersomeness, which in turn results in more participation, thereby increasing experience and reducing bothersomeness further in the process.

Coping Styles.

It has been suggested that coping styles may influence responses to pain and that contact athletes may employ different coping styles to non-contact or low contact athletes (Meyers et al., 2001). Coping styles refer to a more dispositional view of coping and are more general than coping strategies (Koolhaas & DeBoer, 2008). Direct coping is a style measured by the SIP15 (Bourgeois et al., 2009), that reflects a tendency to see pain positively and as something to “tough out”. Having a high direct coping style may mean that pain is seen not as a distraction, but as a normal, accepted part of sport (Levy et al., 2006). Direct coping has been positively correlated with mental toughness (Levy et al.) and both are associated with a tendency to overcome stressful (or painful) situations (Meyers et al.).

There are few studies examining the effects of direct coping during painful tasks. However, Crust and Clough (2005) correlated mental toughness, which is linked to direct coping, with physical endurance by asking participants to suspend a weight from their arm for as long as possible. Results showed that participants with high mental toughness could suspend the weight for longer than those with lower mental toughness. The authors suggested that the mentally tough participants exerted more control over the pain experience than the less mentally tough participants. As a result, individuals with high direct coping may also perform better in pain than those with low direct coping.

Summary and aims.

Taken together, research suggests that there are a number of factors that interact to produce successful performance during painful tasks. It appears, based on study three, that high direct coping may influence perceptions of pain and pain reporting. This may affect the choice

to approach or avoid contact sports, and as such may influence adherence. Those with little experience of pain within sports may be threatened by pain, have poor coping mechanisms and report it as being more bothersome. Those with a great deal of experience of pain in sports are likely to report low bothersomeness, have high direct coping and feel challenged. It is therefore hypothesised that high contact experienced athletes will be able to maintain performance in pain whereas non-contact athletes will see deteriorated performance in pain. It is less clear how high contact novice athletes will perform, as this may be dependent upon their level of direct coping. However, based on study three, it is anticipated that the high contact novice athletes will be similar to the non-contact athletes for some measures due to having minimal exposure to sports related pain, see Figures 5.1-5.3.

This study aims to examine the influence of experience, challenge and threat states and psychological factors on performance whilst undergoing experimental pressure pain. Athlete groups were compared based on the contact level in the sport (high contact versus non-contact) and their level of experience (new recruits to the sport (< 6 months), and experienced athletes (> 3 years)). Six months was chosen as the cut off for new high contact athletes based on study three. Results showed that at eight months there were differences in pain responses between participating and non-participating contact athletes, but at four months there was not. It was important that the athletes had had some experience of contact sports when this study took place. Therefore, athletes with less than four months experience were initially sought out, but to gain a larger sample size, six months was used as a cut-off.

Hypotheses

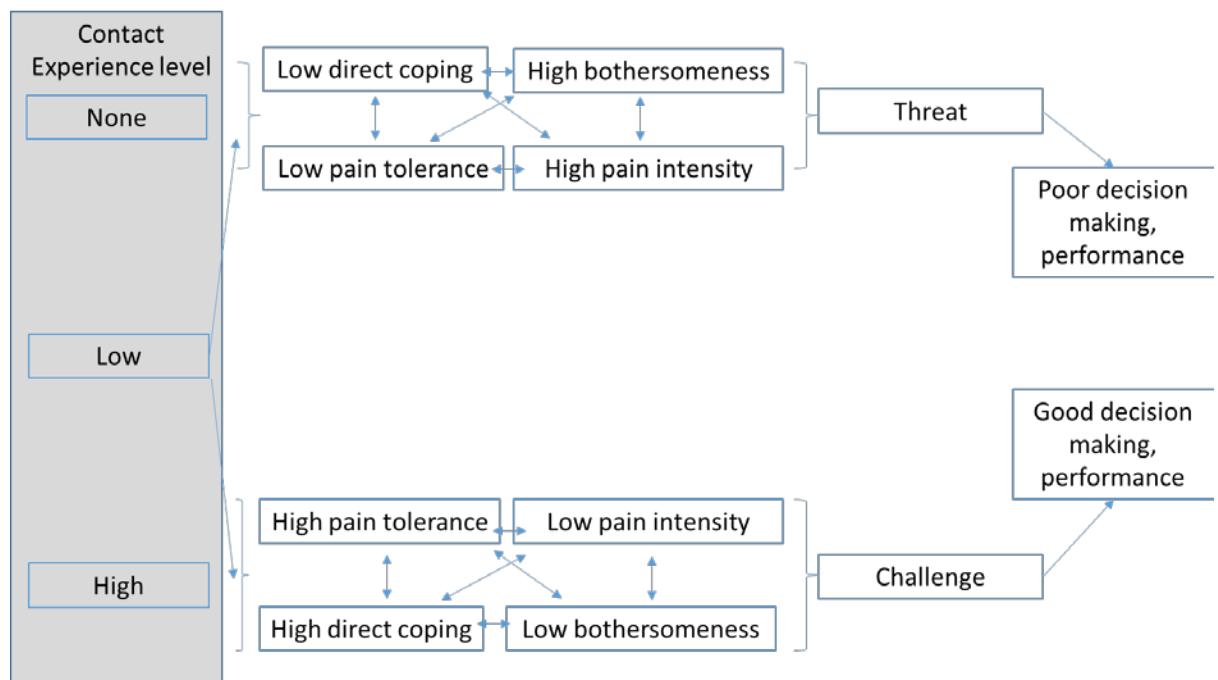
1. High contact experienced athletes will perform better in pain compared to non-contact athletes
 - 1a. High contact experienced athletes will have less decrement in performance in pain compared to when not in pain
 - 1b. Non-contact athletes will perform worse in pain compared to when not in pain
2. High contact experienced athletes respond differently to pain to non-contact athletes:
 - 2a. High contact experienced athletes will have higher pain tolerance
 - 2b. High contact experienced athletes will report pain as less intense
 - 2c. High contact experienced athletes will report pain as less bothersome
 - 2d. High contact experienced athletes will demonstrate higher direct coping.

3. The challenge and threat manipulation will moderate the relationship between athlete type (pain experience level) and performance difference when in pain vs. when not in pain
4. Pain tolerance, bothersomeness and direct coping will mediate the relationship between athlete type (experience level) and performance difference when in pain vs. when not in pain

See fig. 5.1

Figure 5.1:

Model showing the proposed hypotheses



Pilot study.

Before testing began an extensive pilot study was conducted. The pilot study aimed to assess the reliability of the pressure algometer and to allow the researcher to become proficient at using it. Fourteen students volunteered to take part and were required to undergo a pressure pain tolerance test at the site of the extensor indicis proprius, the same site used in the subsequent study. The algometer was pressed on the site vertically and participants were asked to indicate when they could no longer tolerate the pain. Four of the students did not reach tolerance on the first occasion. Lacourt, Houtveen and van Doornen (2012) conducted a study

to assess the validity of using pressure algometry to establish pain tolerance. They reported that on average two trials were required to establish pain tolerance on the thumbnail. As such, the participants underwent another trial using an inter-stimulus time of 30 seconds (as recommended by Lacourt et al.). All participants reached tolerance after three trials. It was therefore decided that during the subsequent experiment, that if participants did not reach tolerance on the first attempt, this same protocol would be followed.

Following the pressure pain task, participants were asked to describe the pain and to comment on whether it was similar to any pain experienced in sport. Pain research using athletes often lacks ecological validity because the pain stimulus applied is often nothing like the pain experienced during sport (Addison et al., 1998). It is therefore important to attempt to use stimuli that reflect sporting pain, where possible. Five of the participants said the pain was nothing like anything they would ever feel in sport, however nine of the participants said the pain reminded them of sporting pain. The pain was described as “blunt”, “pressure” and “like being gripped”. The nine participants who said it was akin to sports pain stated that it was like a “dead arm or leg” or like “the pressure in a scrum”, like “being gripped in a tackle” or “a bit like a bruise”. Therefore, the algometer, at least for some students, did indeed reflect sporting pain.

Following testing the participants were also asked if they felt that the pressure applied was at a steady, incremental rate. All stated that they felt the pressure increase incrementally and that it did feel constant. The researcher then attempted to apply a set amount of pressure at a constant rate on each participant. This was to ensure that the researcher would be able to exert a certain amount of pressure during experimental conditions when 75% of maximum pain tolerance would be applied. 60 Newtons (N) was chosen as the pressure amount because all participants tolerated over 80N of pressure. 60N is 75% of 80, which reflected actual experimental conditions. Thirteen of the 14 trials were successful, indicating that the researcher was proficient at applying pressure at a constant rate.

5.2 Method

Participants.

Participants were drawn from university and college sports teams and clubs. They were invited to participate via social media, notices placed around campus and word of mouth. One hundred and twenty male ($n = 63$) and female ($n = 57$) athletes took part in the study (M age = 22.1 years, $SD = 3.8$ years). Using an alpha level of $p < 0.05$, sample sizes were calculated

based on prospective estimates of power and effect size figures to achieve an acceptable power level of 0.8 and a large effect size of $\eta^2 = 0.138$ (Clark-Carter, 2008). The groups were divided as follows; high contact experienced athletes ($n = 40$) were athletes who took part in sports such as rugby or American football who had been participating for over three years (M experience = 112.24 months, $SD = 61.71$ months); high contact novice athletes ($n = 40$) were athletes who took part in sports such as rugby or American football who had less than six months experience ($M = 3.82$ months, $SD = 0.85$ months); and non-contact athletes ($n = 40$), who were athletes taking part in team sports where contact is not allowed within the rules, for example netball and cricket ($M = 87.85$ months, $SD = 35.80$ months). All participants were pain and injury free at the time of testing.

Ethics.

The study was approved by the University Research Ethics Committee. All participants gave consent to participate and all received an information sheet outlining the procedure for the research (see appendix Q). Participants were excluded if they had an injury to either the hand or wrist.

Materials.

Demographic questionnaire.

Participants were required to provide their age, gender, sport, number of months playing the sport and the level at which they played their sport (e.g. recreational, county, national).

Motor task.

Participants were instructed to aim to hit ten targets with a tennis ball. Twenty numbered targets were placed on a wall in a random order and at different heights. Participants were not told the sequence of targets to hit before the test took place. Rather, the researcher informed them of which target to aim for immediately before each attempt. The sequence for the ten targets was completely random (i.e. not sequential), but was the same for each participant to ensure that the task was consistent for all. Only one attempt at each target was allowed. Performance was measured based on how many targets were successfully hit and also how long it took to complete ten targets. This was to account for decision making and to ensure there was no trade-off for time versus accuracy. All targets were placed in the same way on the wall for all participants and were occluded until the test started so participants could not

memorise the positions of the targets. Participants were seated throughout each task at a distance of five metres from the targets.

Heart rate variability (HRV).

HRV was measured to confirm challenge and threat states. There are many tools to measure HRV, including electrocardiograph (ECG), specialist heart rate monitors and smart phone applications (Flatt & Esco, 2013). However, some of these measures come with limitations; ECG use requires experienced technicians, time and expensive equipment. Heart rate monitors, whilst less time consuming and cheaper also require (sometimes expensive) computer software to interpret HRV results. Smart phone applications are cheaper and quicker to use but have largely, not been validated. Recently however Flatt and Esco have attempted to validate a smart phone application named *ithlete*TM (HRV Fit Ltd. Southampton, UK). This consists of a cone which is placed over the tip of the index finger to measure HRV. Results are then sent to a smart phone application which provides a HRV measure out of 100. *Ithlete*TM measures the root mean square of successive R-R intervals, (RMSSD) within a 55 second time frame. This measure indicates the square root of the mean of the sum of the squares of differences between adjacent normal R-R intervals during the time frame and measures the beat-to-beat variability of heart rate. This has more practical uses when testing in the field as it is not as time consuming as ECG. Flatt and Esco cross validated *ithlete*TM with ECG measures obtained in the laboratory and found a near perfect correlation between the two devices ($r = 0.99$). *Ithlete*TM was therefore used in this study to provide an accurate measure of RMSSD of successive R-R intervals.

Pain.

Pain was induced using a digital pressure algometer (Wagner Force TenTM Digital Force Gage, FDX 50) on the non-dominant arm at the site of the extensor indicis proprius. Pain tolerance was measured by pressing toward the medial side of the radius from a position of three fingers above the radial styloid process, as recommended by Park, Kim, Park, Kim and Jang (2011). The algometer was pressed against the site in a vertical direction while increasing the force at a constant rate of 1N/cm². The pressure creates a dull pain that intensifies with time, but causes no tissue damage (Hezel et al., 2012). Pressure algometry is reported to be a reliable measure of pain tolerance in muscle, joints, tendons, and ligaments (Chesterton, Sim, Wright & Foster, 2007).

Sport Inventory for Pain (SIP15) (Bourgeois et al., 2009).

The SIP15 was used to measure coping styles of the participants. The SIP15 was developed from the original Sports Inventory for Pain (Meyers et al., 1992) and is a 15-item inventory that contains three subscales – Direct Coping, Somatic Awareness and Catastrophizing.

Effort, bothersomeness, pain intensity and cognitive appraisal.

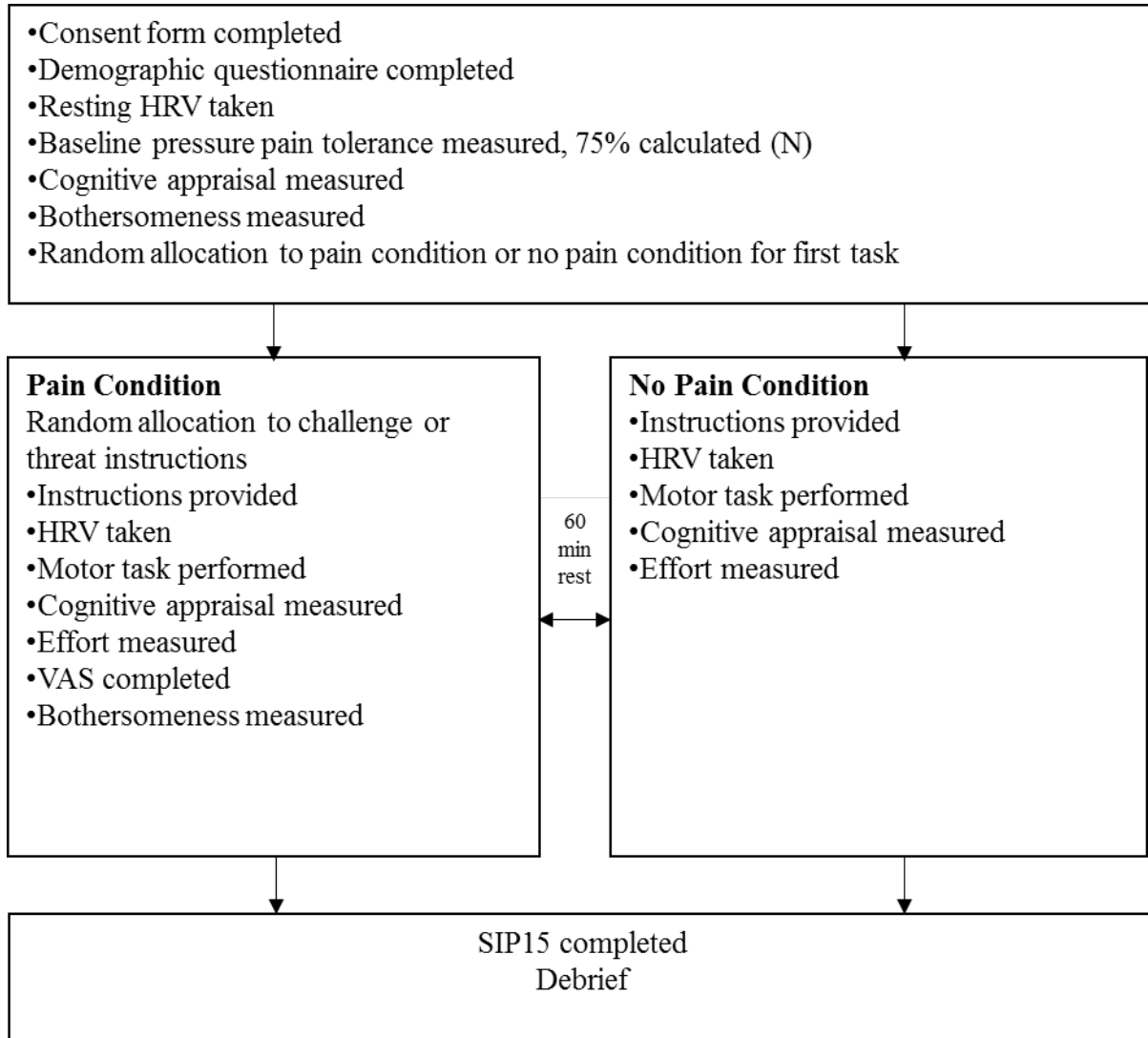
Effort was measured following the motor task to ascertain how hard participants felt they had tried in both the pain and no pain conditions. This was measured on a 5 point Likert scale with anchors of 1 = *no effort at all* and 5 = *a great deal of effort*.

The bothersomeness question asked participants to rate how bothersome the pain was physically and mentally during the motor task. This was measured on a 5 point Likert scale with anchors of 1 = *not bothersome* at all and 5 = *extremely bothersome*. Pain intensity was measured using a Visual Analog Scale (VAS) which consisted of a 10cm line with anchors of 0 = *no pain at all* and 10 = *worst pain imaginable*. Participants were asked to mark on the line how intense the pain was. Measurement was then taken in millimetres from the start of the line to the mark made by the participant. The cognitive appraisal question asked participants to consider their feelings before the test, measured on a 9 point Likert scale with anchors of -4 = *threatened*, 0 = *neither* and +4 = *challenged*. This was based on a study by Turner et al. (2012).

Procedure.

Figure 5.2:

Procedure, outlining the measures taken and the random allocation to between-subjects conditions.



On the testing occasion, participants completed the brief demographic questionnaire, were provided with instructions about the protocol, allowed to ask questions and were informed of the right to withdraw at any time. Resting HRV was then taken as a baseline measure using *ithlete*TM. See Figure 5.2.

Participants then underwent a baseline pressure pain test to measure maximum tolerance in Newtons. This was used to determine 75% of their maximum pain tolerance which was then applied during experimental pain conditions. This was based on the recommendations of Brewer et al. (1990), who defined this as “moderate pain”, using a similar gross pressure device.

Following baseline measurements, participants completed the motor task either without pain (as a baseline measure) or with pain. Conditions were randomised to account for order and carry over effects.

In the pain condition, participants were randomly allocated to a threat or a challenge condition. Accordingly, participants received either challenge or threat based instructions before they completed the motor task in pain. The instructions were derived from the wording of questions related to direct coping on the SIP15. The challenge condition instructions were: *“You will be asked to perform the task whilst you are in pain. You should be able to cope with this, many people do. You should not let the pain stand in the way of completing the task and you should be able to tough it out. You have the ability to be successful at this task and the pain should not interfere with your performance. You can therefore be confident that you will score highly. The protocol is set up in a way to allow you complete the task without any complications”*.

The threat condition instructions were: *“You will be asked to perform the task whilst you are in pain. You may not be able to cope with this, many people do not. The pain may stand in the way of completing the task and you may not be able to withstand it. You may fail at this task and the pain may interfere with your performance. You therefore can’t be confident that you will score highly. The protocol is set up in a way which may hinder your performance in the task.”* The instructions were read out verbatim from an instruction sheet and were read by the same researcher on each occasion.

Following these instructions, HRV was taken again, then participants completed the motor task whilst undergoing pressure pain. Pressure was applied to the site, using a 1 cm rubber tip, at a constant rate, based on 75% of the maximum established at baseline. Immediately after the pain condition, participants completed the VAS to indicate the intensity of the pain.

Following testing all participants completed the SIP15 and the bothersomeness, cognitive appraisal and effort questionnaires. A brief rest period of 60 minutes was given the participants between pain and non-pain tests.

The non-pain condition followed the same procedure, but with no pain stimulus present. HRV was taken after instructions were provided. Following the non-pain task participants completed the effort and cognitive appraisal questionnaires. At the completion of testing all participants were thanked and debriefed.

Data analysis.

Data were analysed to determine how each group of athletes performed in pain and to examine the other variables measured such as direct coping, bothersomeness and challenge and threat states. All data were screened for normality and the relevant test outcomes can be seen in appendices R-X, except where assumptions were not met and further explanation was required. A 3x2x7 MANOVA was conducted to examine differences between the groups of athletes. The independent variables were athlete type (high contact experienced, high contact novice, non-contact athlete) and pain condition (pain or no pain), the dependent variables were performance (targets hit and time to complete), physical and psychological bothersomeness, cognitive appraisal, HRV and effort. SIP subscale scores (direct coping, catastrophizing, somatic awareness) were analysed in a separate 3x3 MANOVA as these were only taken once. 3x2 mixed ANOVAs were conducted to examine differences in groups for pain tolerance and pain intensity.

5.3 Results.

Challenge and threat and effort manipulation check.

Groups were compared, using paired samples t-tests for HRV and cognitive appraisal. High contact experienced athletes felt more challenged according to cognitive appraisal in the pain condition compared to the no pain condition, $t_{(39)} = -2.96$, $p = 0.005$, $r = 0.42$, a medium effect size. The same was true for HRV $t_{(39)} = 3.68$, $p = 0.001$, $r = 0.51$, a large effect size. High contact novice athletes also felt significantly more challenged in the pain condition compared to the no pain condition, $t_{(39)} = -2.39$, $p = 0.02$, $r = 0.35$, a medium effect size for cognitive appraisal only. The non-contact athletes felt significantly more threatened in the pain condition according to cognitive appraisal compared to the no pain condition, $t_{(39)} = 3.78$, $p = 0.001$, $r = 0.51$, a large effect size. The same was also true for HRV, $t_{(39)} = -2.24$, $p = 0.03$, $r = 0.33$, a medium effect size. See table 5.3 for descriptive statistics. In order to assess effort levels in pain and not in pain, a 2x2x3 mixed ANOVA was conducted. There were no differences in effort.

To assess whether the challenge and threat instructions affected HRV and cognitive appraisal, independent samples t-tests were conducted between challenge and threat conditions. HRV was significantly higher in the challenge group compared to the threat

group following instructions for the pain task, $t_{(118)} = 3.60$, $p < 0.0001$, $r = 0.31$, a medium effect size. Cognitive appraisal was higher in the challenge condition compared to the threat condition, $t_{(118)} = 1.94$, $p = 0.05$, $r = 0.17$, a small effect size. See table 5.1.

Table 5.1:

Descriptive Statistics: HRV and Cognitive Appraisal according to challenge and threat state and athlete type

| Type of Athlete | No Pain Condition | HRV | | Cognitive Appraisal | |
|--------------------------|-------------------|-------|--------------------|---------------------|--------------------|
| | | Mean | Standard Deviation | Mean | Standard Deviation |
| High contact experienced | Challenge | 81.00 | 6.23 | 1.65 | 1.03 |
| | Threat | 79.90 | 8.83 | 1.35 | 1.08 |
| High contact novice | Challenge | 79.05 | 5.21 | 1.40 | 0.94 |
| | Threat | 76.60 | 5.29 | 1.70 | 0.97 |
| Non-contact | Challenge | 74.00 | 6.39 | 1.85 | 1.03 |
| | Threat | 76.80 | 10.55 | 1.80 | 1.05 |
| Type of Athlete | Pain Condition | Mean | Standard Deviation | Mean | Standard Deviation |
| High contact experienced | Challenge | 84.90 | 6.47 | 2.00 | 0.64 |
| | Threat | 79.95 | 9.41 | 1.90 | 1.78 |
| High contact novice | Challenge | 82.95 | 5.34 | 1.90 | 0.85 |
| | Threat | 76.00 | 5.82 | 1.80 | 1.00 |
| Non-contact | Challenge | 75.50 | 6.30 | 1.70 | 0.92 |
| | Threat | 72.05 | 11.06 | 0.90 | 1.07 |

Performance in pain and no pain

MANOVA was used to test the first set of hypotheses (1, 1a and 1b) regarding group differences in performance in pain. There was a significant interaction between pain condition and athlete type, $F_{(14,218)} = 5.23$, $V = 0.50$, $p < 0.0001$, $r = 0.15$, a small effect size. Contrasts revealed that athlete groups differed in pain for targets hit, $F_{(2,114)} = 8.12$, $p < 0.001$, $r = 0.25$. Post hoc Bonferroni tests revealed that high contact experienced athletes hit significantly more targets in pain than non-contact athletes, $p < 0.0001$. High contact novice athletes also hit significantly more targets in pain compared to the non-contact athletes, $p = 0.001$. Contrasts also revealed that athlete groups differed in pain for time to complete the task, $F_{(2,114)} = 6.59$, $p = 0.002$, $r = 0.23$. Post hoc Bonferroni tests revealed that high contact experienced athletes completed the task significantly faster than non-contact athletes, $p = 0.001$. High contact novice athletes also completed the task significantly faster than the non-contact athletes, $p = 0.01$. Hypothesis 1 was therefore supported.

In order to test hypotheses 1a and 1b, paired samples t-tests were performed within each athlete group to examine differences in performance whilst in pain compared to when not in pain. Hypothesis 1a stated that high contact experienced athletes would perform better in pain compared to when not in pain. The high contact experienced athletes performed significantly faster in pain than not in pain, $t_{(39)} = 2.46$, $p = 0.02$, $r = 0.36$, a medium effect size, however there were no performance differences for targets hit $t_{(39)} = -1.83$, $p = 0.07$, $r = 0.28$, a small effect size. Hypothesis 1a was therefore supported regarding time to complete, but not targets hit.

Hypothesis 1b stated that non-contact athletes would perform worse in pain compared to when not in pain. Non-contact athletes hit significantly less targets in pain compared to when not in pain, $t_{(39)} = 3.87$, $p < 0.0001$, $r = 0.52$, a large effect size and were significantly slower in pain compared to when not in pain, $t_{(39)} = -2.11$, $p = 0.04$, $r = 0.32$, a medium effect size. Therefore, hypothesis 1b was supported. There were no performance differences in pain compared to not in pain in the high contact novice group, see figs 5.3 and 5.4.

Figure 5.3:

Targets hit in pain according to challenge and threat state and athlete type

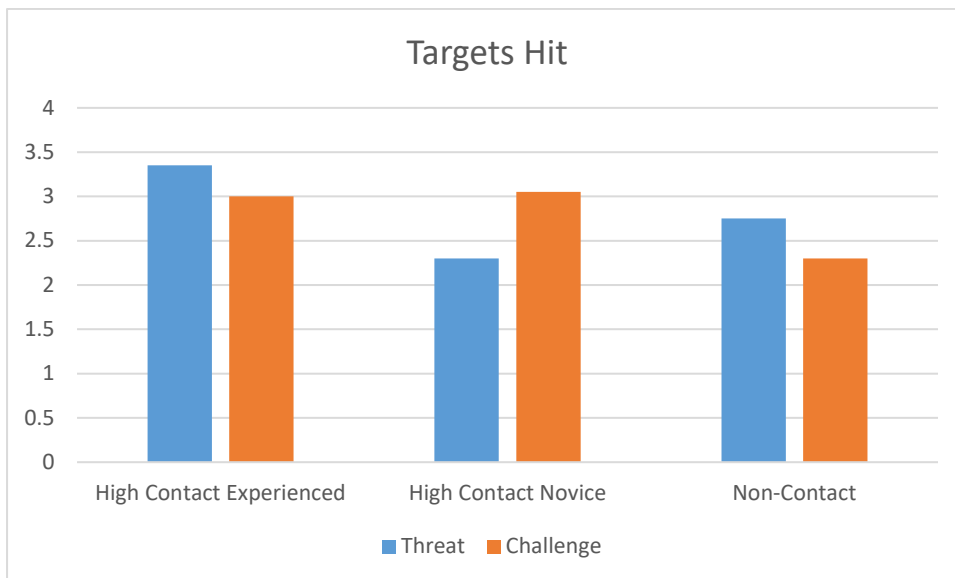
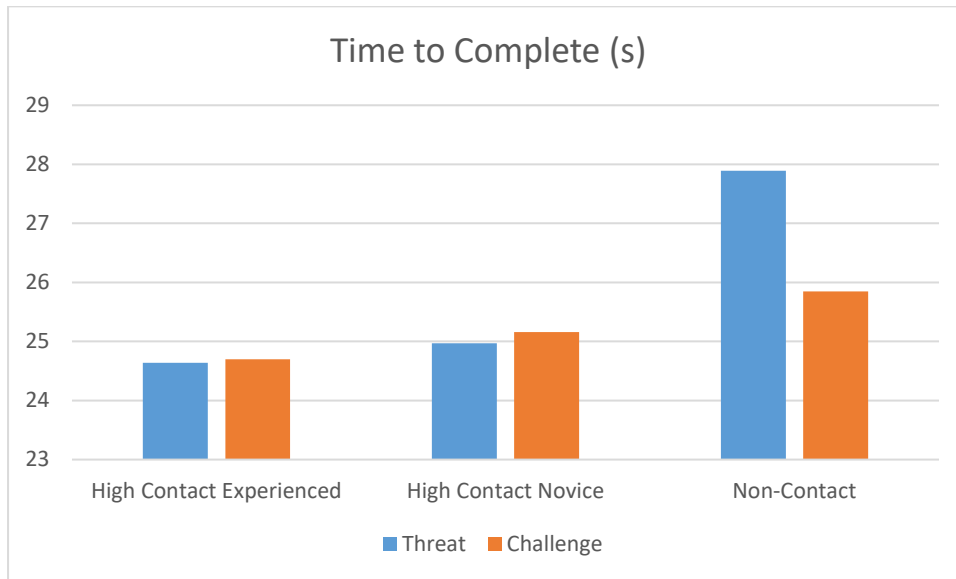


Figure 5.4:

Time to complete motor task in pain according to challenge and threat state and athlete type



MANOVA and ANOVA were used to examine the second set of hypotheses regarding pain responses. Hypothesis 2a stated that high contact athletes would have higher pain tolerance than non-contact athletes. A one-way ANOVA indicated that there was a significant effect of athlete type on pain tolerance, $F_{(2,117)} = 41.63$, $p < 0.0001$, $r = 0.64$, a large effect size. Post-hoc Games-Howell tests revealed that high contact experienced athletes had a higher pain tolerance than high contact novice athletes, $p < 0.0001$ and non-contact athletes, $p < 0.0001$, supporting hypothesis 2a. There were no differences between high contact novice and non-contact athletes, $p = 0.29$. See table 5.2.

Table 5.2

Descriptive Statistics: Pressure Pain Tolerance in Newtons (N) and Pain Intensity Reports (100mm VAS) according to athlete type

| Type of Athlete | Pain Tolerance | | Pain Intensity | |
|--------------------------|----------------|------------------------|----------------|-------------------------|
| | Mean (N) | Standard Deviation (N) | Mean (mm) | Standard Deviation (mm) |
| High contact experienced | 169.33 | 26.37 | 24.22 | 12.39 |
| High contact novice | 124.93 | 20.20 | 41.35 | 19.83 |
| Non-contact | 115.06 | 36.11 | 47.62 | 21.21 |

A one-way ANOVA was conducted to test hypothesis 2b that high contact experienced athletes would report pain as less intense than non-contact athletes. There was a significant effect of athlete type on pain intensity, $F_{(2,117)} = 17.65$, $p < 0.0001$, $r = 0.48$, a medium effect size. Post-hoc Games-Howell tests revealed that high contact experienced athletes perceived the pain to be significantly less intense than non-contact athletes, $p < 0.0001$, supporting hypothesis 2b. High contact experienced athletes also reported pain as less intense than high contact novice athletes, $p < 0.0001$. There were no differences between high contact novice and non-contact athletes, $p = 0.36$. See Table 5.2.

Hypothesis 2c stated that high contact experienced athletes would find pain less bothersome than non-contact athletes. MANOVA indicated that there was a significant interaction between pain condition and athlete type, $F_{(14,218)} = 1.77$, $V = 0.21$, $p = 0.44$, $r = 0.09$. Contrasts revealed that there was a significant difference between groups for psychological bothersomeness of pain, $F_{(2,114)} = 3.44$, $p = 0.03$, $r = 1.17$. Post-hoc Bonferroni tests revealed that high contact experienced athletes found pain less psychologically bothersome than non-contact athletes, and high contact novice athletes, $p < 0.0001$. Therefore hypothesis 2c was supported for psychological bothersomeness, but not physical bothersomeness.

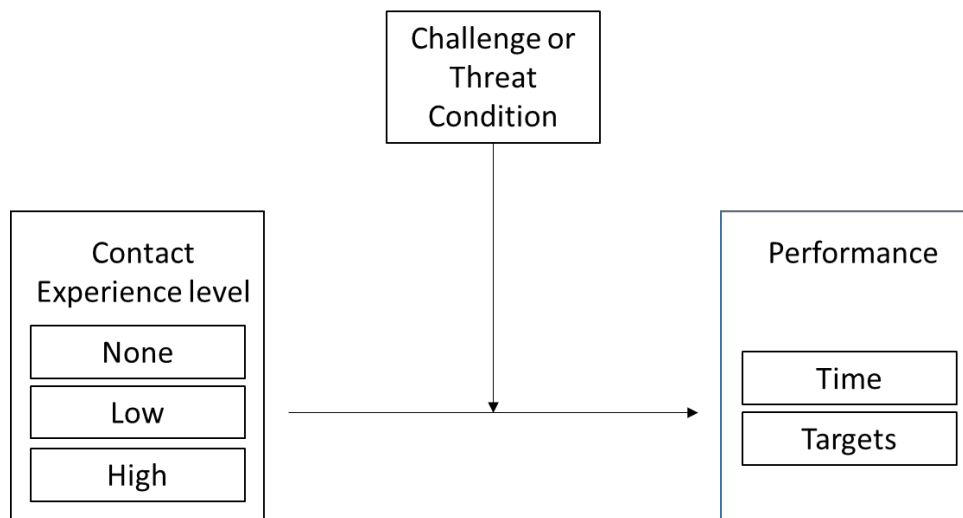
Hypothesis 2d stated that high contact experienced athletes would have higher direct coping than non-contact athletes. A one-way ANOVA indicated that there was a significant effect of athlete type on direct coping, $F_{(2,117)} = 15.50$, $p < 0.0001$, $r = 0.34$, a medium effect

size. Post-hoc Games-Howell tests revealed that high contact experienced athletes had higher direct coping than high contact novice athletes and non-contact athletes, $p < 0.0001$. In addition, high contact novice athletes had higher direct coping than non-contact athletes, $p = 0.05$. Therefore hypothesis 2c was supported.

Moderation analysis was conducted using PROCESS for SPSS to test hypothesis 3. Model 1 was employed, using Athlete type as the predictor, performance difference between the pain and no pain condition as the outcome variable and challenge or threat manipulation as the moderator, see fig 5.5.

Figure 5.5:

Challenge and threat moderation model using athlete type (experience level) as predictor and performance measures as outcomes



Performance difference was calculated for time to complete the task by subtracting the time taken to complete the task not in pain from the time to complete the task in pain. The same calculation was performed for targets hit. As such, lower (and more negative) scores indicate better/quicker performance for both measures. Correlations were performed beforehand to confirm that all variables were related.

For the performance measure of time to complete, there was no significant relationship between athlete type and performance when challenge and threat was used as a moderator, $b = 0.62$, 95 CI [-0.26, 1.51], $t = 1.40$, $p = 0.16$. However on examination of the conditional effect of X on Y, following a Bonferroni correction, there was a significant positive relationship when threat was high, $b = 0.98$, 95 CI [-0.36, 1.10], $t = 3.77$, $p < 0.001$.

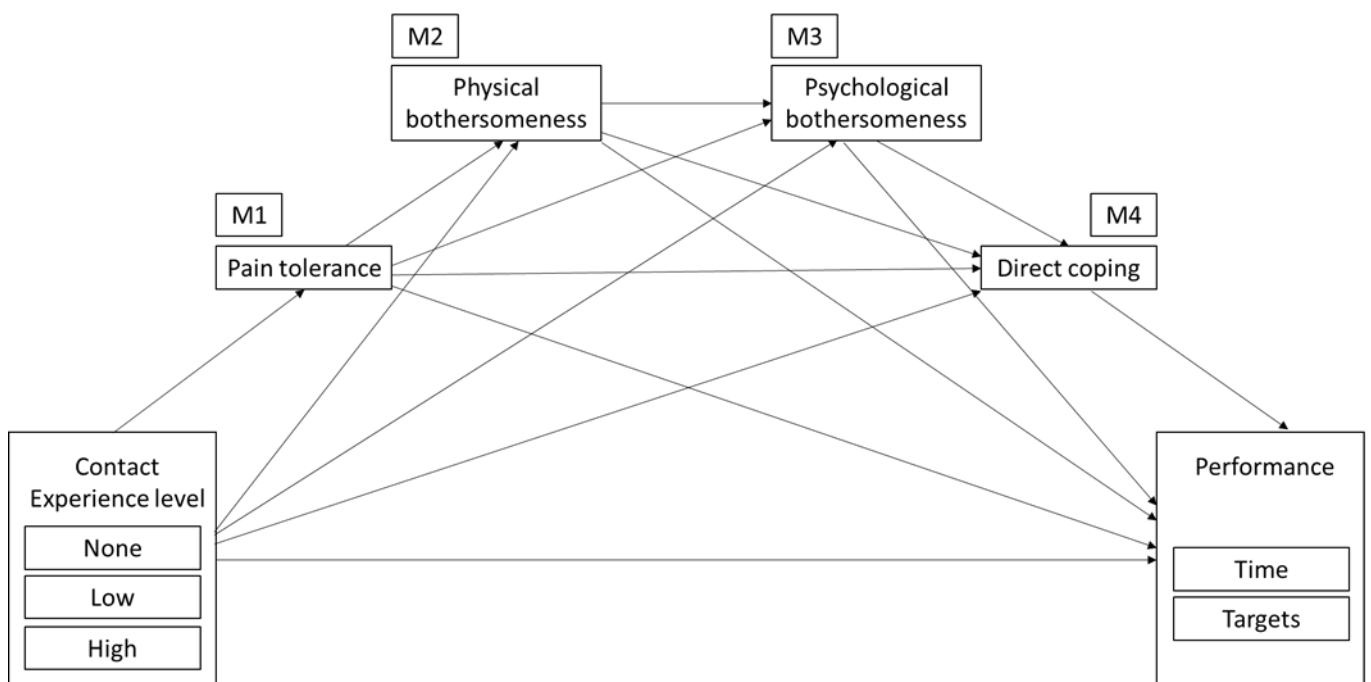
This indicates that within the threat group only, there was a significant positive relationship between athlete type and time difference to complete the task. Therefore, those with more experience of pain performed better in pain compared to when not in pain in comparison to those with less experience, when threatened.

For the performance measure of targets hit, there was a significant relationship between athlete type and performance when challenge and threat was used as a moderator, $b = -0.67$, 95 CI [-1.3, -0.70], $t = -2.21$, $p = 0.02$. There was no significant relationship in challenge, but in threat there was a significant negative relationship, using a Bonferroni correction, $b = -1.0$, 95 CI [-1.37, -0.62], $t = -5.26$, $p < 0.0001$. This indicates that within the threat group, those with more experience of pain performed better than those with less experience.

Mediation analysis using PROCESS for SPSS was then conducted using model 6 to test hypothesis 4 (see fig 5.6).

Figure 5.6:

Mediation model number 6 in PROCESS using athlete type (experience level) as predictor and performance measures as outcome



The predictor variable was again, athlete type and the outcome was performance difference (in terms of targets hit and time to complete the task). The four mediators were placed into the model in the following order; pain tolerance, physical pain bothersomeness, psychological pain bothersomeness and direct coping. Bonferroni corrections were applied when examining each mediator.

Mediation for time to complete

Athlete type significantly predicted time to complete the task, $b = 0.67$, $t = 3.12$, $p < 0.001$. When the mediators were added to the model, there was a significant indirect effect of athlete type on time to complete the task through pain tolerance, $b = 0.02$, $t = 1.98$, $p = 0.04$ CI [0.08, 0.81]. Physical bothersomeness was also a significant mediator, $b = -0.62$, $t = -1.91$, $p = 0.05$ CI [0.07, 1.11]. These results indicate that athletes with higher pain tolerance and lower physical pain bothersomeness performed better on the task.

Athlete type significantly predicted pain tolerance, $b = 27.12$, $t = 8.25$, $p < 0.0001$ and physical bothersomeness, $b = -0.90$, $t = -10.15$, $p < 0.0001$. Physical bothersomeness predicted psychological bothersomeness, $b = 0.65$, $t = 7.70$, $p < 0.0001$. Pain tolerance predicted direct coping, $b = 0.03$, $t = 3.41$, $p < 0.0001$.

Mediation for targets hit

Athlete type significantly predicted targets hit, $b = -0.66$, $t = 3.39$, $p < 0.0001$, however none of the variables significantly mediated this relationship.

Athlete type significantly predicted pain tolerance, $b = 27.13$, $t = 8.25$, $p < 0.0001$. Athlete type significantly predicted physical bothersomeness, $b = -0.89$, $t = -10.015$, $p < 0.0001$. Physical bothersomeness predicted psychological bothersomeness, $b = 0.65$, $t = 7.69$, $p < 0.0001$. Direct coping significantly predicted pain tolerance, $b = 0.02$, $t = 3.41$, $p < 0.0001$.

Summary

The first set of hypotheses regarding performance were supported. High contact experienced athletes performed better in pain than the non-contact athletes. Indeed, both groups of high contact athletes outperformed the non-contact athletes in the pain condition. Hypothesis 1a was supported regarding time to complete the task, but not for targets hit. High contact experienced athletes performed faster in pain compared to when not in pain but did

not hit more targets. Hypothesis 1b was supported as non-contact athletes performed worse in pain compared to when not in pain for both measures. There were no performance differences within the high contact novice group.

The second set of hypotheses were generally supported. Hypothesis 2a, that high contact athletes would have higher pain tolerance than non-contact athletes was fully supported. They also had higher pain tolerance than high contact novice athletes. Hypothesis 2b that high contact experienced athletes would report pain as less intense than non-contact athletes was also supported. Again, they also reported pain as less intense than high contact novice athletes. Hypothesis 2c was supported for psychological bothersomeness, with high contact experienced athlete reporting less bothersomeness than both non-contact athletes and novice contact athletes. There were no differences for physical bothersomeness. Hypothesis 2d was supported as high contact experienced athletes had higher direct coping than non-contact athletes and high contact novice athletes. High contact novice athletes also had higher direct coping than non-contact athletes.

Hypothesis 3 was supported regarding the performance measure of targets hit, but not for time to complete the task. Results indicated that when threatened, those with more experience of pain in sport performed better than those with less. This suggests that the threat manipulation moderated performance, but the challenge manipulation did not. This could be due to the high contact athletes reporting feeling challenged in pain regardless of the instructions given for the manipulation.

Hypothesis 4 was supported regarding the performance measure of time to complete the task but not targets hit. In the overall model, pain tolerance and physical bothersomeness significantly mediated the relationship between athlete type (i.e. experience of pain) and time to complete. However there was no mediation effect for targets hit. These results suggest that increasing pain tolerance and reducing bothersomeness in athletes could affect performance.

5.4 Discussion

Overall the results indicated that high contact athletes, and, in particular experienced high contact athletes, reported pain in a different way to non-contact athletes (see Table 5.3). In pain, both groups of contact athletes outperformed non-contact athletes, were more challenged, reported less pain bothersomeness and had higher direct coping. The high contact experienced athletes had higher pain tolerance than the other groups and reported less pain intensity. These were the only two measures where high contact novices and non-contact athletes did not differ. In addition, the high contact experienced athletes had higher direct coping and reported less psychological pain bothersomeness than the high contact novice athletes. Thus, the high contact experienced athletes and the high contact novice athletes differed only on measures of pain tolerance, intensity, direct coping and psychological bothersomeness. The high contact novices differed from non-contact athletes on most measures, apart from pain tolerance and intensity.

Table 5.3:

Summary of Hypotheses and Major Findings

| Hypothesis number | Supported Y/N/Partially | Comments |
|--|----------------------------|---|
| 1: High contact experienced athletes would perform better in pain than non-contact athletes | Yes | High contact experienced athletes performed better than non-contact athletes. High contact novice athletes also performed better than non-contact athletes |
| 1a: High contact experienced athletes would perform better in pain compared to when not in pain | Yes | High contact experienced athletes maintained performance for targets hit but bettered performance for time to complete. High contact novice athletes also maintained performance in pain. |
| 1b: Non-contact athletes would perform worse in pain compared to when not in pain | Yes | Non-contact athletes performed worse in pain compared to when not in pain |
| 2: High contact experienced athletes would respond differently to pain than non-contact athletes | Yes | They were different for most measures taken |
| 2a.: High contact athletes would have higher pain tolerance than non-contact athletes | Yes | They also had higher pain tolerance than high contact novice athletes |
| 2b: High contact experienced athletes would report less pain intensity than non-contact athletes (VAS) | Yes | They also reported pain as less intense than high contact novice athletes |
| 2c: High contact experienced athletes would report pain as less bothersome than non-contact athletes | Partially | They reported less psychological pain bothersomeness than non-contact athletes and novice contact athletes. High contact |

| | | |
|---|--|---|
| | | novice athletes also reported less psychological bothersomeness than non-athletes. There were no differences for physical bothersomeness. |
| 2d: High contact experienced athletes would have higher direct coping than non-contact athletes | Yes | They had higher direct coping than non-contact athletes and high contact novice athletes. High contact novice athletes also had higher direct coping than non-contact athletes. |
| 3. The challenge and threat manipulation would moderate the relationship between athlete type (pain experience level) and performance difference when in pain vs. not in pain | Yes for targets hit No for time to complete task | During threat, those with more experience of pain in sport performed better than those with less. |
| 4. Pain tolerance, bothersomeness and direct coping will mediate the relationship between athlete type (experience level) and performance difference when in pain vs. not in pain | Partially for time to complete No for targets hit | Pain tolerance and physical bothersomeness significantly mediated the relationship between athlete type (i.e. experience of pain) and time to complete. |

Between Group Differences.

The only differences between high contact experienced athletes and high contact novice athletes were for pain tolerance, intensity, direct coping and psychological bothersomeness. The experienced athletes had higher pain tolerance, reported less pain intensity, had higher direct coping and found pain less psychologically bothersome. In pain, both groups of high contact athletes performed better, felt more challenged, found pain less bothersome, and had higher direct coping than non-contact athletes. As such, the differences between high contact athletes, regardless of experience level are discussed below.

Challenge and Threat Manipulation Check.

The manipulation checks indicated that both groups of high contact athletes had higher HRV and cognitive appraisal in the pain condition compared to the non-contact athletes, regardless of the instructions provided, indicating a challenge state. Experience of painful sports may result in athletes feeling challenged by pain (Nixon, 1992). Contact sports participation is characterised by regular pain and discomfort (Ryan & Kovacic, 1966) and some athletes report feeling challenged by this (Liston et al., 2006). Contact athletes may therefore feel challenged by experimental pain. Furthermore, the high contact athletes may have habituated to pain during their sport and did not feel threatened during experimental conditions (e.g. Hall & Davies, 1991). This could be due to motivational and control factors (Karsdorp et al., 2013). Karsdorp et al. stated that performance in painful tasks is often goal directed, and if a goal is not present, performance and motivation may decrease. High contact athletes have made a conscious choice to participate in a painful sport that has clear goals. As such these athletes may have viewed the pain and the task as necessary and motivational, resulting in a challenge state.

Challenge and threat moderated the relationship between athlete type (experience level) and performance for targets hit and for time (following a Bonferroni correction). For both performance measures, when threat was high there was a significant relationship between athlete type and time difference to complete the task. This indicates that threat moderated the relationship between experience level of pain (i.e. athlete type) and performance. There were no effects present in the challenge condition. As such, having more experience of pain may result in better performance especially if the situation is seen as threatening. There are two possible explanations for this. One is that the high contact experienced athletes simply did not feel threatened by the pain even if they received threat instructions. Results indicated that the high contact athletes as a whole, felt more challenged in the pain condition regardless of instructions provided. They therefore may have felt more motivated and able to complete the task. The second is that the pain stimulus may have exacerbated feelings of threat in the non-contact athletes, regardless of the instructions they were given. As such, even in the challenge condition these athletes may have felt threatened by the pain stimulus. The challenge condition may have been more varied and prone to error due to high contact athletes feeling challenged anyway and non-contact athletes feeling threatened. It has been suggested that it may be easier to invoke threat responses than challenge responses (e.g. Williams, Cumming & Balanos, 2010), therefore especially within the non-contact group, the challenge instructions may not

have been enough to overcome the threat of the pain stimulus. This may explain the moderation effects in the threat condition and not challenge.

Performance.

There were no performance differences between any groups in the no pain condition. However, during pain, both groups of high contact athletes performed better than the non-contact athletes. This suggests that high contact athletes were not distracted by the pain and that they were able to perform the task despite the pain stimulus. It is therefore possible that the non-contact athletes suffered from attentional bias and their attention was drawn to the pain stimulus and not the task itself (Eysenck et al., 2007), though it must be noted that this was not directly measured. There were no performance differences between the high contact experienced athletes and the high contact novice athletes. This indicates that less than six months experience of playing a contact sport may be enough to function well during experimental pain. Experience of contact in sports may therefore help athletes to attend to tasks whilst in pain. Athletes may learn how to essentially ignore pain so that they can focus on executing skills (Brewer et al., 1990). According to these results, this effect may take less than six months.

Pain Tolerance.

The high contact experienced athletes had higher pain tolerance than the other two groups and the effect size was large. There were no pain tolerance differences between high contact novice athletes and non-contact athletes, suggesting that longer exposure to contact sports may influence pain tolerance. This accords with Ryan and Kovacic (1966) who found similar results and suggested that experience of painful activities may alter pain tolerance. Raudenbush et al. (2012) stated that repeated exposure to heavy contact within sports may desensitize athletes to pain and that athletes may learn to ignore or accept this pain. Therefore, those with more experience of pain within sports may be more able to tolerate experimental pain.

The high contact novice athletes had perhaps not yet had enough experience of contact sports to have become desensitized to pain. They may also not have had enough time to develop pain coping strategies. This suggests that pain exposure time may be a factor in improved pain tolerance. This accords with the findings of study three, that suggested that it took eight months for pain tolerance to increase in participating contact athletes. Furthermore, the experienced athletes may have been less willing to report pain due to sporting culture. Contact sports

athletes have reported that sometimes showing pain can be seen as a weakness (Liston et al., 2006). As such, playing hurt is commonplace in some sports, and athletes may not feel able to report feeling pain (Nixon, 1992). This was found in study one, where contact athletes stated that they sometimes played through pain due to team culture. In this study, the novice athletes may not have had enough exposure to this culture to feel unwilling to report pain.

In addition, study three indicated that pain tolerance increased after eight months of playing contact sports. The novice athletes therefore had less pain exposure than the experienced athletes, resulting in them being able to tolerate less pain. Research has suggested that pain tolerance can increase due to more experience of pain (e.g. Dar et al., 1995). Habituation to pain can occur due to increased exposure, which in turn results in increased pain tolerance (Sheiner et al., 1998). It could be expected that in experimental settings, that the experienced athletes would be able to tolerate more pain than less experienced participants.

It is also possible that the non-contact athlete's pain tolerance was lower because they catastrophized more about the pain. This is in accord with other research that suggests that high catastrophizing results in lower pain tolerance (e.g. Wang et al., 2016). This is because attention is often drawn to the pain stimulus, which can create anxiety or a threat state, thereby causing participants to withdraw from the pain (Wang et al.). Indeed, in this study, the non-contact athletes felt more threatened during experimental conditions.

Pain tolerance mediated the relationship between athlete type (experience level) and time to complete the task. This suggests that the relationship between experience level and performance can be explained by pain tolerance. Results indicated that athletes with more experience of pain and higher pain tolerance performed faster than those with less (i.e. non-contact athletes). Riley et al. (2002) suggested that pain is experienced in a linear fashion, first is pain intensity, which is predominantly a physiological response, second is pain tolerance which is also physiological but also may have some psychological elements, in that there may be variations in motivation to tolerate pain for a length of time. These results indicate that performance during pain may be a result of physiological and psychological factors. That is, athletes who have experienced pain in sport may be more motivated or may have a different psychological response to pain than those with little pain experience.

Pain Intensity.

The high contact experienced athletes perceived pain to be less intense than the other groups. There were no pain intensity reporting differences between high contact novice athletes

and non-contact athletes. This accords with Raudenbush et al. (2012) and Straub et al. (2003) who both found that high contact athletes reported pain as being less intense than other athlete groups. This suggests that high contact athletes may become desensitized to pain and as a result, report less pain intensity in laboratory settings. In addition, pain intensity may also be reduced due to habituation (Crombez et al., 1997). It has been suggested that exposure to high levels of athletic training may reduce the intensity of experimental pain (e.g. Geva & Defrin, 2013). As such, those with more experience of training for contact sports may report less pain intensity than those with little experience. These results do not accord with study three, where there were no changes in pain intensity over an athletic season. This could be due to the nature of the pain stimuli used in both studies.

It also cannot be ruled out that the high contact experienced athletes responded in a socially desirable way to the VAS. Nixon (1992) suggested that sporting cultures may influence how willing an athlete is to admit to being in pain. Therefore, the experienced high contact athletes may have reported less pain due to being culturally conditioned into not reporting it. It also suggests that if sporting culture influences pain reporting (e.g. Liston et al., 2006), the novice athletes may not have been playing long enough to be influenced by this.

Bothersomeness.

Both groups of high contact athletes found pain less psychologically bothersome than the non-contact athletes. This supports the performance data, in that the athletes who performed the best in pain also found the pain less bothersome. DeRoche et al. (2012) suggested that athletes who can ignore pain and do not allow it to bother them can maintain performance in sports for longer than those who cannot. This perhaps creates a cyclical or reciprocal situation where more experience of pain leads to less bothersomeness and less bothersomeness leads to more experience of pain. The non-contact athletes who presumably had little experience of pain in their sports, therefore found the pain to be distracting. This resulted in poorer performance and higher bothersomeness ratings.

High contact experienced athletes also found pain less psychologically bothersome than the high contact novice athletes. This suggests that psychological pain bothersomeness may take longer than six months to reduce. Despite reporting pain as more intense and bothersome, the novice athletes still performed to the same level as the experienced contact athletes. This indicates that psychological bothersomeness and intensity of pain may not necessarily affect

performance during pain. Perhaps novice athletes were able to employ pain coping strategies to maintain performance. Further research is needed however to explore this fully.

Physical bothersomeness mediated the relationship between athlete type (pain experience level) and time to complete the task. This suggests that physical pain bothersomeness explains the relationship between experience level (i.e. athlete type) and the performance measure of time to complete. As such, finding pain physically bothersome resulted in slower performance of the task. This is in accord with the pain tolerance results which indicated that athletes with higher pain tolerance were more likely to perform better than those with lower tolerance. Physical bothersomeness of pain and tolerance therefore may be very closely linked to one another. That is, those with higher pain tolerance may find pain less physically bothersome.

Direct Coping.

High contact experienced athletes had higher direct coping and lower catastrophizing than non-contact athletes. Direct coping is a positive coping style where pain is viewed as part of sport and is something that can be endured and pushed through (Bourgeois et al., 2009). This style is linked to mental toughness and resilience (Levy et al., 2006). During their sports, high contact athletes are expected to deal with collisions, and often they view these as necessary and a fundamental part of sport (Liston et al., 2006). In study one, it was noted that some contact athletes celebrated pain and viewed it positively. It is unclear whether this is developed through habituation and experience or whether resilient individuals self-select to play high contact painful sports (Raudenbush et al., 2012). As both the experienced and novice high contact athletes had higher direct coping than non-contact athletes, it may be that this style is developed early during contact sports or that mentally tough or resilient individuals deliberately choose to play contact sports. Study three supports the latter idea, as participating contact athletes had higher direct coping for pain at the beginning of an athletic season.

The experienced high contact athletes had even higher direct coping than the novices. This suggests that relatively high direct coping may continue to be developed over time during participation in high contact sports. Coping styles have been viewed as a dynamic but learned behaviour (Koolhaas & DeBoer, 2008) and as such may take time to develop in athletes. Study three indicated that high direct coping was present at the beginning of a contact sports season in participating athletes, suggesting that having a this coping style at the outset may be a factor

in adherence to contact sports. However, direct coping may continue to increase over time due to exposure to pain in sports, though further research is needed.

Within group differences.

High contact experienced athletes.

The high contact experienced athletes maintained performance whilst in pain and took less time to complete the task with no decrease in targets hit. There are a number of mechanisms that may explain this finding. First, this group had high direct coping, which indicates that the pain was viewed as something to be overcome rather than something to be feared. This, coupled with being challenged may help participants to ignore the pain and work at completing the task due to better attentional control (Hansen et al., 2009). More attentional resources can be used to complete a task when perceived threat is low (Crombez et al., 2013). This results in maintained or superior performance.

A second mechanism is that this group reported low levels of pain, low bothersomeness and had high pain tolerance. These factors together indicate that the pain was less likely to be a distraction during performance of the task. This is likely a function of experience and the fact this group would regularly have been exposed to pain. It is possible that an adaptation may have occurred resulting in them being able to accept pain and focus on the task (Raudenbush et al., 2012). Manning and Fillingim (2002) suggested that experience of pain may result in athletes being less worried and bothered by it. Qualitative research has shown that high contact athletes often view pain as an occupational hazard and as a fundamental part of sport (e.g. Liston et al., 2006). Therefore, in the laboratory these athletes may have simply viewed pain as inevitable and challenging.

Third, this group felt more challenged in pain compared to when not in pain regardless of the instructions provided. This suggests that despite any instructions given, this group were motivated and challenged by the pain stimulus. Challenge states have been shown to result in superior performance compared to threat states (Turner et al., 2012). Even for a novel task such as this, performance can be maintained especially when the individual is in a challenge state, due to attentional focus and the ability attend to the task and not the pain (Vine et al. 2013).

The reason for this group feeling more challenged could also be due to motivational and self-efficacy factors (Raudenbush et al., 2012). That is, athletes who are used to playing in pain may find it motivational and part of the challenge of sporting endeavour. As a result of

repeated performance accomplishments in pain, self-efficacy may increase, thereby influencing motivation and challenge states (Bandura, 1997). Maintained (approaching superior) performance in pain therefore appears to be a function of having high direct coping, high pain tolerance, low pain intensity reporting and more than 6 months experience of playing contact sports. This leads to low pain bothersomeness, a challenge state in pain compared to baseline, which ultimately leads to maintained or superior performance in pain.

High contact novice athletes.

High contact novice athletes also maintained performance whilst in pain. The mechanisms for this are likely the same as those for high contact experienced athletes, however there are two notable exceptions. One is that the high contact novice athletes had lower direct coping and reported higher psychological bothersomeness than the high contact experienced athletes. This suggests that moderate levels of each of these variables may still result in maintained performance whilst in pain.

The second is that the high contact novice athletes were significantly less pain tolerant and reported significantly more pain than the high contact experienced group, however they still maintained performance like the high contact experienced athletes. This could be a result of attentional focus and both groups being able to accept or ignore pain (Wilson, 2008). This may be something that is learned early in high contact sports in order for athletes to be able to perform successfully and maintain participation. On the other hand, pain tolerance and pain perception may take more time to develop and change and these may have a smaller effect on performance. This is supported by the data in study three that showed that pain tolerance took a whole season to increase in participating athletes.

The high contact novices reported feeling more challenged in pain compared to when not in pain, but the HRV data did not support this. Self-report measures of cognitive appraisal and physical measures of cardiovascular reactivity have been found to be weakly correlated in other studies (e.g. Turner et al., 2013). It therefore cannot be determined whether these athletes were more challenged in pain or not and thus, more research is warranted.

In sum, the results for the high contact novice group indicate that moderate direct coping, moderate levels of bothersomeness and a potential challenge state can result in maintained performance in pain. This is despite having lower pain tolerance, higher perceived pain intensity and low levels of experience of sports related pain. Maintained performance in pain in this group seems to be a function of having moderate levels of direct coping, lower pain

tolerance, higher pain intensity reporting and having up to six months experience of playing contact sports. This leads to moderate pain bothersomeness, a possible challenge state (compared to baseline), which ultimately results in maintained performance whilst in pain.

Non-contact athletes.

The non-contact athletes performed worse in pain compared to baseline and the effect size was large. This suggests that the pain had a considerable negative effect on their performance. This may have occurred if the non-contact athletes were worried about the pain stimulus. Research has shown that when anxiety is present, performance deteriorates (Moore, Keogh & Eccleston, 2013). Indeed, this group catastrophized about the pain, which has been linked to decreased performance in motor tasks (Hansen et al., 2009). Catastrophizing can divert attention from relevant stimuli to the pain stimulus (Quartana, Campbell & Edwards, 2009), suggesting that attentional bias occurred, as postulated by ACT (Eysenck et al., 2007).

The non-contact athletes also felt significantly more threatened in pain compared to when not in pain, as evidenced by both cognitive appraisal and HRV data. The effect size for cognitive appraisal was large. Jackson et al. (2012) reported that if a pain stimulus is considered to be threatening, and pain is not accepted, pain tolerance decreases as a result of catastrophizing. The results support this, as this group catastrophized more and had low pain tolerance.

The non-contact athletes also reported pain to be highly bothersome and found the pain to be more intense compared to the other groups. Taken together it is unsurprising that this group performed poorly in pain, as these factors have been linked to reduced performance in pain tasks (Karsdorp et al., 2013). In addition, this group also had lower scores for direct coping, indicating that they did not view pain as something to be overcome. This likely resulted in the threat state, increased catastrophizing and ultimately, poor performance.

Deteriorated performance in pain seems to be a function of having low direct coping, low pain tolerance, high pain intensity reporting and low levels of experience of contact sports/and or pain. This results in attentional bias (Eysenck et al, 2007) which can lead to high pain bothersomeness, a threat state (compared to baseline), which ultimately results in poorer performance when in pain.

Summary.

Overall, the between-subjects results indicate that there are a number of factors that work together to influence performance in pain and these are related to experience. When comparing the high contact experienced and high contact novice athletes, it appears that the main differences between these groups were related to pain reporting (i.e. tolerance and perception). Pain tolerance and physical pain bothersomeness mediated the relationship between athlete type and performance (time to complete), indicating that this may be an important factor in performance. Moderation analysis indicated that the threat manipulation moderated performance, but the challenge manipulation did not. This could be due to the high contact athletes reporting feeling challenged in pain regardless of the instructions given for the manipulation. Therefore, in the context of sport, individuals who may be reluctant to participate in contact sports due to having low pain tolerance and high pain sensitivity should be encouraged to continue, because if direct coping and challenge states can be manipulated, this may result in these individuals adhering to sport and learning to cope with pain.

The study employed a between-subjects design for challenge and threat whereby participants were allocated to a threat or challenge condition following baseline measurements. Therefore, it cannot be determined whether challenge and threat conditions affected performance when participants were not in pain and how this differed among athlete groups. This means that it is difficult to determine how pain and challenge and threat conditions interacted. Future studies should employ a design where performance is measured in challenge and threat states both in pain and no pain conditions. This would determine whether performance differences occur also when no pain is present according to challenge and threat.

Future studies could utilise more specialist equipment to index challenge and threat states such as a Bio-Impedance cardiograph integrated system as used by Turner et al. (2012). To date only one other study has examined HRV as a marker of challenge and threat specifically (Laborde & Lautenbach, 2015) and therefore some degree of caution should be exercised when interpreting the results here. More studies should be conducted with the aim of predicting performance in pain by manipulating the variables used in this study but employing different data collection methods and pain tasks. Further, research also should examine whether inherent traits such as personality or more transitory states such as emotions influence how individuals perform in and approach pain.

Future studies should aim to examine pain responses in true novice high contact athletes. This study used athletes with less than six months experience of contact sports; it would be interesting to determine if athletes at the very start of their contact sport career would be different from those used here.

Conclusions.

This study has shown that high contact experienced athletes differed from high contact novice athletes and non-contact athletes in their responses to pain. Indeed, all high contact athletes overall performed better in pain, reported less bothersomeness of pain and had higher direct coping than non-contact athletes. It is therefore clear that psychological factors and experience of pain within contact sports alter reactions to pain.

The challenge and threat manipulation moderated the relationship between athlete type (contact experience level; high contact experienced, high contact novice and non-contact athletes) and performance for the targets hit performance measure, but only when participants were threatened. This suggests that the pain task may have created threat states in some athletes regardless of the instructions provided. Pain tolerance and physical bothersomeness of pain mediated the relationship between athlete type (experience level) and the performance measure of time to complete the task, indicating that higher pain tolerance and lower physical pain bothersomeness may result in better performance in more experienced high contact athletes but not non-contact athletes.

This study has implications for coaches and sports development officers who may work to encourage athletes to adhere to contact sports. If pain tolerance can be enhanced and physical pain bothersomeness reduced, within athletes new to contact sports, adherence to these activities may increase. In addition this study shows that experience of pain can alter how individuals respond to pain; this has implications for anyone performing or working within painful sports. Early interventions to support athletes within contact sports would potentially increase adherence in these often risky and painful activities.

Chapter Six: General Discussion

6.1 Introduction

The current thesis had three aims: Aim one was to develop an understanding of the pain experiences of different athlete groups, examining the proposed mechanisms of learning, attrition and individual differences (this was achieved in the literature review, study one, two and three). Aim two was to compare high and low/non-contact athletes' responses to pain (this was achieved in study two, three and four). The final aim was to examine the role of challenge and threat states, performance in pain and pain responses in high and non-contact athletes (achieved in study four).

These aims were addressed by completing a literature review and four studies. The literature review drew together the current research regarding pain within athlete groups. The first study was a qualitative investigation focusing on the pain experiences of athletes from both contact and non-contact sports. The second study used questionnaires to examine differences in pain coping styles, personality and pain bothersomeness between contact and non-contact athletes. The third study was a longitudinal investigation into pain tolerance, coping and bothersomeness over an athletic season. The study compared participating athletes to non-participating athletes who were new to contact sports. The final study of the thesis was an experimental study that investigated performance in pain and challenge and threat states using contact and non-contact athletes.

The studies within this thesis examined, both qualitatively and quantitatively, the experiences of athletes of varying contact levels to attempt to understand how contact within sports interacts with pain responses. In addition, the source of pain was accounted for by examining contact, injury and exertion related pain in the first three studies. The purpose of this chapter is to provide a general discussion of the thesis findings. This will begin with a summary of the thesis and a review of the studies undertaken. Next, a discussion of the theoretical implications and recommendations for future research will be included. Finally, there will be a discussion of the applied implications of the thesis findings and concluding remarks.

6.2. Summary of main findings

This thesis has explored how contact and non-contact athletes experience and cope with pain. In Chapter One, the key literature was reviewed, indicating that athletes have a higher pain tolerance and report less pain than non-athletes (e.g. Hall & Davies, 1991; Tesarz et al.,

2012). In addition, some limited research indicated that high contact athletes have a higher pain tolerance than low or non-contact athletes (Ryan & Kovacic, 1966) and that they may perform better in pain than other groups (Sheffield et al., 2017).

Three mechanisms were proposed for these findings; learning, attrition and individual differences. There has been little exploration of these mechanisms, and learning has received the most research attention. It has been suggested that contact athletes may learn to cope with pain via experience in a number of ways. First, athletes may use coping strategies in a more efficient way compared to non-athletes (Ord & Gijssbers, 2003). They may also have a high direct coping style, which is characterised by approaching pain positively and seeing it as necessary for sport (Bourgeois et al., 2009). Having such a style may prevent maladaptive responses to pain, such as catastrophizing (Meyers et al., 1992). Second, athletes may appraise pain differently to non-athletes, viewing it as a challenge rather than a threat (Kopka-McDowell & LaChappelle, 2005). Athletes who perceive pain as a challenge exhibit higher pain tolerance and report less pain than others (Ryan & Foster, 1967). Third, athletes may perceive pain as less intense due to desensitisation (Wandner et al., 2001). Athletes may interpret pain more realistically than those with less experience of sports related pain (Paparizos et al., 2005). Therefore, when experiencing experimental pain, athletes may appraise it as benign and unthreatening, resulting in higher pain tolerance (Raudenbush et al., 2012). Finally, athletes may be influenced by social and cultural factors. Particularly in contact sports, athletes regularly play in pain, feel that they should continue even when injured and sometimes celebrate pain as a fundamental part of their sport (Liston et al., 2006). Having such a mind-set may cause athletes to respond to experimental pain in the same manner. Furthermore, due to the masculine culture of some sports, athletes may be unwilling to report pain (Bird, 2011). As such, some athletes may demonstrate increased pain tolerance or report low pain intensity due to machismo. This attitude towards pain permeates both male and female dominated sports (Bird) and may account for differences in pain reporting amongst athletes and non-athletes.

The mechanism of attrition has not been widely explored. It has been suggested that people who are more sensitive to pain may be more likely to disengage from painful sporting activities (Manning & Fillingim, 2002). This could be due to increased pain-related anxiety (Bardel et al., 2013), fear avoidance (Crombez et al. 2012) or low pain-related self-efficacy (Pen & Fisher, 1994). Consequently, when pain is measured under experimental conditions, the differences between athletes and non-athletes may be magnified, especially if non-athletes

have lower self-efficacy or heightened anxiety. More research using athletes is required to examine this.

It has also been proposed that athletes may be different to non-athletes due to individual differences. Fitness levels for example, have been suggested as a moderator of pain reporting (Anshel & Russell, 1994). Athletes may exhibit higher pain tolerance due to enhanced endogenous pain inhibition as a result of exposure to exhausting training (Geva & Defrin, 2013). Personality factors have also been proposed as a mechanism for heightened pain tolerance in dancers (Tajet-Foxell & Rose, 1995). Neuroticism for example, has been associated with increased pain ratings within dancers (Paparizos et al., 2005) and within clinical populations (Vassend et al., 2003).

Chapter One therefore demonstrated that there are pain reporting differences between athletes and non-athletes. However, the mechanisms for these remained relatively unexplored. Learning to cope with pain was proposed as the most likely mechanism for differences between athletes and non-athletes and intra-athlete differences.

The first aim was addressed in Chapter Two by completing a qualitative study examining the pain experiences of athletes who played sports of varying contact levels. Previous qualitative research has tended to focus on pain as an over-arching term and has not involved heterogeneous groups of athletes (e.g. Nixon, 1992). Five key themes emerged from the interviews. The first theme, individual differences, suggested that high contact athletes described themselves as fundamentally different from other athletes in terms of personality. The second theme relating to self-efficacy and control indicated that high contact athletes felt in control of pain, whereas low contact athletes did not, agreeing with Meyers et al. (2001). The third theme centred on pain bothersomeness and explained how athletes appraised pain according to their experience of sports pain. High contact athletes were not bothered by contact pain and approached it positively, according with Nixon (1994). Non-contact athletes were particularly blasé about contact and injury pain and could not appraise pain as realistically as high contact athletes. The fourth theme indicated that athletes used a range of coping strategies to manage pain such as imagery and self-talk. Finally, athletes discussed how social and cultural factors influenced their response to pain. High contact athletes embraced contact pain and viewed it as a necessary part of sport, and in team based sports, contact pain was deemed part of the team ethic. These findings agreed with sociological research examining contact sports culture (e.g. Liston et al., 2006).

As a result of this study, it was clear that high contact athletes perceived pain differently to others. High contact athletes approached pain more positively and appraised it more realistically than low contact athletes. Often this was a function of sporting culture and experience of pain in the past. In addition, there were also differences in how each type of pain was experienced. Most athletes viewed exertion pain positively and injury pain negatively. Low or non-contact athletes felt negatively about contact pain whereas high contact athletes approached it positively.

Due to the differences described in study one (Chapter Two), study two (Chapter Three) aimed to examine the differences between high contact and non-contact athletes regarding pain responses and personality. This specifically addressed aims one and two of the thesis and focused on the proposed mechanisms of individual differences and learning. The study employed questionnaires to examine pain bothersomeness, pain coping styles and personality. Individual differences and learning were assessed by examining the big five personality traits (Gosling et al., 2003) and direct coping using the SIP15 (Bourgeois et al., 2009). Contact and low/medium contact athletes were studied to establish if there were differences according to contact level. High contact athletes were less agreeable than low/medium contact athletes, but no other group differences were observed. In addition, high contact athletes exhibited higher direct coping low/medium contact athletes, echoing the findings of study one. High contact athletes viewed contact pain as less physically bothersome than low/medium contact athletes. This study therefore indicated that direct coping and perception of bothersomeness may be important to explain differences in pain responses.

Study three (Chapter Four) also addressed aim two but focused on the mechanisms of learning and attrition. This was a longitudinal study measuring pain tolerance, perception, bothersomeness and coping styles over an athletic season. In this study, novice high contact athletes were examined over eight months to observe differences between those who participated in the sport and those who dropped out. There were no differences in cold pain tolerance between groups at the start of the season; however, participating athletes approached being significantly more tolerant to ischemic pain at this time. At the end of the season, participating athletes were significantly more tolerant to both pain stimuli compared to non-participating athletes. In addition, participating athletes had higher ischemic pain tolerance at the end of the season compared to the start. These results suggest that tolerance of pain may take time to develop and that having a high pain tolerance does not necessarily predict sports choice. Participating athletes were also found to have higher direct coping than non-

participating athletes, agreeing with study two. There were no differences between groups for pain intensity as measured by VAS. Within the participating group only, pain bothersomeness was significantly reduced over the season. Within the non-participating group only, pain tolerance was significantly reduced over the season for both pain stimuli, and catastrophizing increased over time. The results of this study demonstrated that experience may moderate responses to pain. Therefore, more research was needed to examine how experience might impact on performance in pain.

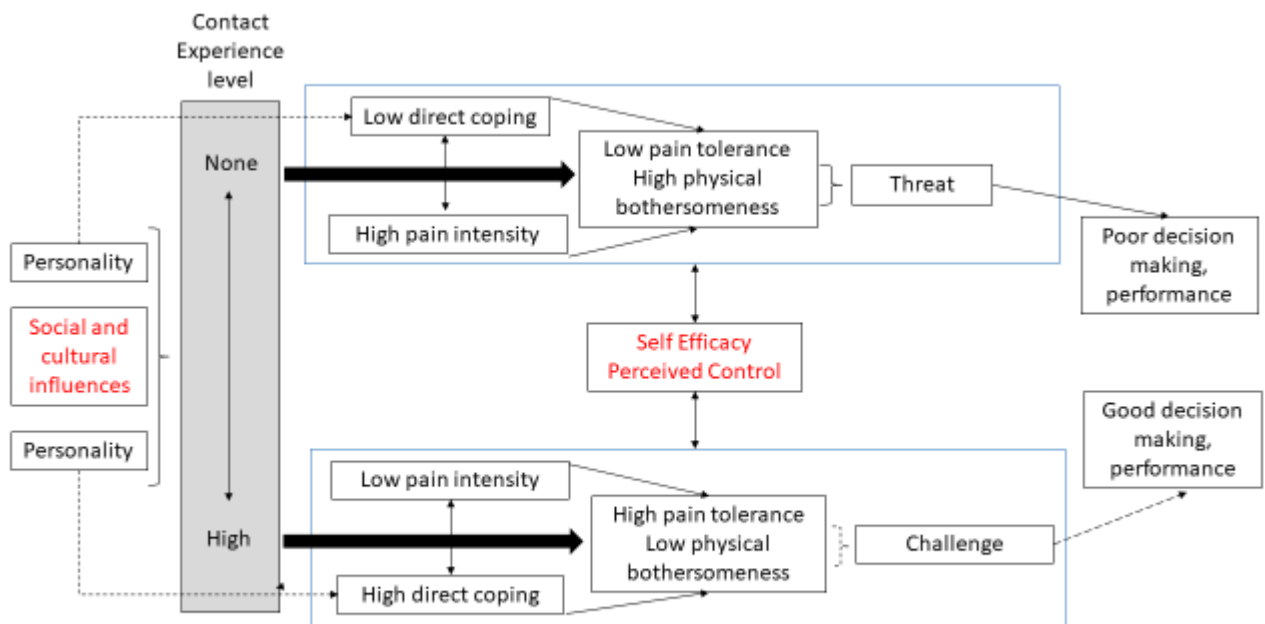
Study four (Chapter Five) examined the role of challenge and threat states and performance in pain. Due to the findings of study three relating to the role of experience, this study compared pain responses in novice and experienced high contact athletes. This addressed aim three, which was to examine the role of challenge and threat states, performance in pain and pain responses in high and non-contact athletes. Results indicated that both experienced and novice high contact athletes performed better in pain than non-contact athletes. Both groups of high contact athletes maintained their performance whilst in pain whereas the non-contact athletes performed significantly worse. In addition, both groups of high contact athletes reported pain as less bothersome and were more challenged when in pain compared to non-contact athletes. Indeed, high contact athletes were challenged in pain despite receiving threat instructions. This was reflected in the moderation analysis results that showed that only the threat manipulation moderated performance in pain. High contact experienced athletes had higher pain tolerance and direct coping and felt pain less intensely than high contact novice athletes and non-contact athletes. Mediation analysis showed that physical pain bothersomeness and pain tolerance mediated the relationship between athlete type and time to complete the task. Overall, this study demonstrated that high contact athletes were more able to cope with pain. This was reflected in the key finding that their performance was not hampered by pain.

The model presented in the Introduction (Chapter 1) was used as a framework to develop the direction of thesis. The findings of the studies within the thesis are such that a new figure is presented to illustrate the key results and outcomes. Figure 6.1 illustrates the revised model based on the thesis findings. Solid lines indicate strong paths where evidence exists for relationships and interactions, dotted lines indicate paths that still require more research or confirmation. Red font indicates areas that were not directly measured in the thesis, but evidence exists that they may have an impact on athletes. These are areas for future research. The figure shows that the amount of experience of contact related pain in sport has an impact

upon the pain responses outlined in the first model, and these responses to pain impact ultimately on performance. Future researchers should therefore consider how to mitigate the effects of pain on sports performance and should further explore the psychological factors that result in maladaptive responses to pain. Further future directions are discussed below after each aim.

Figure 6.1

Final Mechanisms Model showing the inter-relationships between proposed mechanisms for intra-athlete differences in pain reporting.



6.3 Theoretical Implications and Future Directions

This section will discuss the aims of the thesis and how the studies together have addressed them. It will also present future directions for research and the theoretical implications.

Aim One.

Aim one was to develop an understanding of the pain experiences of different athlete groups, examining the proposed mechanisms of learning, attrition and individual differences. These mechanisms were discussed in Chapter One, based upon the current literature regarding pain and athletes. Following this review, it was clear that athletes and non-athletes differed in their responses to pain. As the mechanisms had not been widely researched, more exploration

was warranted. This provided a foundation for the thesis by exploring the pain experiences of athletes from a range of sports in Chapter Two. Areas were then identified to be further examined in Chapters Three and Four. This was important because there had been little empirical exploration of the mechanisms. In addition, previous research had tended to define pain very generally and had not differentiated between different sources of pain (e.g. Liston et al., 2006).

Research has already demonstrated that high contact athletes differ from non-contact athletes in their responses to pain (Ryan & Kovacic, 1966). To recap, many studies have examined pain tolerance, threshold or perception in different groups (athletes vs. non-athletes and high contact athletes vs. non-contact athletes; Tesarz et al., 2012). Most studies agree that high contact athletes have higher pain tolerance than low or non-contact athletes (Ryan & Kovacic) and that athletes perceive pain as less intense than non-athletes (Hall & Davies, 1991). Little research has focused on the reasons for these differences, with many studies speculating upon rather than measuring actual mechanisms. Study one explored the pain experiences of a range of athletes whilst differentiating between sources of pain (contact, injury and exertion). The mechanisms were discussed via semi-structured interviews and themes emerged to explain how athletes experienced pain in their sports.

Mechanism one: Learning to cope with pain.

Study one found a range of themes to explain how athletes experienced the three sources of sports-related pain. It emerged that contact athletes viewed contact pain differently to low and non-contact athletes. As suggested in the literature review, learning to cope with pain via experience appears to be the most plausible explanation for differences in pain reporting between contact and non-contact athletes. Studies have shown that pain perception is altered via experience and that those with greater experience of pain appraise it more realistically than those with less experience (Wandner et al., 2001). Other studies have indicated that athletes with more experience are more conservative in their approach to injury pain (Griffith et al., 2006). Study one supported this.

In addition, learning to use coping strategies can help athletes to tolerate more pain and alter pain responses (e.g. Ord & Gijbers, 2003). Many athletes in study one reported using strategies to overcome pain. Contact athletes reported that they coped with contact pain by accepting it as part of the sport. Indeed, sporting culture can condition athletes into accepting pain and in some cases, celebrating it (e.g. Malcolm & Sheard, 2002). This was reflected in the

responses of high contact athletes in study one and may have altered how athletes responded to experimental pain.

Study one indicated that contact athletes had a positive attitude towards contact pain and reported that they saw it as necessary for their sport, reflecting a high direct coping style (Bourgeois et al., 2009). Direct coping distinguished high contact and non-contact athletes in all studies in this thesis. High direct coping for pain therefore appears to be important for playing contact sports. In study three there was no change in direct coping over a season in both participating and non-participating athletes, indicating that it may be a stable characteristic. However, this may be a temporal issue and direct coping may take more time to develop than eight months. High direct coping appears to be fundamental to involvement in contact sports; every study in this thesis found that high contact athletes possessed higher direct coping than low or non-contact athletes. It remains to be seen if this is developed over time or whether it is something that is inherent, i.e. it is a personality trait. There is speculation as to whether coping styles are learned or whether they are inherited (Connor-Smith & Flachsbarth, 2007). Coping styles are believed to be influenced by the situational context and as such are considered to be fluid and dynamic in nature, i.e. a process (Koolhaas & DeBoer, 2008). As such, it can be argued that whilst there is support that coping and personality are linked, coping styles may be dependent upon the situation and the subsequent interpretation of that context. In contact sports, for example, the culture or norms of the sport may influence how an athlete reacts to pain, which may then predispose them to adopt a high direct coping style. Specifically, athletes may be cultured into viewing pain as part of the sport or as necessary for success (Egan, 1987). In addition, a culture of machismo may condition contact athletes to under-report pain or even celebrate it, regardless of sex (Bird, 2011). More research is therefore required to determine how pain coping styles originate to clarify whether they are learned or inherited.

Mechanism two: Attrition.

The theme of attrition was examined in studies one and three. This has received little attention in sports pain research. Chronic pain literature has suggested that some individuals may avoid activities that are deemed as painful due to fear, i.e. fear-avoidance (Crombez et al., 2012). Fear-avoidance occurs when certain movements are deemed to exacerbate pain, and are subsequently avoided due to pain related fear. Chronic pain patients who exhibit fear-avoidance often exhibit heightened anxiety and catastrophic pain-related thoughts (Vlaeyen & Linton, 2000). Athletes who develop chronic sports related pain may therefore avoid sports all together

if they are perceived as contributing to pain. There has been no exploration of this within contact sports and it is therefore an avenue for further research.

Some authors have suggested that pain-related self-efficacy may explain why some people drop out of painful sports (e.g. DeRoche et al., 2011), however there has not been any empirical investigation of this. Attrition in contact sports may be a result of decreased pain tolerance over an athletic season, as evidenced in study three. This could be a result of increased pain related anxiety or self-efficacy (Bandura et al., 1987). Study three revealed that continued participation in contact sports was related to high direct coping, finding contact pain less bothersome and increases in pain tolerance over time. This was the first study to examine pain responses in a longitudinal manner to explore participation and attrition in contact sports. Findings agree with speculative suggestions by Ryan and Kovacic (1966) that experience of contact sports may alter pain tolerance. More research is required however to determine the reasons for reduced pain tolerance and participation in non-contact athletes. This was explored within study one, but research could be conducted to explore this in more depth.

In study one, many low contact athletes reported that they felt too small or weak to participate in contact sports such as rugby. They also stated that they tried high contact sports but simply did not like the pain. In study three, those who participated in high contact sports enjoyed the sport more and felt more positive about pain experienced. The opposite was the case for those who ceased participation in contact sports. Attrition could therefore account for observed differences in pain tolerance within experimental research. It was clear in study three that non-participating athletes were less pain tolerant at the end of the season compared to the start, and they were less pain tolerant at the end of the season when compared to the participating group. Whilst these results could be attributed to lack of motivation in the non-participating group, they indicate that non-adherence to contact sports may be a result of reduced pain tolerance (Manning & Fillingim, 2002). On the other hand, continued participation in contact sports may result in maintained or improved pain tolerance. Therefore, when measurements of pain tolerance are taken in the laboratory, differences between athletes and non-athletes may be magnified (Bardel et al., 2013). In addition, when differences between high contact athletes and low or non-contact athletes are measured, we may be simply witnessing the effects of high contact athletes' motivation and continued engagement with painful activities, and the magnified effects of low and non-contact athletes who chose to disengage from such sports.

Mechanism three: Individual differences.

Individual differences were examined in study two, where personality was measured and in study one where discussions took place during interviews. There has been little investigation of personality as a mechanism for differences in pain reporting and only tentative suggestions have been made regarding traits that might predict pain responses. Tajet-Foxell and Rose (1995) suggested that neuroticism differentiated pain response of dancers from non-dancers, but this has not been widely tested. In Chapter Two, high contact athletes reported that they believed that certain characteristics were needed to participate in their sports. They used words such as “sadistic”, “beyond the norm” and “hard” to describe themselves. Low/medium and non-contact athletes did not describe themselves this way. When asked why they did not engage in contact sports many stated that it was physical make up that was a barrier, such as “I am not big enough” or “I would get hurt by the bigger guys”.

Due to these findings, study two (Chapter Three) examined personality as a variable to explain participation in contact sports. High contact athletes were less agreeable than non-contact athletes but there were no other differences. It should however be noted that the questionnaire to measure personality was used for its brevity and there are reliability problems (with low coefficient alphas) with using short inventories (Gosling et al., 2003). Despite this, personality cannot be discounted as an influencing factor on pain behaviour variances within athlete groups. More research needs to be conducted to examine personality traits in high contact athletes using the Big Five measures. In study two, it was suggested that high contact athletes may be considered to be calculated risk takers due to their willingness to put themselves into potentially dangerous, high injury risk situations (Schroth, 1995). High risk takers have higher extraversion and lower conscientiousness than low risk takers (Castanier et al., 2010). As such, the results of study two do not accord with these findings.

Overall, the findings indicate that learning as a mechanism is the most plausible to explain differences in pain responses. More research could be conducted to examine the role of experience and learning via qualitative methods. In particular, this should focus on the reasons for non-participation in painful sports. Further longitudinal studies should be carried out to explore changes in pain related behaviour in contact athletes. These should also focus more specifically on those who do not adhere to contact sports. This would allow an exploration of the reasons for non-participation in contact sports so that interventions could be developed to prevent attrition. Future research should also aim to explore personality in more detail using

more robust instrumentation. This would allow coaches to understand the characteristics of their athletes and help them to tailor their behaviours accordingly. In addition, more research should be conducted to examine the role of social and cultural influences on athletes' responses to pain (Bird, 2011). This would develop an understanding of how the presence or absence of others and sporting culture may alter pain related behaviours. This would help coaches to develop strategies to aid athletes who may benefit from support while experiencing pain. Furthermore, research could focus on physiological indicators that may account for differences in pain response such as altered endogenous inhibitory mechanisms (e.g. Geva & Defrin, 2013).

Aim Two.

Aim two was to compare high and low/non-contact athletes' responses to pain. This was achieved in studies two, three and four. In these studies, direct coping, catastrophizing and somatic awareness were measured using SIP15 (Bourgeois et al., 2009), as well as bothersomeness. In study three, enjoyment and feelings towards pain were also measured alongside cold and ischemic pain tolerance and intensity ratings (using VAS) and in study four, pressure pain tolerance was measured alongside pain intensity ratings. Each will be discussed in turn.

Sports Inventory for Pain (SIP15).

The SIP15 was used to examine how athletes coped with pain. Across all studies the results showed that high contact athletes had higher direct coping for contact pain than low or non-contact athletes. They also catastrophized less about contact pain. There were no differences in somatic awareness between high contact and low or non-contact athletes. These results support previous studies that found that high contact rodeo athletes had higher direct coping and lower catastrophizing than low contact rodeo athletes (Meyers et al., 2001). High direct coping has also been linked to resilience (Levy et al., 2006) which, in turn, is related to better adaptation to pain in sports (Crust & Clough, 2005), as is reduced catastrophizing (Anderson & Hanrahan, 2008). In addition, resilient individuals are able to withstand high levels of pain, but show low levels of emotional and behavioural distress (Karoly & Ruehlman, 2006). Thus, direct coping appears to be a particularly important factor for participation in contact sports and could explain why high contact athletes can tolerate more pain than other groups.

Bothersomeness.

In all studies, results indicated that high contact athletes found contact pain to be less bothersome than low or non-contact athletes. For the purpose of this thesis, bothersomeness was defined as how pain interferes with thoughts (psychological bothersomeness) and actions (physical bothersomeness) during sport. No studies have examined pain bothersomeness in athletes using the distinction between physical and psychological bothersomeness. This thesis has therefore contributed new information to this area and highlighted how different athletes are troubled by pain. Finding pain less bothersome results in adaptive behaviours and more positive attitudes toward sport participation (e.g. DeRoche et al., 2011). In study three participating contact athletes reported less contact pain bothersomeness than those who disengaged from sport, indicating that bothersomeness might influence sports participation. Bothersomeness reduced over the season in participating athletes, which is potentially due to experience (DeRoche et al.) or reframing of pain (Swift, 2015). Athletes may reframe their pain based on the anchors provided on a bothersomeness scale. As athletes experience more pain, the anchors associated with bothersomeness may change. As such, those who have endured great amounts of pain may report it as less bothersome (DeRoche et al.). However, in study two, injury occurrence was positively correlated with injury pain bothersomeness, suggesting that experience of injuries does not act as a buffer to bothersomeness. This may be because injury can prevent participation in sport in the short and long term (Tracey, 2010) or that experience of injuries makes athletes more vigilant and aware of the consequences (Meyers et al., 2001). It is also possible that the nature of injury pain, which can become chronic, may result in athletes being more conscious of the significance of such pain. This may be related to chronic pain theory, and fear avoidance (Crombez et al., 2012). Fear avoidance refers to acute pain that has become chronic and the subsequent avoidance of movements that are perceived to exacerbate the pain (Vlaeyen & Linton, 2000). As such, acute injury pain that becomes chronic may result in fear avoidance, and ultimately an increase in bothersomeness. Contact pain on the other hand is usually acute, expected and is episodic in nature, meaning that athletes may react more positively towards it (Taylor & Taylor, 1998). This highlights the importance of considering the source of pain and is an area for further research.

Study three examined feelings towards pain in participating and non-participating contact sports athletes. Participating athletes enjoyed the contact sport more and felt more positively about pain than those who disengaged from the sport. This indicates that perception of pain can be linked to participation in contact sports. There was a positive correlation between

enjoyment and feelings regarding sports related pain. These results suggest that those who drop out of contact sports may do so because they feel negatively about the pain they experience. This warrants more research however, as cause and effect cannot be ascertained from these correlations.

Pain Tolerance.

Cold and ischemic pain tolerance were measured in study three and pressure pain tolerance was examined in study four. Both studies indicated that those with experience of painful sports had higher pain tolerance than those with less experience, according with previous research (e.g. Tesarz et al., 2012). In study three, participating athletes were more tolerant of ischemic pain by the end of the season (eight months) whereas non-participating athletes were less tolerant of both ischemic and cold pain by the end of the season. It was suggested that this may be due to low pain related self-efficacy (Bandura et al., 1997) or pain-related fear within the non-participating group (e.g. Saisto et al., 2001). In study four, experienced high contact athletes had higher pressure pain tolerance than novice high contact athletes and non-contact athletes. Taken together, these results suggest that experience of pain may increase experimental pain tolerance. This accords with other researchers who have suggested that exposure to pain may alter pain tolerance in athletes (e.g. Ryan & Kovacic, 1966; Geva & Defrin, 2013).

Pain tolerance and physical bothersomeness both mediated the relationship between athlete type (high contact experienced or high contact novice athletes and non-contact athletes) and the time taken to complete the task in study four. This suggests that these variables are important in the performance of tasks during painful conditions. As such, maintained performance in pain can be explained by higher pain tolerance and lower physical pain bothersomeness in high contact athletes. This is a novel finding and warrants further research attention.

Pain Intensity (VAS).

Pain intensity was measured in studies three and four using a VAS. Results in study three indicated that there were no differences in VAS scores across the season both within and between groups. However, study four demonstrated that experienced high contact athletes reported pain as less intense than novice high contact athletes or non-contact athletes, according with Straub et al. (2003). The disparity in the results may be due to the pain stimulus used and the length of time that participants were exposed to experimental pain. Study three had a ceiling

time of five minutes and an average exposure time of 194.34s for cold pressor and 240.03s ischemia. Pain tolerance in study four was based on how much pressure the person could withstand before asking that the stimulus be stopped. Therefore, the exposure to the pain was rather brief. The average exposure time for completing the pain task in study four was 25.25s. Therefore, the duration of the pain stimulus may be responsible for the differences in pain intensity reporting across studies.

The results indicate that high contact athletes respond to and view pain differently to low or non-contact participants. The results regarding pain tolerance and perception (i.e. pain intensity) were already generally known before the completion of this thesis, as evidenced in the literature review. However, the bothersomeness results add to the scant literature examining this area. It is now evident that a potential mechanism for increased pain tolerance in contact athletes is that they are simply not bothered by pain. It was already established that high contact athletes had higher pain tolerance and reported less pain intensity than other athletes (e.g., Ryan & Foster, 1967), and as such, research should now move beyond examining these differences and focus further on the mechanisms for these findings. For example, direct coping appears to be an important factor in managing pain. Therefore, future research should examine how and indeed if, direct coping is developed over time. This should focus specifically on the episodic nature of pain experienced within sports and should differentiate between the different sources of pain. High contact athletes for example had high direct coping for contact pain in all studies. This pain is characterised as acute and often expected in contact sports. On the other hand, injury pain can become chronic in nature and tends to be unpredictable (Taylor & Taylor, 1998). Despite these differences, participating high contact athletes had higher direct coping for both pain sources when compared to non-participating athletes in study three. Research should therefore aim to differentiate between these two sources of pain and examine how direct coping is developed according to the source of pain.

Further research should be conducted to examine pain experiences of athletes who experience pain from fatigue rather than contact (for example, endurance athletes). Qualitative research could aim to explore how experience of pain as a result of exertion affects performance and pain ratings. It may be that the lengthy nature of endurance-related pain might invoke different responses to those of contact athletes who experience relatively short bouts of pain (Tesarz et al., 2012; Geva & Defrin, 2013). Exertion pain was discussed within study one, but none of the athletes took part exclusively in endurance sports. Some endurance athletes, for

example, triathletes participated in study two, but their experiences of pain were not explored in depth.

Sports pain bothersomeness has not been examined widely and this thesis has raised some novel insights into how pain bothersomeness affects athletes. Research could examine how bothersomeness is reduced and via what means. Moreover, further predictive studies could be carried out to establish whether pain bothersomeness predicts performance levels. Finally, studies could focus on interventions to reduce pain bothersomeness, which may foster adherence to contact sports.

Aim Three.

The third aim was to examine the role of challenge and threat states, performance in pain and pain responses in high and non-contact athletes. This was achieved in study four, where experienced and novice high contact athletes were compared to non-contact athletes.

Performance in Pain.

Both novice and experienced high contact athletes performed better in pain when compared to non-contact athletes. There were no performance differences between experienced and novice high contact athletes, indicating that experience of pain may not influence performance during experimental pain. In addition, both groups of high contact athletes maintained performance whilst in pain. Experienced high contact athletes actually performed faster in pain compared to when no pain was present. Non-contact athletes, conversely, performed worse in pain. These results suggest that high contact athletes were not distracted by the pain and that non-contact athletes suffered from attentional bias (Eysenck et al., 2007). Therefore, non-contact athletes' attention may have been drawn to the pain stimulus and not the motor task.

Challenge and Threat.

High contact athletes felt more challenged in pain compared to when not in pain. They also felt more challenged than the non-contact athletes during the experimental pain condition. Despite some receiving threat instructions, overall the high contact athletes were challenged in the pain condition. This was reflected in the moderation analysis that indicated that the threat manipulation only moderated the relationship between athlete type and performance of the task. It is suggested that this may be due to motivational and control factors (Karsdorp et al., 2013). Having perceived control over pain and viewing it as goal directed may result in challenge

states in contact athletes (Karsdorp et al.). Conversely non-contact athletes viewed pain as threatening, resulting in poorer performance and lower pain tolerance. Counter to other research (e.g. Turner et al., 2012), there were no performance differences overall between challenge and threat conditions. The pain stimulus may have interacted with the instructions and negated them for some athletes so that the situation was perceived as threatening. More studies need to be conducted to examine the interaction between pain and cognitive appraisal using mixed designs to determine how athletes perform in challenge or threat states both in pain and not in pain. For example, research should measure performance in pain and not in pain using a within subjects design for challenge and threat in both conditions. This would determine how pain and challenge and threat states interact and whether pain negates instructions or not.

Overall the results indicate that contact athletes are able to at least maintain performance and are challenged whilst in pain and this was mediated by pain tolerance and physical bothersomeness of pain. Research should focus on the mechanisms for this mediation effect, for example by examining how pain bothersomeness and tolerance can be manipulated and the subsequent effects on performance. . Attentional studies using eye tracking could be carried out to establish where attention is focused during experimental pain. In addition, further studies should investigate how challenge and threat instructions impact upon attention. More importantly, all studies measuring pain tolerance should aim to use more ecologically valid pain stimuli, for example computer controlled pressure pain devices (Lindley, Zimkowski, Patel & Rentschler, 2012).

Limitations

There were limitations to the studies within this thesis, which should be acknowledged and addressed, where possible, in future research. The first is that the self-report measures used (i.e. TIPI, SIP15, bothersomeness scales) may have issues with reliability and possible bias regarding social desirability, as discussed in each chapter. In previous studies, the SIP15 had relatively low reliability coefficients for the somatic awareness scale (Bourgeois, 2009), however these were higher when analysed for study two in this thesis ($\alpha = 0.77$). In addition, the TIPI is a brief measure of personality and therefore there are problems with low coefficient alphas (Gosling et al., 2003). Therefore, more research needs to be conducted to explore these issues.

In addition, it is acknowledged that pain stimuli used in pain research often are arguably not ecologically valid (Anderson & Hanrahan, 2008). Ischemic pain was used in study three as this is akin to exertion pain, and pressure pain was used in study four as participants associated it with dead leg pain or being in a scrum. However, despite this, laboratory induced pain is always finite and participants are aware that it can be stopped at any time, which does not reflect sports performance situations. Therefore, when interpreting the results within this thesis, these issues must be taken into account.

Finally, classifying athletes according to contact level presents difficulties. As discussed in Chapter One, previous research has examined athlete according to their sport type (e.g. Ryan & Kovacic, 1966), and in this thesis, high, medium, low and non-contact athletes have been examined. Considering pain experience in such a way is useful to compare groups of athletes according to how much pain they may experience in sport. However, it does not account for pain that athletes may experience from other sources e.g. injury or exertion. Nor does it account for the purposes of different sports and the amount of contact that may occur within a high contact sport. For example, a boxer may experience a great deal of contact pain, whereas a rugby winger may seldom tackle, ruck or maul, depending on the game. This should therefore be considered as a caveat when interpreting the research. This thesis has attempted to examine pain in sport from the perspective of amount of contact experienced. Studies within have also accounted for the amount of experience (in months) of contact sports (in studies three and four). Further research should continue to use contact and experience level to examine differences between athlete groups. Future studies could also examine pain experience by classifying athletes according to number and severity of injuries or consider intensity of training and levels of exertion pain in top flight athletes such as cyclists.

6.4 Applied Implications

In this section, the main applied implications that arose from this research will be discussed. The main findings of the thesis can be divided into three key, related areas. First, contact athletes clearly view and respond to pain differently to low/medium or non-contact athletes. This is in terms of performance in pain, pain response measurements and perception of pain. This was evidenced in all chapters of the thesis where high contact athletes saw pain as less bothersome, appraised it as a challenge, performed better when in pain compared to when not in pain and viewed pain positively. Second, high contact athletes are characterised by having a high direct coping style and this appears to be important for continued participation

in contact sports. This was a consistent finding in all chapters of the thesis where high contact athletes and participating high contact athletes had higher direct coping for contact pain. Finally, experience of playing contact sports appears to be a moderator of pain responses. Chapters Two, Four and Five provided evidence for this finding. In study one, high contact athletes reported that experience of pain made them appraise it more realistically. In study three, participating athletes had higher pain tolerance than non-participating athletes and in study four experienced high contact athletes out-performed non-contact athletes when in pain. The implications for each key finding are discussed below.

Coaches should be aware that contact sports athletes may respond differently to pain than others. They may celebrate contact pain, view injury pain more realistically, find pain less bothersome, report pain as less intense and may tolerate more pain on the field. However, having high pain tolerance does not necessarily predict participation within contact sports. Rather, pain tolerance may increase over time. Therefore, coaches could use interventions such as stress inoculation training (e.g., Driediger et al., 2006) to help athletes who have low pain tolerance or experience high pain intensity. Furthermore, interventions could be put in place to reduce pain bothersomeness or increase pain related self-efficacy. Indeed, increasing pain tolerance and reducing physical pain bothersomeness may result in at least maintained performance in pain. This has implications for sport psychologists who may need to work to develop pain coping strategies with athletes, and these may differ according to the pain source. Psychologists therefore need to be aware of how athletes may respond to different sources of pain and how bothersomeness may be reduced for each source.

Low or non-contact athletes also may not understand the meaning of contact or injury pain. This may result in them being unable to differentiate between benign and harmful pain, as suggested in study one. As such, these athletes may choose to continue to play sports despite being hurt. Paparizos et al. (2005) suggested that experience of pain helps athletes to distinguish between threatening and non-threatening pain and therefore, experienced athletes can make more informed decisions about continued participation. This accords with research by Griffith et al. (2006) who reported that experienced BASE jumpers were more likely to cease participation when hurt compared to less experienced athletes. Coaches should therefore be aware that some athletes may make risky decisions due to inexperience of pain. This may be particularly problematic in professional sports where there is potentially more pressure to play hurt or to take risks with injuries (Valovich Mcleod et al., 2009).

Direct coping appears to be an important factor not only to enhance pain tolerance but also to predict participation in contact sports. As such, coaches and athletes should work to develop this positive coping style. Little research has examined how this style can be developed, however research has suggested that direct coping is linked to resilience (Levy et al., 2006). Resilience to pain can be developed through optimism, acceptance and via social support mechanisms (Sturgeon & Zautra, 2013). In addition, direct coping appears to be linked to challenge states, but this has only been examined in one study (Kopka-McDowell & LaChappelle, 2005). Nevertheless, it is recommended that coaches should aim to promote both challenge states and direct coping when working with athletes. This may be important particularly at grassroots level sport where long term participation is encouraged. In study three direct coping did not change over an athletic season in participating and non-participating athletes. This suggests that either direct coping may take longer than an eight month season to develop or that direct coping simply is an aspect of personality that athletes possess or they do not. More research is required to establish if a direct coping style is developed or inherited. If coping styles can be influenced, attrition rates from high contact sports may be reduced if athletes can be taught how to cope with painful situations.

Experience of playing contact sports appears to be the most important mechanism for enhanced tolerance, reduced bothersomeness and reduced pain intensity ratings. As such, athletes should be encouraged to continue to participate in contact sports, even if they are deterred by pain at the start of playing. This is important at a recreational level where young athletes may be just beginning their sporting career and therefore may need encouragement to maintain participation. Via experience, athletes learn about the meaning of pain, they learn how to cope with it and ultimately they maintain performance despite being in pain. Both experienced high contact athletes and novice high contact athletes outperformed non-contact athletes when in pain, suggesting that even a short period of time spent playing contact sports might alter performance whilst in pain. Coaches could therefore work to encourage athletes to continue to participate in contact sports even if the athlete has difficulties at the outset.

Much of the literature regarding coping with pain has been developed via examining chronic pain patients (e.g. Newth & Delongis, 2004; O'Neill et al., 2007). It should therefore be noted that advice regarding the development of pain coping strategies has not focused on episodic bouts of pain as experienced by contact athletes. As such, coaches should be mindful of the nature of contact sports and the different responses that may occur according to the pain source. In addition, there is a need to account for the fact that contact athletes have chosen to

take part in painful activities, whereas chronic pain patients often do not have a choice. Motivation and passion for painful sports may explain why some athletes are drawn to certain activities. Some athletes may be motivated to play contact sports due to machismo or a willingness to show courage (e.g. Meyers et al., 1992), whereas others may simply have a strong passion for their sport which drives them to participate. There has been little discussion of these within pain literature and they are therefore potential avenues for further exploration.

6.5 Concluding Remarks

To conclude, the aims of the thesis, to examine responses to, and experience of, pain in athletes have been explored and discussed. Study one investigated the pain experiences of different athletes, with a focus on the three sources of sports related pain. Results indicated that high contact athletes were more realistic about contact related pain and that the culture of their sports influenced their appraisal of pain. The mechanisms of learning, attrition and individual differences were explored here, indicating that learning is the most plausible explanation for differences in pain response between athlete groups. This was further supported in the second study that provided insight into the proposed mechanism of individual differences and learning. Only agreeableness differentiated high and low contact athletes in this study, and high contact athletes had a high direct coping style. The third study further supported the notion that learning about pain can alter responses to it, finding that participating contact athletes had a higher pain tolerance by the end of a season compared to non-participating athletes. In addition, they also exhibited higher direct coping and reported less pain bothersomeness. The final study provided some insight into the effect of pain on the performance of a novel motor task, indicating that high contact athletes performed better than non-contact athletes whilst in pain. In addition, high contact athletes were challenged when in pain despite receiving threat based instructions. Non-contact athletes however were threatened when in pain and performed poorly when compared to having no pain.

Studying pain in the arena of sports is beneficial because athletes regularly experience pain and therefore it carries some meaning for them. By focusing on athletes who choose to take part in painful activities, new insights into the effects of pain have been made and these also have relevance to clinical populations. For example, athletes regularly experience brief, episodic bouts of contact pain and this experience may be similar to pathologies such as angina. Understanding how contact athletes cope with this acute, sometimes unexpected pain may help angina patients to manage their pain. In addition, athletes who suffer from long term injury pain may employ strategies that may be useful for other chronic pain sufferers. Direct coping

may be important in both of these situations and if this can be understood, interventions to help other populations may be developed. Another strength of examining pain within sports is that pain tasks may be more meaningful to the participants. Typically, in clinical research, tasks to be completed in pain may be arbitrary, and less meaningful to participants, for example, mental arithmetic or the Stroop test (e.g. Crombez et al., 2013). In study four, participants completed a motor task which may have been more meaningful, as it resembled sporting movements. It is therefore concluded that studying pain in athlete groups is not only of use to coaches and athletes but to other populations, and that using more sports related tasks may have made the research more important to some participants.

Three key messages have emerged from the studies within this thesis. The first is that high contact athletes respond differently to pain compared to other athlete groups. They tolerate more pain, report pain as less bothersome and intense, they can maintain performance and are more challenged when in pain. Pain tolerance and physical pain bothersomeness are important factors and may mediate performance in pain. The second is that experience of sports related pain is important. It appears that learning takes place as a result of experience and this may result in the differences in pain responses. However this is not fully determined and requires further longitudinal investigation. The third is that having a high direct coping style and reporting low pain bothersomeness appear to be key factors regarding pain reporting. More research needs to be conducted to determine how these are developed through contact sport participation. In addition, it is not clear how distinct challenge states and direct coping are from one another. Approaching pain positively and seeing it as something to be “toughed out” may simply be a reflection of being in a challenged state. More research needs to be conducted to examine these two concepts.

The thesis findings are important for coaches and athletes alike, as they indicate that experience of contact sports can alter reactions to pain. Therefore athletes who are deterred by sports related pain should be aware that responses to pain may change over time. In short, the research in this thesis suggests that “it will get easier”. As such, athletes who suffer with performance decrements when in pain, or those who are simply afraid of sports related pain should be optimistic that positive changes may occur over time. In addition, with further research, interventions may be developed to help athletes reduce the bothersomeness of pain and to foster a direct coping style. If these could be implemented early in contact sports participation, adherence and performance may be improved.

It is believed that this thesis has made a contribution to the scant literature on sports-related pain and the role of contact within sports. This thesis also provides insight into the mechanisms that differentiate athletes who are pain tolerant and those who are not. Finally, this thesis has shown that experience of pain, reporting low pain bothersomeness and having a high direct coping style are important factors for not only pain responses but also continued participation in painful contact sports.

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Appendices

Appendix A – Ethical approval documents for study 1

This form is for University members of staff and PhD students making applications to the Psychology (PREC). Complete this form and submit it by email to the Chair *and* Deputy Chair of PREC. Information about submission and approval processes, deadlines, and meeting dates is given at <http://psychology.derby.ac.uk/ethics.html> Once approval has been given, you will be eligible to commence data collection.

| | | |
|--|-----------------|--|
| 1. Name: | Claire Thornton | 2. School/ Research centre (if internal applicant) School of Science, Faculty of Education Health and Sciences |
| 3. Contact Info | [REDACTED] | |
| 4. Position: | PhD Student | |
| 5. Name of supervisor (Director of Studies) if you are PhD student: Professor David Sheffield | | |
| 6. Title or topic area of proposed study | | |
| Athletes and Pain: An interview study of athletes experiences. | | |
| 7. What are the aims and objectives of your study? | | |
| <p>Aim: Provide an understanding of the role pain plays in athletic populations and how pain affects performance.</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Organise a series of 1 to 1 interviews with athletes of different athletic backgrounds to explore their experiences of pain, their interpretation of it and their coping strategies • To transcribe the interviews for analysis • To analyse the transcripts using Interpretative Phenomenological Analysis (IPA) and identify common themes for individuals and across the group • To relate findings to current literature and highlight possible interventions to help athletes deal with pain | | |
| 8. Brief review of relevant literature and rationale for study | | |
| <p>At present there is a paucity of research into how athletes cope with and perform in pain. This is surprising since athletes are perhaps unique as a population in the amount of pain and injury they experience as part of sport. The majority of research which has examined pain and athletic populations has focused on pain tolerance or coping styles. Most researchers agree that athletes are able to tolerate more pain than non-athletes (e.g. Walker, 1971; Manning & Fillingim, 2002) and that they use different coping styles than non-athletes (e.g. Meyers, Bourgeois, Stewart and LeUnes, 1992). Few studies have examined how pain affects motor performance and those which have lacked ecological validity (e.g. Brewer, Van Raalte & Linder 1990) or have not used athletes as participants (e.g. Evans & McGlashan, 1967). A study by Walker (1971) is the only research which focused on athletes and performance in pain. She found that performance was adversely affected by pain in both athletes and non-athletes. However, this researcher (Claire Thornton, [CT]) recently completed a Masters dissertation which examined the effects of pain on motor performance. Performance was hampered in low and non-contact athletes when pain was experienced, however high contact athletes were not hampered by pain. It would therefore be interesting to examine views and experiences of pain amongst athletes from different sporting backgrounds. Understanding how athletes</p> | | |

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| <p>view pain and deal with it may help in implementing pain coping strategies and may result in improved performance (Kress & Statler, 2007).</p> <p>Pain in sport can generally come from one of two sources: Performance related pain is linked with feelings associated with exertion in sport and is something which most athletes will experience. Whilst this type of pain does not usually elicit feelings of threat and it is within the control of the athlete, it can affect enjoyment and motivation in sport (Anderson & Hanrahan, 2008). Injury related pain is usually out of the control of the athlete and can be perceived as threatening (Taylor & Taylor, 1998). This type of pain is becoming a more common occurrence in many sports due to increased pressures of competing (Valovich McLeod, Bay, Parsons, Sauers & Snyder, 2009) and the demands of elite sport (Levy, Polman, Nicholls & Marchant, 2009; Egan, 1987). Injury can affect all aspects of an athletes life and has been shown to affect both sports related and global health related quality of life (Valovich McLeod et al). Examining differences in perception of these two types of pain would be interesting to establish any variances according to sports played. Although there are studies that quantify the experience of pain there are few which examine athletes' views of pain in sport. Therefore this study will examine these experiences and make comparisons between athletes to attempt to gain a detailed understanding of athletes' experiences of pain.</p> |
| <p>9. Outline of study design and methods</p> |
| <p>Design: Qualitative 1 to 1 interviews will be conducted with athletes from different athletic backgrounds (high contact and injury potential athletes and low contact and injury potential athletes). Interviews will explore the subjective experience of pain and the coping strategies employed to deal with it.</p> <p>Procedure: Interpretative Phenomenological Analysis (IPA) will be used to interpret the data collected. IPA aims to gain a better understanding of quality of phenomena by interpreting the experiences of participants (Willig, 2008). Interviews will be recorded using a digital Dictaphone and will be transcribed using a computer. The transcripts will then be read and annotated to establish any themes which emerge from the data. Following re-readings of the transcripts common themes will be developed for individuals and across groups.</p> <p>Timescale: April/May: Prepare materials, recruitment of participants June: Data collection (interviews) August/September: Data analysis October: Write up</p> |
| <p>10. Sample: Please provide a detailed description of the study sample, covering selection, number, age, and if appropriate, inclusion and exclusion criteria.</p> |
| <p>10 athletes of varying sporting backgrounds will be invited to take part. High contact/high injury potential athletes will be selected from sports which allow contact within the rules (e.g. rugby, boxing, martial arts). Low or non-contact athletes will be selected from sports in which contact is not permitted within the rules (e.g. basketball) or sports where contact is not involved at all (e.g. tennis, badminton).</p> |
| <p>11. Are payments or rewards/incentives going to be made to the participants? If so, please give details below.</p> |
| <p>No</p> |
| <p>Do you intend to give <i>Participation Points</i> for taking part in your study? No (Delete as appropriate)</p> |

12. What resources will you require? (e.g. questionnaires, equipment, for example video camera, specialised software; if questionnaires are to be used please give full details here).

Dictaphone
 Suitable room (at Newcastle College) to conduct interviews
 Computer for transcribing of interviews
 Hard copies of participant information sheets/consent forms/debrief forms
 Interview schedule

13. References Give the references for any sources cited in the sections on rationale, methods etc.

Anderson R. & Hanrahan S.J. (2008). Dancing in Pain: Pain appraisal and coping in dancers. *Journal of Dance Medicine & Science*, 12, 9-16
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 Levy A.R., Polman R.C.J. & Nicholls A.R. (2009). Sport injury rehabilitation adherence: Perspectives of recreational athletes. *International Journal of Sport and Exercise Psychology*, 7, 212-229
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14. Ethical Considerations Please indicate how you intend to address each of the following in your study. Points a-i relate particularly to projects involving human participants. Guidance to completing this section of the form is provided at the end of the document.

- a. Consent:** All potential participants will be provided with a participant information sheet which outlines the purposes of the study. They will also be informed via this sheet that: They are free to withdraw at any time without prejudice, that data will be kept securely and confidentially and that they will remain anonymous when the research is written up. The scope of the study will also be outlined and consent to publish findings will also be sought. All participants will be over the age of 18 so no parental consent is required.
- b. Deception:** There is no deception in this study
- c. Debriefing:** All participants will be fully debriefed at the end of interviews. All participants will be provided with a debrief sheet outlining their right to withdraw, the purpose of the interview and how data will be treated. In addition contact details of the research team will be provided, should the participant wish to add further information or withdraw from the study. Students will be referred to student services at Newcastle College if they feel distressed as a result of participating in the research.

- d. Withdrawal from the investigation:** All participants will be informed via the information sheet and the debrief sheet, of their right to withdraw at any time without prejudice. A time limit of 4 weeks will be set for withdrawal post interview. Any data generated from a withdrawn participant will be destroyed.
- e. Confidentiality:** Confidentiality will be assured for the interviews via the participant information sheet. Participant's identities will be protected through the use of pseudonyms and participants will be informed that direct quotes may be used but links to them personally will not be made.
- f. Protection of participants:** During interviews participants may feel distressed when recalling painful sporting experiences or injuries. Participants will be informed of this via the information sheet and will be reminded of their right to withdraw or pause/stop the interview at any time. Students will be referred to student services at Newcastle College (0191) 2004611 if they feel distressed as a result of participating in the research.
- g. Observation research [complete if applicable]:** N/A
- h. Giving advice:** No advice will be given to participants, however students will be referred to student services at Newcastle College (0191 2004611) for further support if they report feeling distressed during or after the interviews.
- i. Research undertaken in public places [complete if applicable]:** N/A
- j. Data protection:** This research will comply with the Data Protection Act and the University of Derby's Good Scientific Practice. All information pertaining to participants will be stored securely. Electronic information (such as written up transcripts, MP3 files of the interviews) will be stored on a password protected computer, not a laptop. Consent forms and other paper based records will be stored separately in different locked cupboards at Newcastle College. Participants will be informed via the information sheet that data will be destroyed if they withdraw from the study. Consent to record interviews will be sought from all participants.
- k. Animal Rights [complete if applicable]:** N/A
- l. Environmental protection [complete if applicable]:** N/A

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

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| |
| 15. Have/do you intend to request clearance from any other body/organisation ? Yes /No (please circle as appropriate) |
| If Yes – please give details below. |

16. Declaration: The information supplied is accurate to the best of my knowledge and belief. I understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Ethical Policy for conducting research with human participants.

Place a √ **in the box above to confirm your agreement with the declaration**

Date of application: 25/03/2011

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Faculty of Education, Health and Sciences

Appendices to the ethics application

Attach on further pages below, but *all in one document*, the text of materials that will be used for the project. These should include all the information that participants receive, in the order that they receive it, from the invitation to participate through to the debriefing.

Please place a ✓ in the boxes below to indicate the material that has been included or explain why it is not available.

- Invitation to participate [✓]
- Consent forms for participants [✓]
- Instructions to participants once they have agreed to participate [✓]
- Questionnaires [N/A – not using]
- Interview schedules [✓]
- Test materials [N/A]
- Debriefing information [✓]

Advice on completing the ethical considerations aspects of a programme of research

Consent

Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

Covert or Deceptive Research

Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

Debriefing

How will participants be debriefed (written or oral)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

Withdrawal from investigation

Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

Protection of participants

Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

Observational research

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If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

Giving advice

Staff should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

Research in public places

You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

Confidentiality/Data Protection

You must comply with the Data Protection Act and the University's Good Scientific Practice <http://www.derby.ac.uk/research/policy-and-strategy> This means:

- It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
- You must not do anything with the personal information you collect over and above that for which you have consent.
- You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
- Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
- You must store data securely. Consent forms and data should be stored separately and securely.
- You should only collect data that is relevant to the study being undertaken.
- Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
 - The data is not being used to take decisions in respect of any living individual.
 - The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
- You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
- All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

Animal rights.

Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

Environmental protection

The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.

Psychology Research Ethics Committee (PREC)

Faculty of Education, Health and Sciences

Invitation to Participate in Research (to be posted on Blackboard virtual learning environment at Newcastle College and notice boards around campus)

I am conducting some interview-based research which will examine athletes' experiences of pain in sport.

I am interested in hearing from any athlete who would like to:

- Discuss thoughts/feelings/emotions relating to pain experienced in sport
- Talk about coping with pain in sport
- Discuss how pain affects sports performance
- Talk about general experiences of pain in sport

If you would like to participate in this research or would like more information about what this research would entail, please contact Claire Thornton: claire.thornton@ncl-coll.ac.uk or (0191) 2004638.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Pain and Athletes

University of Derby

Statement of Informed Consent

Please tick each box
to indicate you have
read the statement:

I understand that I have agreed to participate in
study exploring experience of pain in sports settings

I have received a copy of the project information sheet and have been given an opportunity to ask
questions about my participation in the study.

I understand that my participation in the study is entirely voluntary, and that if I wish to withdraw
from the study at any time I may do so at any point, and that I do not have to give any reasons or
explanations for doing so. I understand that if I wish to withdraw after participating that I should
inform the researcher within 4 weeks and that my information will not be used.

I understand that the 1-1 interview will be recorded and a written account of these sessions will be
produced.

I have read and understood this information and consent to take part in the study.

Signed (Participant)

Date.....

Unique participant Code: _____ (to be completed by the researcher)

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
Pain and Athletes

I would like to invite you to take part in a research study. Before you decide whether you would like to take part, it is important to understand why the research is being done and what it would involve for you. Please take some time to read the following information carefully and speak to the researcher if you have any questions or concerns. If there is anything that is not clear or you would like further information please speak to the researcher.

Why is this research being done?

We have a limited understanding of how pain affects athletes and the strategies they use to deal with pain. Understanding the experiences athletes have of pain will help sport psychologists to intervene to help athletes to cope with pain better.

Who is doing the research?

Claire Thornton is conducting the research as part of a PhD at the University of Derby. You can contact her supervisor at any time if you need further information: Professor David Sheffield, Ph.D., Associate Head of Centre for Psychological Research, Faculty of Education, Health and Sciences, University of Derby, Kedleston Road, Derby, DE22 1GB, Tel: 01332-592038, d.sheffield@derby.ac.uk

Why have I been invited to take part?

You are being invited because you responded to an advertisement asking for participants and you have met the criteria to participate. That is, you are either a high contact athlete (you experience a lot of contact in your sport and your sport has high injury potential), a low contact athlete (you play a sport which involves minimal contact and contact is not permitted within the rules) or a non-contact athlete (your sport is an individual rather than a team sport and contact is not permitted within the rules).

Do I have to take part?

No – it is up to you. If you decide to take part, you will be asked to sign a consent form and you will be given a copy of this information sheet and the consent form to keep. You are free to stop taking part at any time without giving a reason.

What will happen to me if I take part?

If you are happy to take part, we will arrange a time for a 1-1 interview at a convenient time. These sessions will normally be held at Newcastle College; however it is possible to arrange a mutually convenient place if access to Newcastle College is difficult for you.

The information obtained during the interviews will be anonymised before being analysed by the researcher. When you arrive for the 1-1 interview, the facilitator will go through the information sheet and ask you to sign a consent form. The interview will involve discussing your experiences of pain in sport. The interview will be recorded using a digital recorder in order to make sure that we have an accurate account.

What are the possible disadvantages and risks of taking part?

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

The interview may take up to an hour and a half of your time. As you will be discussing personal experiences there is the possibility that you may find the topic of the discussions distressing. However, you are free to stop at any time and talk to the facilitator. You can also contact Student Services at Newcastle College on (0191) 2004611 if you feel distressed as a result of taking part.

What are the possible benefits of taking part?

It is hoped that you will find it interesting taking part in the research and that discussing your experiences of pain may make you more aware of how you cope/deal with it. There are also believed to be a range of possible benefits to taking part in sessions such as this, including the therapeutic effect of the discussion and increased self-awareness.

What if there is a problem?

If you have a concern or complaint about any aspect of this study, you should ask to speak to the researcher and she will do her best to answer your questions (please telephone Claire Thornton on (0191) 2004638). If you remain unhappy and wish to complain formally, you can do so through the University of Derby ethics committee chair: James Elander, at j.eland@derby.ac.uk. You can also contact Student Services at Newcastle College who will be able to refer you to appropriate support should you feel distressed. You can call in to see them at Rye Hill House, Newcastle College or telephone them on (0191) 2004611.

Will my information be kept confidential?

Your information will be treated with the strictest confidence by the research team and we will stress the importance of confidentiality before beginning the interview. All information (electronic and paper-based) will be stored securely then it will be destroyed. Data and personal information will only be held as long as necessary to write up and publish the study (up to 1 year). No personal reference to you will be made once the research is written up; all participants will be given pseudonyms to prevent identification. Direct quotes may be used in write up, but these will be in no way linked to you by name. The only people who may listen to interviews or read transcripts are the researcher (Claire Thornton) and her supervisory team (Professor David Sheffield and Andrew Baird from the University of Derby).

What will happen if I don't want to carry on with the study?

You are free to stop taking part at any time during the interview, without giving a reason and without prejudice. If you change your mind after taking part, you can contact me up to four weeks after participating and any identifiable data will be destroyed. As a result none of your direct quotes or information from the interview will be used in the study.

What will happen to the results of the research study?

The results of the study will be written up for publication in an academic journal. Results will also be included as part of my PhD thesis. You will not be identified in any report or publication and any quotes will be anonymous. I will send all participants a copy of the results, if you would prefer not to receive this please let the facilitator know.

Who has reviewed the study?

This research has been approved by the Research Ethics Committee at the University of Derby. This means that it has been agreed by an independent panel that this research does not breach your safety, rights or well being.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Further information and contact details

If you would like any further information please contact Claire Thornton on (0191) 2004638 or Claire.thornton@ncl-coll.ac.uk. Or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk

If you decide to participate you will be given a copy of this information sheet and a signed consent form to keep.

Thank you for taking the time to read this information sheet and considering taking part in this study.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
Participant Information

Participant number:

Gender: M/F

Age:

Sport(s)/activities:

How often?:

At what level?:

For how many years?:

Number of major injuries (sprains, fractures etc which resulted in you being out of action for over 2 weeks+):

Number of minor injuries (bruises, scrapes, minor strains):

What do you do when injured – play through it?

Exertion pain – play through it?

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
INTERVIEW SCHEDULE

[Pain and Athletes]

Welcome and thanks for attending interview.

Meaning and personal experience

Do you experience pain as part of your sport?

Prompts: Provide an example, when, how often? In what ways? What did it feel like?

Prompts: Explore each of these and ask for examples. E.g. is it exertion related, injury related etc.

What does being in pain mean to you? Address injury and exertion pain separately

Prompts: Why? E.g. is pain appraised as a threat or challenge?

Prompts: How do you view the pain you experience?

What do you find yourself thinking about when you feel pain?

Prompts: Negative/positive? Are there differences in your thoughts according to whether pain is injury related or exertion related?

How do you feel, what emotions do you experience, when you feel pain?

Prompts: Ask for examples – anxiety etc? Positive emotions/negative emotions?

Prompts: Are there any differences according to whether pain is injury related or exertion related?

Coping

What do you do to deal with pain?

Prompts: Coping strategies – distraction, imagery, relaxation etc? Differences between injury related pain and exertion pain.

Is there anything that particularly stands out that reduces the intensity of pain?

Examples – focusing on it, ignoring it. Differentiate between injury and exertion pain.

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Faculty of Education, Health and Sciences

Are there any people around you who have helped or can help with coping with pain?

Prompts: Coaches? Team-mates? Family etc?

Prompts: In what way do they help you/can help you?

Pain as part of sport

How do you feel about the pain you experience in your sport?

Prompts: Differentiate between injury and exertion. Is it a necessary part of sport? Is it an occupational hazard?

How do you think others around you in your sport feel about pain experienced?

Prompts: Differentiate between injury and exertion. Is it a necessary part of sport? Is it an occupational hazard?

Has pain ever prevented you from carrying on participating in your sport? How did it make you feel? How do you think it made others feel about you?

Prompts: Differentiate between exertion and injury pain. Were there differences according to type? Did you feel pressure to carry on?

Prompts: Do you regularly play with pain/injury? How do you feel about playing with pain/injury?

How does pain affect your sports performance?

Prompts: Positive or negative? Does it distract you? Does it make you focus?

We have covered a lot in our discussions so far is there anything you think we have missed or that you would like to add?

Thank you for your time.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

DEBRIEF SHEET

Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to explore experiences of pain in sports settings and to examine coping strategies which are employed to deal with pain. It is hoped that this research will provide an insight into how different athletes view and deal with pain.

If any aspect of the interview has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will only be held as long as necessary to write up and publish the study (up to 1 year).

If you think of any further information that you think would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

Psychology Research Ethics Committee (PREC)

Faculty of Education, Health and Sciences

Approval Letter: Psychology Research Ethics Committee

University of Derby

3rd June 2011

James Elander

Acting Chair, Psychology Research Ethics Committee, University of Derby

Dear Claire,

Ethics Ref No: 040-11-CT: Athletes and Pain: An interview study of athletes experiences

I have now reviewed the revised documents you sent following the feedback you received on your initial application, and I am satisfied that all of the issues raised have been dealt with. The application can now therefore be approved.

The following documents have now been reviewed:

1. Revised participant information forms
2. Revised consent form
3. Revised debriefing information

If any changes to the study described in the application or supporting documentation is necessary, you must notify the committee and may be required to make a resubmission of the application.

Good luck with the study.

Yours sincerely

James Elander

Appendix B – Ethical approval documents for study 2

Request For Ethical Approval For Individual Study / Programme Of Research

This form is for University members of staff and PhD students making applications to the Psychology Research Ethics Committee (PREC). Complete this form and submit it by email to the Chair *and* Deputy Chair of PREC. Information about submission and approval processes, deadlines, and meeting dates is given at <http://www.derby.ac.uk/science/psychology/psychology-ethics-committee>

Once approval has been given, you will be eligible to commence data collection.

| | | | |
|---|-----------------|---|---|
| 1. Name: | Claire Thornton | 2. School/ Research centre (if internal applicant) | School of Science, Faculty of Education Health and Sciences |
| 3. Contact Info | [REDACTED] | | |
| 4. Position: | PhD Student | | |
| 5. Name of supervisor (Director of Studies) if you are PhD student: Professor David Sheffield | | | |
| 6. Title or topic area of proposed study: | | | |
| Pain coping strategies in high and low contact athletes | | | |
| 7. What are the aims and objectives of your study? | | | |
| <p>Aim: To appraise the coping strategies of high contact athletes and low contact athletes in the field.</p> <p>Objectives:</p> <ul style="list-style-type: none"> To examine pain coping strategies for 3 different pain types – exertion, contact and injury – in high and low contact athletes; Analyse the data collected to make comparisons between the two groups To relate findings to current literature and highlight possible interventions to help athletes deal with pain | | | |
| 8. Brief review of relevant literature and rationale for study | | | |
| <p>Research has demonstrated that high contact sports participants tolerate more pain than low or non-contact athletes (e.g. Ryan & Kovacic, 1966). Pain is an integral part of sports participation and ultimately can set a limit on what athletes are able to achieve (Epstein, 2011). Athletes regularly experience pain through injury, contact with external objects and exertion. The ability to maintain performance in painful conditions is crucial to continued participation in most sports and ultimately could be the deciding factor in whether an athlete is successful or not (Egan, 1987). Understanding how pain affects athletes is critical for all stakeholders in sport and is key to the development of pain coping strategies (Kress & Statler, 2007). An athlete with an understanding of pain and coping strategies could potentially perform better and adhere to sport longer than an uneducated athlete (Scott & Gijssbers, 1981; Egan, 1987).</p> <p>I have recently completed a qualitative study which explored the responses to pain in high and low contact athletes. It was highlighted that high contact athletes may appraise and cope with pain differently to low contact athletes. In particular high contact athletes used coping strategies differently to low contact athletes and therefore I would like to explore this further. Specifically the high contact athletes were more conservative in their approach to pain and would be more willing to stop if they perceived pain to be a sign of harm (“if it’s just a little knock or a broken finger I’ll just carry on, but with the more serious stuff, I’d say enough is enough”). Athletes were also able to differentiate between different types of pain. In particular they discussed pain in terms of fatigue (exertion), contact and injury (“the pain of</p> | | | |

**Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences**

lifting weights is nothing compared to tearing your muscle"). There were differences in how all athletes appraised and coped with these types of pain so I would also like to explore this further. Finally there were differences in willing to continue in pain between individual sports and team sports athletes. In particular team based athletes were more willing to participate in pain for social or team reasons ("I don't want to let the team down") whereas individual athletes were more willing to continue in pain due to competitive reasons ("the will to win"). This study will allow further investigation of this area by examining differences between high and low contact participants, team and individual sports participants and also briefly assess the personality of the participants to establish whether individual differences can account for sports choice and pain responses.

9. Outline of study design and methods

Design: Field based study using questionnaires (Sport Inventory for Pain [SIP15]) and questionnaire assessing bothersomeness of pain, personality and demographic information.

Procedure: High contact athletes and low contact athletes will be used as participants across team and individual sports. Questionnaire packs will be taken to training sessions and distributed. A brief explanation of the study and how to complete the questionnaires will be given.

Timescale:

February 2013: Prepare materials

March 2013: Recruit participants and begin data collection

April 2013: Data collection

May/June 2013: Begin data analysis and write up this will be completed within the duration of the PhD

10. Sample: Please provide a detailed description of the study sample, covering selection, number, age, and if appropriate, inclusion and exclusion criteria.

It is anticipated that around 200 athletes will take part in this study. The target group is athletes/sports people who compete in sports events regularly (–see inclusion criteria below). Participants will be approached either by letter or email (writing to local clubs/teams in the area), Noticeboards (at Newcastle College, local sports centres and Northumbria University [Sports Central]) or via social media (Blackboard VLA at Newcastle College, Facebook). I will be visiting each group of participants and distributing questionnaire packs. I will also collect these in afterwards. Where visits are not possible packs will be posted to participants.

Inclusion criteria:

All participants must compete in their sports (for example regarding athletics, it is not enough to go out for a recreational run, the person must be part of a club and compete in an athletic discipline – at any level). Males and females will be included.

| | |
|---|--|
| <ul style="list-style-type: none"> • High contact athlete, Team-based – sports such as ice hockey, American football, rugby and Gaelic football. • Contact is part of the sport and is allowed within the rules | <ul style="list-style-type: none"> • High contact athlete, Individual – sports such as martial arts, wrestling and boxing. • Contact is part of the sport and is allowed within the rules |
| <ul style="list-style-type: none"> • Low contact athlete, Team-based – sports such as football (soccer), basketball, volleyball, netball, cricket and hockey • Contact occurs in the sport but is not encouraged and if excessive will be penalised. | <ul style="list-style-type: none"> • Low contact athlete, Individual – sports such as badminton, tennis, athletics, swimming, cycling, rowing • Contact may occur in the sport, generally with objects (but could be with others), but is not integral to the nature of the sport |

11. Are payments or rewards/incentives going to be made to the participants? If so, please give details below.

No

**Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences**

Do you intend to give *Participation Points* for taking part in your study? **No** (Delete as appropriate)

12. What resources will you require? (e.g. questionnaires, equipment, for example video camera, specialised software; if questionnaires are to be used please give full details here).

SIP 15

Self-designed bothersomeness and demographic questionnaire

Personality questionnaire (Ten Item Personality Measure [TIPI]) (Gosling, Rentfrow & Swann, 2003) – this has been included to assess whether there is a difference in personality types (based on the Big 5) between high and low contact participants. It has been chosen because it is a short measure of personality which is therefore not too lengthy for the participants to complete. It has been recommended that this measure is used when personality is not the primary focus of a study and a brief, user friendly inventory is needed (Gosling et al, 2003).

13. References Give the references for any sources cited in the sections on rationale, methods etc.

Epstein D. (2011). The truth about pain : It's in your head. *Sports Illustrated*, 115, 58-66

Egan S. (1987). Acute-pain tolerance among athletes. *Canadian Journal of Sports Sciences*, 12, 175-178

Gosling, S. D., Rentfrow, P. J., & Swann, W. B., Jr. (2003). A Very Brief Measure of the Big Five Personality Domains. *Journal of Research in Personality*, 37, 504-528

Kress J.L. & Statler T. (2007). A naturalistic investigation of former Olympic cyclists' cognitive strategies for coping with exertion pain during performance. *Journal of Sport Behavior*, 30, 428-452

Ryan E.D. & Kovacic C.R. (1966). Pain tolerance and athletic participation. *Perceptual and Motor Skills*, 22, 383-390

Scott V. & Gijssbers K. (1981). Pain perception in competitive swimmers. *British Medical Journal*, 283, 91-93

14. Ethical Considerations Please indicate how you intend to address each of the following in your study. Points a-i relate particularly to projects involving human participants. Guidance to completing this section of the form is provided at the end of the document.

m. Consent All potential participants will be provided with a participant information sheet which outlines the purposes of the study. They will also be informed via this sheet that: They are free to withdraw at any time without prejudice, that data will be kept securely and confidentially and that they will remain anonymous when the research is written up. The scope of the study will also be outlined and consent to publish findings will also be sought. All participants will be over the age of 18 so no parental consent is required.

n. Deception There is no deception in this study

o. Debriefing All participants will be fully debriefed at the end of data collection. All participants will be provided with a debrief sheet outlining their right to withdraw, the purpose of the study and how data will be treated. In addition contact details of the research team will be provided, should the participant wish to add further information or withdraw from the study. Students will be referred to student services at Newcastle College if they feel distressed as a result of participating in the research.

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- p. Withdrawal from the investigation** All participants will be informed via the information sheet and the debrief sheet, of their right to withdraw at any time without prejudice. A time limit of 4 weeks will be set for withdrawal post questionnaire completion. Any data generated from a withdrawn participant will be destroyed.
- q. Confidentiality** will be assured for the study via the participant information sheet. Participants will not need to include their name on the SIP questionnaire, and their demographic information will only include basic information such as age, time spent in their sport, gender, number of injuries etc, The participants will not have to disclose their name.
- r. Protection of participants** During questionnaire completion participants may feel distressed when recalling painful sporting experiences or injuries/experiences. Participants will be informed of this via the information sheet and will be reminded of their right to withdraw or pause/stop the questionnaire completion at any time. Students will be referred to student services at Newcastle College (0191) 2004611 if they feel distressed as a result of participating in the research.
- s. Observation research [complete if applicable]** N/A
- t. Giving advice** No advice will be given to participants
- u. Research undertaken in public places [complete if applicable]** Data will be collected in public places such as sports centres and fitness facilities. Consent will be gained from all interested parties (such as facility managers, coaches, trainers etc.) to gain access to facilities and participants.
- v. Data protection** This research will comply with the Data Protection Act and the University of Derby's Good Scientific Practice. All information pertaining to participants will be stored securely. Consent forms and other paper based records will be stored separately in different locked cupboards at Newcastle College. Participants will be informed via the information sheet that data will be destroyed if they withdraw from the study.
- w. Animal Rights [complete if applicable]** N/A
- x. Environmental protection [complete if applicable]** N/A

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

| |
|--|
| |
| <p>15. Have/do you intend to request clearance from any other body/organisation ? Yes/No (please circle as appropriate)</p> <p>If Yes – please give details below.</p> |

16. Declaration: The information supplied is accurate to the best of my knowledge and belief. I understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Ethical Policy for conducting research with human participants.

Place a ✓ **in the box above to confirm your agreement with the declaration**

Date of application: 11/02/13

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Appendices to the ethics application

Attach on further pages below, but *all in one document*, the text of materials that will be used for the project. These should include all the information that participants receive, in the order that they receive it, from the invitation to participate through to the debriefing.

Please place a ✓ in the boxes below to indicate the material that has been included or explain why it is not available.

Invitation to participate [✓]

Consent forms for participants [✓]

Instructions to participants once they have agreed to participate [✓]

Questionnaires [✓]

Interview schedules []

Test materials []

Debriefing information [✓]

Advice on completing the ethical considerations aspects of a programme of research

Consent

Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

Covert or Deceptive Research

Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

Debriefing

How will participants be debriefed (written or oral)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

Withdrawal from investigation

Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

Protection of participants

Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

Observational research

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If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

Giving advice

Staff should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

Research in public places

You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

Confidentiality/Data Protection

You must comply with the Data Protection Act and the University's Good Scientific Practice <http://www.derby.ac.uk/research/policy-and-strategy> This means:

- It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
- You must not do anything with the personal information you collect over and above that for which you have consent.
- You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
- Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
- You must store data securely. Consent forms and data should be stored separately and securely.
- You should only collect data that is relevant to the study being undertaken.
- Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
 - The data is not being used to take decisions in respect of any living individual.
 - The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
- You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
- All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

Animal rights.

Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

Environmental protection

The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.

**Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences**

Supplementary Information

Recruitment Advert, Information Sheet, Consent form, Debrief Sheet, Participant Questionnaire, Sports Inventory for Pain, additional Personality Questionnaire

Advertisement for Participants

I am looking for athletes who regularly play and compete in sport to take part in a questionnaire based study.

I am looking for:

| | |
|--|---|
| <ul style="list-style-type: none"> • High contact athletes who play team-based sports, for example: • Ice hockey, American football, rugby and Gaelic football. • Or any sport where contact is part of the sport and is allowed within the rules | <ul style="list-style-type: none"> • High contact athletes who take part in individual sports or activities, for example: • Martial arts, wrestling and boxing. • Or any sport/activity where contact is part of the sport and is allowed within the rules |
| <ul style="list-style-type: none"> • Low contact athletes who play team-based sports, for example: • Football (soccer), basketball, volleyball, netball, cricket and hockey • Or any sport where contact may occur but is not encouraged and if excessive will be penalised. | <ul style="list-style-type: none"> • Low contact athletes who take part in individual sports or activities, for example: • Badminton, tennis, athletics, swimming, cycling and rowing • Or any sport/activity where contact may occur generally with objects (but could be with others), but is not integral to the nature of the sport |

You will be asked to complete a batch of questionnaires which ask about you and your experiences of pain in your sport. You will be asked to think about 3 different types of pain: contact related pain (this is pain you would feel as a result of coming into contact with an object or another person during your sport), injury related pain (this is pain you would feel as a result of damage to tissue – e.g. a sprain or strain) and exertion related pain (this is pain you would experience as a result of fatigue or training hard). It is anticipated that this will take around 15 minutes to complete. If interested please contact Claire.thornton@ncl-coll.ac.uk (tel. 0191 2004638).

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Pain and Athletes

I would like to invite you to take part in a research study. Before you decide whether you would like to take part, it is important to understand why the research is being done and what it would involve for you. Please take some time to read the following information carefully and speak to the researcher if you have any questions or concerns. If there is anything that is not clear or you would like further information please speak to the researcher.

Why is this research being done?

We have a limited understanding of how pain affects athletes and the strategies they use to deal with pain. Understanding the experiences athletes have of pain will help sport psychologists to intervene to help athletes to cope with pain better.

Who is doing the research?

Claire Thornton is conducting the research as part of a PhD at the University of Derby. You can contact her supervisor at any time if you need further information: Professor David Sheffield, Ph.D., Associate Head of Centre for Psychological Research, Faculty of Education, Health and Sciences, University of Derby, Kedleston Road, Derby, DE22 1GB, Tel: 01332-592038, d.sheffield@derby.ac.uk

Why have I been invited to take part?

You are being invited because you responded to an advertisement asking for participants and you have met the criteria to participate: You are either a high contact athlete (you experience a lot of contact in your sport and your sport has high injury potential) or you are a low contact athlete (you play a sport which involves minimal contact and contact is not permitted within the rules).

Do I have to take part?

No – it is up to you. If you decide to take part, you will be asked to sign a consent form and you will be given a copy of this information sheet and the consent form to keep. You are free to stop taking part at any time without giving a reason.

What will happen to me if I take part?

If you are happy to take part, you will be issued with a pack containing a number of questionnaires. These will address a number of issues surrounding pain experienced in your sport. You will be asked to differentiate between 3 different types of pain: contact related pain (this is pain you would feel as a result of coming into contact with an object or another person during your sport), injury related pain (this is pain you would feel as a result of damage to tissue – e.g. a sprain or strain) and exertion related pain (this is pain you would experience as a result of fatigue or training hard).

You will not have to provide your name, only some basic information about your sport, experience and age. You will also be asked to complete a very short personality questionnaire.

Psychology Research Ethics Committee (PREC)

Faculty of Education, Health and Sciences

What are the possible disadvantages and risks of taking part?

The questionnaires should take a maximum of 15 minutes to complete. Apart from this there are no risks.

What are the possible benefits of taking part?

It is hoped that you will find it interesting taking part in the research and that thinking about your experiences of pain may make you more aware of how you cope/deal with it.

What if there is a problem?

If you have a concern or complaint about any aspect of this study, you should ask to speak to the researcher and she will do her best to answer your questions (please telephone Claire Thornton on (0191) 2004638). If you remain unhappy and wish to complain formally, you can do so through the University of Derby ethics committee chair: Dr Frances Maratos, at f.maratos@derby.ac.uk. You can also contact Student Services at Newcastle College who will be able to refer you to appropriate support should you feel distressed. You can call in to see them at Rye Hill House, Newcastle College or telephone them on (0191) 2004611.

Will my information be kept confidential?

Your information will be treated with the strictest confidence by the research team and we will stress the importance of confidentiality before beginning data collection. All information will be stored securely then it will be destroyed. Data and personal information will only be held as long as necessary to write up and publish the study (up to 1 year). No personal reference to you will be made once the research is written up as you will not have to provide your name.

What will happen if I don't want to carry on with the study?

You are free to stop taking part at any time, without giving a reason and without prejudice.

What will happen to the results of the research study?

The results of the study will be written up for publication in an academic journal. Results will also be included as part of my PhD thesis. You will not be identified in any report or publication and any quotes will be anonymous. I will send all participants a copy of the results, if you would prefer not to receive this please let the facilitator know.

Who has reviewed the study?

This research has been approved by the Research Ethics Committee at the University of Derby. This means that it has been agreed by an independent panel that this research does not breach your safety, rights or well being.

Further information and contact details

If you would like any further information please contact Claire Thornton on (0191) 2004638 or Claire.thornton@ncl-coll.ac.uk. Or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk

If you decide to participate you will be given a copy of this information sheet and a signed consent form to keep.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Pain and Athletes

University of Derby

Statement of Informed Consent

Please tick each box
to indicate you have
read the statement:

I understand that I have agreed to
participate in this study exploring experience of pain in sports settings

I have received a copy of the project information sheet and have been given an
opportunity to ask questions about my participation in the study.

I understand that my participation in the study is entirely voluntary, and that if I wish
to withdraw from the study at any time I may do so at any point, and that I do not have
to give any reasons or explanations for doing so. I understand that if I wish to withdraw
after participating that I should inform the researcher within 4 weeks and that my information
will not be used.

I understand that the data I provide will not be linked to me in any way.

I have read and understood this information and consent to take part in the study.

Signed (Participant)

Date.....

Unique participant Code: _____ (to be completed by the researcher)

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

DEBRIEF SHEET

Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to explore experiences of pain in sports settings and to examine coping strategies which are employed to deal with pain. It is hoped that this research will provide an insight into how different athletes view and deal with different types of pain.

If any aspect of the process has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will only be held as long as necessary to write up and publish the study (up to 1 year).

If you think of any further information that you think would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Participant Information

Participant number:

Gender: M/F

Age:

Main sport/activity:

How often?:

At what level?:

For how many years?:

At what point in the season are you right now (i.e. start of season, mid-season, end of season etc.?):

Number of major injuries you have had as a result of your sport (sprains, fractures etc. which resulted in you being out of action for over 2 weeks+):

Number of minor injuries you have had as a result of your sport (bruises, scrapes, minor strains):

Have you ever experienced **contact related pain** as part of your sport? (i.e. pain as a result of coming into contact with objects or other people):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you physically? (i.e. how much does pain interfere with any aspect of your physical performance?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

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Have you ever experienced **injury pain** as part of your sport? (i.e. pain as a result of tissue damage, for example a sprain):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

Have you ever experienced **exertion related pain** as part of your sport? (i.e. pain as a result of fatigue or hard training):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

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Sports Inventory for Pain

Below is a list of statements that describe the way athletes often feel about discomfort and its influence on performance. Please read each statement and circle the letters associated with the response that best describes your feelings at this time. There are no right or wrong answers.

Please use the following response scale:

SA = Strongly Agree

A = Agree

N = Neutral

D = Disagree

SD = Strongly Disagree

| | Strongly Agree | | | | Strongly Disagree |
|--|----------------|---|---|---|-------------------|
| 1. I see pain as a challenge and I don't let it bother me. | SA | A | N | D | SD |
| 2. I owe it to myself and those around me to perform even when my pain is bad. | SA | A | N | D | SD |
| 3. When in pain, I tell myself it doesn't hurt. | SA | A | N | D | SD |
| 4. When injured, I pray for the pain to stop. | SA | A | N | D | SD |
| 5. If I feel pain during a game, it's probably a sign that I'm doing damage to my body. | SA | A | N | D | SD |
| 6. I have little or no trouble with my muscles twitching. | SA | A | N | D | SD |
| 7. At this point, I am more interested in returning to my sport than trying to stop the pain | SA | A | N | D | SD |
| 8. When in pain, I imagine that the pain is outside my body | SA | A | N | D | SD |
| 9. When injured, I feel that it's never going to get better. | SA | A | N | D | SD |
| 10. When injured, I could perform as well as ever if my pain would go away. | SA | A | N | D | SD |

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| | | | | | |
|--|----|---|---|---|----|
| 11. I do not worry about being injured. | SA | A | N | D | SD |
| 12. Pain is just a part of the game. | SA | A | N | D | SD |
| 13. When hurt, I play mental games with myself to keep my mind off the pain. | SA | A | N | D | SD |
| 14. When hurt, I worry all the time about whether it will end. | SA | A | N | D | SD |
| 15. When in pain, I have to be careful not to make it worse. | SA | A | N | D | SD |
| 16. I seldom or never have dizzy spells or headaches. | SA | A | N | D | SD |
| 17. When I am hurt, I just go on as if nothing happened. | SA | A | N | D | SD |
| 18. When in pain, I mentally replay great past performances. | SA | A | N | D | SD |
| 19. If in pain, I often feel I can't stand it anymore. | SA | A | N | D | SD |
| 20. The worst thing that could happen to me is to injure/reinjure myself. | SA | A | N | D | SD |
| 21. I seldom notice minor injuries. | SA | A | N | D | SD |
| 22. When injured, I tell myself to be tough and carry on. | SA | A | N | D | SD |
| 23. When hurt, I do anything to get my mind off the pain. | SA | A | N | D | SD |
| 24. When hurt, I tell myself I can't let the pain stand in the way of what I want to do. | SA | A | N | D | SD |
| 25. No matter how bad any pain gets, I can handle it. | SA | A | N | D | SD |

Ten-Item Personality Inventory-(TIPI)

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Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

- 1 = Disagree strongly
- 2 = Disagree moderately
- 3 = Disagree a little
- 4 = Neither agree nor disagree
- 5 = Agree a little
- 6 = Agree moderately
- 7 = Agree strongly

I see myself as:

1. _____ Extraverted, enthusiastic.
2. _____ Critical, quarrelsome.
3. _____ Dependable, self-disciplined.
4. _____ Anxious, easily upset.
5. _____ Open to new experiences, complex.
6. _____ Reserved, quiet.
7. _____ Sympathetic, warm.
8. _____ Disorganized, careless.
9. _____ Calm, emotionally stable.
10. _____ Conventional, uncreative.

TIPI scale scoring ("R" denotes reverse-scored items):

Extraversion: 1, 6R; Agreeableness: 2R, 7; Conscientiousness: 3, 8R; Emotional Stability: 4R, 9; Openness to Experiences: 5, 10R.

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Approval Letter: Psychology Research Ethics Committee

University of Derby

Date 16th April 2013

Dear Claire,

Ethics Ref No: 074-13-CT

Thank you for submitting this revised application to the Psychology Research Ethics Committee.

I have now reviewed the revised documents you sent following the feedback you received on your initial application, and I am satisfied that all of the issues raised have been dealt with. The application can now therefore be approved.

If any changes to the study described in the application or supporting documentation is necessary, you must notify the committee and may be required to make a resubmission of the application.

Good luck with the study.

Yours sincerely

Frances Maratos

Dr Frances Maratos
Chair, Psychology Research Ethics Committee, University of Derby

Appendix C – Study 2, bothersomeness scales K-S test

| Bothersomeness Scale | D | p |
|---|------|---------|
| Bothersomeness of contact pain physically | .238 | <0.0001 |
| Bothersomeness of contact pain psychologically | .271 | <0.0001 |
| Bothersomeness of injury pain physically | .172 | <0.0001 |
| Bothersomeness of injury pain psychologically | .176 | <0.0001 |
| Bothersomeness of exertion pain physically | .197 | <0.0001 |
| Bothersomeness of exertion pain psychologically | .211 | <0.0001 |

*df for all scales = 264

Z scores were calculated and the value 2.58 was used to indicate significant skewness or kurtosis, as recommended by Field (2009). Psychological bothersomeness of contact pain was positively skewed for all groups apart from high contact team athletes. Physical bothersomeness of contact pain for high contact individual athletes and psychological bothersomeness of exertion pain for high contact team and individual athletes were also skewed. In addition, psychological bothersomeness for exertion pain in high contact individuals was significantly leptokurtic. Transformations using square root and natural log did not normalise the data.

Appendix D – Study 2, bothersomeness scales z scores skewness

| Scale | Z _{Skewness} Value |
|---|-----------------------------|
| Contact pain physical bothersomeness for high contact individual athletes | 6.6 |
| Contact pain physical bothersomeness for low/medium contact team athletes | 4.2 |
| Contact pain psychological bothersomeness for high contact team athletes | 5.3 |
| Contact pain psychological bothersomeness for high contact individual athletes | 10.7 |
| Contact pain psychological bothersomeness for low/medium contact team athletes | 6.8 |
| Contact pain psychological bothersomeness for low/medium contact team athletes | 9.5 |
| Injury pain physical bothersomeness for high contact team athletes | -3.5 |
| Injury pain physical bothersomeness for high contact individual athletes | 2.6 |
| Injury pain psychological bothersomeness for low/medium contact individual athletes | 4.1 |
| Exertion pain physical bothersomeness for high contact team athletes | 3.6 |
| Exertion pain physical bothersomeness for high contact individual athletes | 3.6 |
| Exertion pain psychological bothersomeness for high contact team athletes | 6.5 |
| Exertion pain psychological bothersomeness for high contact individual athletes | 7.8 |

Appendix E – Study 2, bothersomeness scales z scores kurtosis

| Scale | Z _{kurtosis} Value |
|--|-----------------------------|
| Contact pain physical bothersomeness for low/medium contact individual athletes | -5.1 |
| Contact pain psychological bothersomeness for high contact individual athletes | 9.9 |
| Contact pain psychological bothersomeness for low/medium contact team athletes | 3.1 |
| Contact pain psychological bothersomeness for low/medium contact individual athletes | 3.4 |
| Injury pain physical bothersomeness for high contact team athletes | -3.9 |
| Injury pain physical bothersomeness for high contact individual athletes | -4.1 |
| Injury pain physical bothersomeness for low/medium contact team athletes | 3.6 |
| 1 Injury pain physical bothersomeness for low/medium contact individual athletes | 4.2 |
| Injury pain psychological bothersomeness for high contact team athletes, | 4.3 |
| Injury pain psychological bothersomeness for high contact individual athletes | -6.1 |
| Injury pain psychological bothersomeness for low/medium contact team athletes | -5.1 |
| Exertion pain physical bothersomeness for high contact team athletes | -4.1 |
| Exertion pain physical bothersomeness for low contact team athletes | 4.7 |
| Exertion pain psychological bothersomeness for low/medium contact team athletes | 5.4 |

| | |
|---|------|
| Exertion pain psychological bothersomeness for low/medium contact individual athletes | -4.9 |
|---|------|

Appendix F – Study 2, bothersomeness correlations

All of the bothersomeness scales for physical and psychological bothersomeness were correlated ($p < 0.0001$, $r = 0.56$ for contact pain, $p < 0.0001$, $r = 0.79$ for injury pain and $p < 0.0001$, $r = 0.77$ for exertion pain). The effect sizes for these were medium. Some of the psychological bothersomeness scales were also correlated according to pain type ($p < 0.001$, $r = 0.36$ for exertion and injury pain, $p < 0.001$, $r = 0.56$ for contact and injury pain). Only contact pain and exertion pain were not correlated ($p = 0.7$, $r = 0.11$). The effect sizes for these were small to medium. All pain types were correlated for physical bothersomeness, ($p < 0.001$, $r = 0.23$ for injury and contact pain; $p = 0.01$, $r = 0.15$ for contact and exertion pain; $p < 0.001$, $r = 0.37$ for injury and exertion pain). The effect sizes for these scales were small.

Appendix G – Study 2, SIP15 subscales K-S test

| Injury Pain | | |
|-------------------|-------|---------|
| SIP Subscale* | D | P |
| Direct Coping | 0.104 | <0.0001 |
| Catastrophizing | 0.088 | <0.0001 |
| Somatic Awareness | 0.12 | <0.0001 |
| Contact Pain | | |
| Direct Coping | 0.084 | <0.0001 |
| Catastrophizing | 0.13 | <0.0001 |
| Somatic Awareness | 0.097 | <0.0001 |
| Exertion Pain | | |
| Direct Coping | 0.117 | <0.0001 |
| Catastrophizing | 0.094 | <0.0001 |
| Somatic Awareness | 0.11 | <0.0001 |

*df for all scales = 264

Appendix H – Study 2, TIPI subscales K-S test

| Personality subscale* | D | P |
|-------------------------|-------|---------|
| Extraversion | 0.127 | <0.0001 |
| Agreeableness | 0.115 | <0.0001 |
| Conscientiousness | 0.174 | <0.0001 |
| Emotional stability | 0.169 | <0.0001 |
| Openness to experiences | 0.120 | <0.0001 |

*df for all scales = 264

Appendix I – Study 2, TIPI subscales z scores skewness and kurtosis

| Scale | Z _{kurtosis} Value |
|---|-----------------------------|
| Extraversion for low/medium contact individual athletes | -3.7 |
| Conscientiousness for high contact individual athletes | -4.6 |
| Conscientiousness for low/medium contact individuals | -2.8 |
| Emotional stability for low/medium contact team athletes | -3.19 |
| Openness to experience for low/medium contact team athletes | -4.05 |
| Agreeableness for high contact team athletes | 2.9 |

Z scores were calculated and the following scales were found to be skewed: Extraversion for low/medium contact athletes was positively skewed, as was agreeableness for high contact athletes, conscientiousness for low/medium contact athletes, emotional stability for high contact athletes and low/medium contact athletes and openness to experience for low/medium contact based athletes. In addition, conscientiousness for high contact athletes was negatively skewed.

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Appendix J: Ethical Approval Documents for Study 3

Request For Ethical Approval For Individual Study / Programme Of Research

This form is for University members of staff and PhD students making applications to the Psychology Research Ethics Committee (PREC). Complete this form and submit it by email to the Chair *and* Deputy Chair of PREC. Information about submission and approval processes, deadlines, and meeting dates is given at <http://www.derby.ac.uk/science/psychology/psychology-ethics-committee>

Once approval has been given, you will be eligible to commence data collection.

| | | |
|---|-----------------|---|
| 1. Name: | Claire Thornton | 2. School/ Research centre (if internal applicant) |
| | | School of Science, Faculty of Education Health and Sciences |
| 3. Contact Info | | |
| | | |
| 4. Position: | PhD Student | |
| 5. Name of supervisor (Director of Studies) if you are PhD student: Professor David Sheffield | | |
| 6. Title or topic area of proposed study: | | |
| A longitudinal study examining pain tolerance as a predictor of performance and commitment in high contact sports. | | |
| 7. What are the aims and objectives of your study? | | |
| <p>Aim: To investigate how pain tolerance influences and predicts pain appraisal, pain coping, participation, adherence and commitment to high contact sports over a rugby season.</p> <p>Objectives:</p> <ul style="list-style-type: none"> • To examine pain coping strategies and tolerance in rugby players over a season • To measure adherence, enjoyment, participation rates and commitment to rugby • Analyse the data collected to make comparisons between time points • Interview athletes who drop out of the sport • To relate findings to current literature and highlight possible interventions to help athletes deal with pain and to remain in sport | | |
| 8. Brief review of relevant literature and rationale for study | | |
| <p>Pain is an integral part of sports participation and ultimately can set a limit on what athletes are able to achieve (Epstein, 2011). Athletes regularly experience pain through injury, contact with external objects and exertion. The ability to maintain performance in painful conditions is crucial to continued participation in most sports and ultimately could be the deciding factor in whether an athlete is successful or not (Egan, 1987). Understanding how pain affects athletes is critical for all stakeholders in sport and is key to the development of pain coping strategies (Kress & Statler, 2007). An athlete with an understanding of pain and coping strategies could potentially perform better and adhere to sport longer than an uneducated athlete (Scott & Gijssbers, 1981; Egan, 1987). Research has demonstrated that high contact sports participants tolerate more pain than low or non-contact athletes (e.g. Ryan & Kovacic, 1966). The mechanisms behind this are unclear and therefore further investigation is needed. Within the literature three possible mechanisms have been highlighted: Learning, attrition or individual differences.</p> <p>A qualitative study which explored the responses to pain in high and low contact athletes has already been completed as part of this thesis. It was highlighted that high contact athletes may appraise and cope with pain differently to low</p> | | |

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contact athletes. In particular high contact athletes used coping strategies differently to low contact athletes. This gives some support to the mechanism of learning. In addition a field based study has just been started which uses questionnaires to examine differences in pain coping and view of pain in high and low contact athletes. This study aims to address coping and learning mechanisms but will also examine individual differences (the participants were given a personality questionnaire). This study aims to continue exploring learning and individual differences, but also aim to address the issue of attrition.

It is proposed that this study would begin at the start of a season in a high contact sport (namely, rugby) and examine how responses to pain are moderated during the season. Focusing on rugby alone will hopefully address the issue of attrition (i.e. do people drop out of high contact sports as a result of having low tolerance to pain). It is anticipated that the study will use athletes who are “new” to contact sports and will therefore provide a basis for discussing reasons for drop outs of high contact sports and will also provide the opportunity to examine reasons for why those who stay in the sport choose to do so. This type of study has not been attempted before in the literature to date and therefore acts as a pilot study to a potentially larger future study. It is acknowledged that the sample size used within this study may be small, bringing limitations, however it will hopefully highlight future research directions.

9. Outline of study design and methods

Design: Mixed, longitudinal design, taking measurements at 3 key points: the start of the season, the mid point of the season, the end of the season. Measurements taken will be in the form of pain tasks, questionnaires and at the end of the season, interviews (the interviews will be addressed in a separate ethics application).

Procedure: Athletes who are new to contact sports will be invited to take part (it is anticipated that this will be a female rugby team at a university). There are 2 pain tasks, the order of these will be randomised and athletes will use their dominant hand for the cold pressor and non-dominant hand for ischemia:

Cold Pressor

Pain will be induced in a lab setting using a cold pressor on the hand and wrist; a tank containing iced water will be used, with the water circulated using a fish tank pump. Athletes will be asked to place their dominant hand in the water and keep it there for as long as they can, with a ceiling time of 5 minutes. Participants will be asked to rate pain on a visual analog scale (VAS) at 1 minute intervals until the ceiling time is reached or when they withdraw.

Ischemia

Pain will be induced in a lab setting using a sphygmomanometer and a handgrip dynamometer, following the submaximal effort tourniquet protocol outlined by Manning and Fillingim (2002). Participants will raise their non-dominant arm above their heads for 30 seconds, after which a blood pressure cuff will be placed round the upper arm and inflated to 230mm Hg. Participants will then lower their arm to horizontal position and perform 20 handgrip dynamometer exercises at 50% of their maximum grip strength (max grip strength will be determined by taking 3 baseline readings and using the mean value). Participants will be asked to hold the grip for 5 seconds before releasing the dynamometer grip handle – this counts as 1 exercise. VAS ratings will be taken before and after the handgrip exercises are performed. The arm will remain in the horizontal position and time will be recorded until the participant can withstand the pain no more. VAS will be used at 1-minute intervals.

Cold pressor and ischemia have been chosen as pain tasks because of all of the possible pain tasks available, these are the most relevant to sport Addison, Kremer and Bell (1998). Ischemic pain for example is often felt as a result of exertion and cold pain is sometimes felt during injury treatment, through the use of ice packs etc. It is acknowledged that these tasks do not accurately mirror pain felt in sport and that as a result ecological validity is compromised, but there are no other methods of inducing sport related pain in the lab in an ethical manner.

The pain tasks will be repeated at the mid point of the season and again at the end.

In addition, attendance at training and matches will be monitored via examining team sheets and attendance records (with the permission of participants and the coaching staff).

Throughout the season any athlete who disengages from the sport all together will be contacted to complete a brief questionnaire about why they dropped out. Athletes will be given three different adapted copies of SIP15 to complete. The questionnaire has been adapted to focus on contact pain, injury pain and exertion pain. Athletes will be asked to complete the 3 questionnaires at the mid point and the end of the season.

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| |
|---|
| <p>A brief bothersomeness questionnaire and an enjoyment scale will also be completed (only mid season and end of season).</p> <p>At the end of the season athletes will be divided into 3 groups: “committed” (regular players, attend all matches and training), “not committed” (irregular attenders at matches at training) and “disengaged” (dropped out all together). 3 athletes will be randomly selected from each group and they will be interviewed about their feelings towards pain and high contact sport. Ethical approval for these interviews will be sought at a later date.</p> <p>Timescale: August 2013: Prepare materials September 2013: Recruit participants and begin data collection: Pain tasks, demographic information December 2013/Jan 2014: Data collection (mid-point): Pain tasks, questionnaire pack May 2014: Data collection (end-point): Pain tasks, questionnaire pack, interviews June-Sept 2014: Data analysis and write up</p> |
| <p>10. Sample: Please provide a detailed description of the study sample, covering selection, number, age, and if appropriate, inclusion and exclusion criteria.</p> <p>It is anticipated that around 20-30 athletes will take part in this study. Participants will be new to contact sports – meaning that they have not engaged in sports involving contact at a competitive level before. It is anticipated that the participants will be part of a female rugby team at a university – the participants in general have never played rugby or contact sports before and are trying it out as part of their first year at university.</p> <p>Inclusion criteria: All participants must be new to contact sports (e.g. rugby, martial arts, ice hockey).</p> <p>Exclusion criteria: Participants who have injuries to the hand or arm, circulatory problems, heart conditions, high blood pressure or Reynaud’s disease will not be allowed to take part.</p> |
| <p>11. Are payments or rewards/incentives going to be made to the participants? If so, please give details below.</p> <p>It is proposed that as this is a longitudinal study and requires participation at multiple points that those who complete the whole study will be given a £10 voucher for Love2Shop</p> <p>Do you intend to give <i>Participation Points</i> for taking part in your study? No (Delete as appropriate)</p> |
| <p>12. What resources will you require? (e.g. questionnaires, equipment, for example video camera, specialised software; if questionnaires are to be used please give full details here).</p> <p>SIP 15 x 3 – related to contact pain, exertion pain and injury pain – already available Bothersomeness questionnaire – already designed and available Sphygmomanometer – available in section/department Hand grip dynamometer – available in section/department VAS – already available Cold pressor – already available in section/department and used before in previous study Enjoyment rating scale – already designed and available Disengagement questionnaire – already designed and available</p> |

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13. References Give the references for any sources cited in the sections on rationale, methods etc.

Addison T., Kremer J. & Bell R. (1998). Understanding the psychology of pain in sport. *Irish Journal of Psychology*, 19, 486-503

Epstein D. (2011). The truth about pain : It's in your head. *Sports Illustrated*, 115, 58-66

Egan S. (1987). Acute-pain tolerance among athletes. *Canadian Journal of Sports Sciences*, 12, 175-178

Kress J.L. & Statler T. (2007). A naturalistic investigation of former Olympic cyclists' cognitive strategies for coping with exertion pain during performance. *Journal of Sport Behavior*, 30, 428-452

Manning E.L. & Fillingim R.B. (2002). The influence of athletic status and gender on experimental pain responses. *The Journal of Pain*, 3, 421-428 doi:10.1054/jpai.2002.128068

Ryan E.D. & Kovacic C.R. (1966). Pain tolerance and athletic participation. *Perceptual and Motor Skills*, 22, 383-390

Scott V. & Gijbbers K. (1981). Pain perception in competitive swimmers. *British Medical Journal*, 283, 91-93

14. Ethical Considerations Please indicate how you intend to address each of the following in your study. Points a-i relate particularly to projects involving human participants. Guidance to completing this section of the form is provided at the end of the document.

y. Consent All potential participants will be provided with a participant information sheet which outlines the purposes of the study. They will also be informed via this sheet that: They are free to withdraw at any time without prejudice, that data will be kept securely and confidentially and that they will remain anonymous when the research is written up. The scope of the study will also be outlined and consent to publish findings will also be sought. All participants will be over the age of 18 so no parental consent is required.

z. Deception There is no deception in this study

aa. Debriefing All participants will be fully debriefed at the end of each data collection point. All participants will be provided with a debrief sheet outlining their right to withdraw, the purpose of the study and how data will be treated. In addition contact details of the research team will be provided, should the participant wish to add further information or withdraw from the study. Students will be referred to student services at Newcastle College if they feel distressed as a result of participating in the research.

bb. Withdrawal from the investigation All participants will be informed via the information sheet and the debrief sheet, of their right to withdraw at any time without prejudice. A time limit of 4 weeks will be set for withdrawal post questionnaire/pain task completion. Any data generated from a withdrawn participant will be destroyed. ID numbers will be given to participants.

cc. Confidentiality Confidentiality will be assured for the study via the participant information sheet. Participants will not need to include their name on the questionnaires, and their demographic information will only include

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basic information such as age, time spent in their sport, gender, number of injuries etc, The participants will not be asked to disclose their name. ID numbers will be used instead.

dd. Protection of participants During questionnaire completion participants may feel distressed when recalling painful sporting experiences or injuries/experiences. Participants will be informed of this via the information sheet and will be reminded of their right to withdraw or pause/stop the questionnaire completion at any time. Students will be referred to student services at Newcastle College (0191) 2004611 if they feel distressed as a result of participating in the research. During pain induction tasks participants will feel discomfort and pain. They will be fully briefed (via participant information sheet) about this and they will be informed that the pain has no long term harmful effects. The cold pressor task is risk assessed (attached) and all electrical leads (for pump) will be taped to the floor (see risk assessment)

ee. Observation research [complete if applicable] N/A

ff. Giving advice No advice will be given to participants

gg. Research undertaken in public places [complete if applicable] N/A

hh. Data protection This research will comply with the Data Protection Act and the University of Derby's Good Scientific Practice. All information pertaining to participants will be stored securely. Consent forms and other paper based records will be stored separately in different locked cupboards at Newcastle College. Participants will be informed via the information sheet that data will be destroyed if they withdraw from the study.

ii. Animal Rights [complete if applicable] N/A

jj. Environmental protection [complete if applicable] N/A

15. Have/do you intend to request clearance from any other body/organisation ? ~~Yes~~/No (please circle as appropriate)

If Yes – please give details below.

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16. Declaration: The information supplied is accurate to the best of my knowledge and belief. I understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Ethical Policy for conducting research with human participants.

Place a ✓ in the box above to confirm your agreement with the declaration

Date of application: 27/06/13

Psychology Research Ethics Committee (PREC)**Faculty of Education, Health and Sciences**

Appendices to the ethics application

Attach on further pages below, but *all in one document*, the text of materials that will be used for the project. These should include all the information that participants receive, in the order that they receive it, from the invitation to participate through to the debriefing.

Please place a ✓ in the boxes below to indicate the material that has been included or explain why it is not available.

Invitation to participate [✓]

Consent forms for participants [✓]

Instructions to participants once they have agreed to participate [✓]

Questionnaires [✓]

Interview schedules []

Test materials []

Debriefing information [✓]

Advice on completing the ethical considerations aspects of a programme of research**Consent**

Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

Covert or Deceptive Research

Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

Debriefing

How will participants be debriefed (written or oral)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

Withdrawal from investigation

Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

Protection of participants

Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

Observational research

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If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

Giving advice

Staff should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

Research in public places

You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

Confidentiality/Data Protection

You must comply with the Data Protection Act and the University's Good Scientific Practice <http://www.derby.ac.uk/research/policy-and-strategy> This means:

- It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
- You must not do anything with the personal information you collect over and above that for which you have consent.
- You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
- Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
- You must store data securely. Consent forms and data should be stored separately and securely.
- You should only collect data that is relevant to the study being undertaken.
- Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
 - The data is not being used to take decisions in respect of any living individual.
 - The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
- You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
- All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

Animal rights.

Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

Environmental protection

The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.

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Pain and Athletes

I would like to invite you to take part in a research study. Before you decide whether you would like to take part, it is important to understand why the research is being done and what it would involve for you. Please take some time to read the following information carefully and speak to the researcher if you have any questions or concerns. If there is anything that is not clear or you would like further information please speak to the researcher.

Why is this research being done?

We have a limited understanding of how pain affects athletes who are starting to play high contact sports. I would like to investigate how responses to pain are developed.

Who is doing the research?

Claire Thornton is conducting the research as part of a PhD at the University of Derby. You can contact her supervisor at any time if you need further information: Professor David Sheffield, Ph.D., Associate Head of Centre for Psychological Research, Faculty of Education, Health and Sciences, University of Derby, Kedleston Road, Derby, DE22 1GB, Tel: 01332-592038, d.sheffield@derby.ac.uk

Why have I been invited to take part?

You are being invited because you are beginning to play a high contact sport and you have not previously played contact sports before.

Do I have to take part?

No – it is up to you. If you decide to take part, you will be asked to sign a consent form and you will be given a copy of this information sheet and the consent form to keep. You are free to stop taking part at any time without giving a reason.

What will happen to me if I take part?

If you are happy to take part, you will be asked to attend 3 data collection sessions. These will involve you filling in some questionnaires and undergoing 2 pain induction tasks. The pain induction tasks involve you placing your hand and wrist into cold water which is circulated with a pump (this is called a cold pressor). There is no long term risk from such a task, and the apparatus is used frequently in pain research. If you feel uncomfortable you are free to withdraw at any time and you can ask the researcher any questions you feel you need to. You will be seated during the task and you will be asked to remove any jewellery. You will then submerge your hand into the cold water and keep it there for as long as you can. You are able to remove your hand at any time. The second task involves using a blood pressure cuff to induce muscle soreness (usually in the form of a dull ache). You will raise your hand above your head for 30 seconds and then lower it and a blood pressure cuff will be inflated around your arm. You will then perform 20 hand grip exercises which will result in you experiencing pain in your arm. You will be asked to tolerate the pain for as long as you can and you will be asked how you feel throughout. You are free to stop the task at any time you wish.

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You will have to provide some brief demographic information such as your age and how long you have been playing sports as well as some information about how pain affects you in sport. You will also be given some brief questionnaires to complete. These measure your responses to pain, enjoyment and how much pain bothers you. These will be given out at 3 time points – at the start of the season, the middle of the season and at the end of the season. If you take part in the research at all time points you will receive a £10 voucher for Love2Shop. If you decide to drop out of the sport all together you will be asked to complete a brief questionnaire about why you chose to drop out.

What are the possible disadvantages and risks of taking part?

The cold pressor and the ischemia tasks are painful and do involve discomfort, however you are able to stop the tasks at any time you wish. You may experience some redness of the skin and some numbness as a result of the cold pressor but there are no long term dangers of this and this is a safe way to induce pain. Ischemic pain should dissipate once the blood pressure cuff is deflated. There are no long term dangers of performing this task. You can be reassured that a full risk assessment has been carried out and that your safety is the first priority. You can withdraw from the study at any time without explanation or stop the tasks at any time. In addition to the pain tasks, you will need to give up some of your time to complete questionnaires at multiple time-points. This should not take long and the disruption to your training will be minimised.

What are the possible benefits of taking part?

It is hoped that you will find it interesting taking part in the research and that thinking about your experiences of pain may make you more aware of how you cope/deal with it.

What if there is a problem?

If you have a concern or complaint about any aspect of this study, you should ask to speak to the researcher and she will do her best to answer your questions (please telephone Claire Thornton on (0191) 2004638). If you remain unhappy and wish to complain formally, you can do so through the University of Derby ethics committee chair: Dr Frances Maratos, at f.maratos@derby.ac.uk. You can also contact Student Services at Newcastle College who will be able to refer you to appropriate support should you feel distressed. You can call in to see them at Rye Hill House, Newcastle College or telephone them on (0191) 2004611.

Will my information be kept confidential?

Your information will be treated with the strictest confidence by the research team and we will stress the importance of confidentiality before beginning data collection. All information will be stored securely then it will be destroyed. Data and personal information will only be held as long as necessary to write up and publish the study (up to 1 year). No personal reference to you will be made once the research is written up and you will be given a unique participant number to identify you, so your name will not be used.

What will happen if I don't want to carry on with the study?

You are free to stop taking part at any time, without giving a reason and without prejudice.

What will happen to the results of the research study?

The results of the study will be written up for publication in an academic journal. Results will also be included as part of my PhD thesis. You will not be identified in any report or publication

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and any quotes will be anonymous. I will send all participants a copy of the results, if you would prefer not to receive this please let the facilitator know.

Who has reviewed the study?

This research has been approved by the Research Ethics Committee at the University of Derby. This means that it has been agreed by an independent panel that this research does not breach your safety, rights or well being.

Further information and contact details

If you would like any further information please contact Claire Thornton on (0191) 2004638 or Claire.thornton@ncl-coll.ac.uk. Or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk

If you decide to participate you will be given a copy of this information sheet and a signed consent form to keep.

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Pain and Athletes

University of Derby

Statement of Informed Consent

Please tick each box
to indicate you have
read the statement:

I understand that I have agreed to
participate in this study exploring experience of pain in sports settings

I have received a copy of the project information sheet and have been given an
opportunity to ask questions about my participation in the study.

I understand that my participation in the study is entirely voluntary, and that if I wish
to withdraw from the study at any time I may do so at any point, and that I do not have
to give any reasons or explanations for doing so. I understand that if I wish to withdraw
after participating that I should inform the researcher within 4 weeks and that my information
will not be used.

I understand that the data I provide will not be linked to me in any way.

I have read and understood this information and consent to take part in the study.

Signed (Participant)

Date.....

Unique participant Code: _____ (to be completed by the researcher)

Participant Information – Data collection point 1

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Participant number and name:

Gender: M/F

Age:

Main sport/activity:

How often?:

At what level?:

For how many years?:

At what point in the season are you right now (i.e. start of season, mid-season, end of season etc.?):

Number of major injuries you have had as a result of your sport (sprains, fractures etc. which resulted in you being out of action for over 2 weeks+):

Number of minor injuries you have had as a result of your sport (bruises, scrapes, minor strains):

Are you looking forward to beginning this new sport?

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much do you think you will enjoy this sport?

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How do you think you will feel about the pain you may experience in this sport?

| | | | | |
|----------------------|------------|------------|---------|-------------------|
| 1 | 2 | 3 | 4 | 5 |
| Dislike it very much | Dislike it | No opinion | Like it | Like it very much |

Any further comments?

SPORTS INVENTORY FOR PAIN

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PLEASE ANSWER THIS QUESTIONNAIRE WITH INJURY PAIN IN MIND

Injury pain relates to pain you would feel if you sustained tissue damage (such as a tear, sprain, strain, fracture etc.)

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my injury pain is bad | | | | | |
| When injured, I feel that it's never going to get better. | | | | | |
| When in injury pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I am injured, I just go on as if nothing happened. | | | | | |
| When injured, I worry all the time about whether it will end. | | | | | |
| When injured, I tell myself to be tough and carry on. | | | | | |
| Pain from my injuries is awful and I feel overwhelmed. | | | | | |
| When injured, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |
| I hardly ever notice my heart pounding and I am seldom short of breath. | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| When injured, I just ignore the pain. | | | | | |
| I can't seem to keep injury pain out of my mind. | | | | | |
| I do not allow injury pain to interfere with my performance. | | | | | |
| I often worry about being injured. | | | | | |
| I very seldom have spells of the blues when thinking about injuries | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH CONTACT PAIN IN MIND

Contact pain relates to pain you would feel if you came into contact with other people or objects.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my contact pain is bad | | | | | |
| When in pain through contact, I feel that it's never going to get better. | | | | | |
| When in contact pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have contact pain, I just go on as if nothing happened. | | | | | |
| When hurting through contact, I worry all the time about whether it will end. | | | | | |
| When I have contact pain, I tell myself to be tough and carry on. | | | | | |
| Pain from contact is awful and I feel overwhelmed. | | | | | |
| When hurting through contact, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath. | | | | | |
| When I experience contact pain, I just ignore it. | | | | | |
| I can't seem to keep contact pain out of my mind. | | | | | |
| I do not allow contact pain to interfere with my performance. | | | | | |
| I often worry about being contacted in sport. | | | | | |
| I very seldom have spells of the blues when thinking about contact pain | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH EXERTION PAIN IN MIND

Exertion pain relates to pain you would feel through training or fatigue.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my exertion pain is bad | | | | | |
| When I experience exertion pain, I feel that it's never going to get better. | | | | | |
| When in exertion pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have exertion pain, I just go on as if nothing happened. | | | | | |
| When having exertion pain I worry all the time about whether it will end. | | | | | |
| When feeling exertion pain, I tell myself to be tough and carry on. | | | | | |
| Pain from exertion is awful and I feel overwhelmed. | | | | | |
| When experiencing exertion pain I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|--|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath | | | | | |
| When fatigued, I just ignore the pain. | | | | | |
| I can't seem to keep exertion pain out of my mind. | | | | | |
| I do not allow exertion pain to interfere with my performance. | | | | | |
| I often worry about being fatigued. | | | | | |
| I very seldom have spells of the blues when thinking about injury pain | | | | | |

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INSTRUCTION SHEET PAIN TASKS **(this is the same for all data collection points)**

Cold Pressor

Please remove all jewellery from your dominant hand and wrist. Please place your hand into the water tank and leave it in there as long as possible. You are able to withdraw your hand at any time.

Ischemia

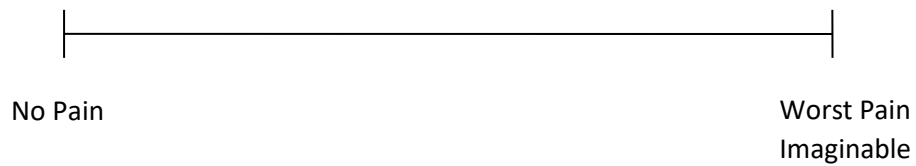
Please raise your hand above your head until you are asked to stop. Once the blood pressure cuff is secure please perform 20 hand-grip repetitions. Remain in the same position for as long as you can. You can stop the test at any time.

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Visual Analog Scale

participant no.

Cold Pressor



Ischemia



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DEBRIEF SHEET – Time point 1
Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to explore experiences of pain in sports settings and to examine how pain responses may change over a season. The demographic questionnaire you have completed will be used to in data analysis. The pain tasks will allow us to establish your pain tolerance levels.

If any aspect of the process has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will only be held as long as necessary to write up and publish the study (up to 5 years).

If you think of any further information that you think would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

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Questionnaire pack – data collection point 2

Participant number and name:

At what point in the season are you right now (i.e. start of season, mid-season, end of season etc.):

Have you ever experienced **contact related pain** as part of your sport? (i.e. pain as a result of coming into contact with objects or other people):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you physically? (i.e. how much does pain interfere with any aspect of your physical performance?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

Have you ever experienced **injury pain** as part of your sport? (i.e. pain as a result of tissue damage, for example a sprain):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

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Have you ever experienced **exertion related pain** as part of your sport? (i.e. pain as a result of fatigue or hard training):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much are you enjoying your sport?

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How do you feel about the pain you have felt in your sport so far?

| | | | | |
|-------------------------|------------|------------|---------|----------------------|
| 1 | 2 | 3 | 4 | 5 |
| Dislike it very much | Dislike it | No opinion | Like it | Like it very much |

Any further comments?

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH INJURY PAIN IN MIND

Injury pain relates to pain you would feel if you sustained tissue damage (such as a tear, sprain, strain, fracture etc.)

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my injury pain is bad | | | | | |
| When injured, I feel that it's never going to get better. | | | | | |
| When in injury pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I am injured, I just go on as if nothing happened. | | | | | |
| When injured, I worry all the time about whether it will end. | | | | | |
| When injured, I tell myself to be tough and carry on. | | | | | |
| Pain from my injuries is awful and I feel overwhelmed. | | | | | |
| When injured, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |
| I hardly ever notice my heart pounding and I am seldom | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| short of breath. | | | | | |
| When injured, I just ignore the pain. | | | | | |
| I can't seem to keep injury pain out of my mind. | | | | | |
| I do not allow injury pain to interfere with my performance. | | | | | |
| I often worry about being injured. | | | | | |
| I very seldom have spells of the blues when thinking about injuries | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH CONTACT PAIN IN MIND

Contact pain relates to pain you would feel if you came into contact with other people or objects.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my contact pain is bad | | | | | |
| When in pain through contact, I feel that it's never going to get better. | | | | | |
| When in contact pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have contact pain, I just go on as if nothing happened. | | | | | |
| When hurting through contact, I worry all the time about whether it will end. | | | | | |
| When I have contact pain, I tell myself to be tough and carry on. | | | | | |
| Pain from contact is awful and I feel overwhelmed. | | | | | |
| When hurting through contact, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath. | | | | | |
| When I experience contact pain, I just ignore it. | | | | | |
| I can't seem to keep contact pain out of my mind. | | | | | |
| I do not allow contact pain to interfere with my performance. | | | | | |
| I often worry about being contacted in sport. | | | | | |
| I very seldom have spells of the blues when thinking about contact pain | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH EXERTION PAIN IN MIND

Exertion pain relates to pain you would feel through training or fatigue.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my exertion pain is bad | | | | | |
| When I experience exertion pain, I feel that it's never going to get better. | | | | | |
| When in exertion pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have exertion pain, I just go on as if nothing happened. | | | | | |
| When having exertion pain I worry all the time about whether it will end. | | | | | |
| When feeling exertion pain, I tell myself to be tough and carry on. | | | | | |
| Pain from exertion is awful and I feel overwhelmed. | | | | | |
| When experiencing exertion pain I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|--|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath | | | | | |
| When fatigued, I just ignore the pain. | | | | | |
| I can't seem to keep exertion pain out of my mind. | | | | | |
| I do not allow exertion pain to interfere with my performance. | | | | | |
| I often worry about being fatigued. | | | | | |
| I very seldom have spells of the blues when thinking about injury pain | | | | | |

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
DEBRIEF SHEET – Time point 2
Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to explore experiences of pain in sports settings and to examine how pain responses may change over a season. The questionnaires you have completed will be used in data analysis and will allow us to analyse your views about the pain you have experienced. The pain tasks will allow us to establish your pain tolerance levels once again.

If any aspect of the process has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will only be held as long as necessary to write up and publish the study (up to 1 year).

If you think of any further information that you think would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
Questionnaire pack – data collection point 3

Participant number and name:

At what point in the season are you right now (i.e. start of season, mid-season, end of season etc.):

Have you ever experienced **contact related pain** as part of your sport? (i.e. pain as a result of coming into contact with objects or other people):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you physically? (i.e. how much does pain interfere with any aspect of your physical performance?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

Have you ever experienced **injury pain** as part of your sport? (i.e. pain as a result of tissue damage, for example a sprain):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

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Have you ever experienced **exertion related pain** as part of your sport? (i.e. pain as a result of fatigue or hard training):

If so how often would you say this occurs (e.g. every time you play, on odd occasions etc.)?

How much does this pain bother you when playing your sport? (i.e. consider if pain interferes with any aspect of your performance).

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much does this pain bother you mentally? (i.e. how much does this pain interfere with any aspect of your psychological state while performing?)

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How much are you enjoying your sport?

| | | | | |
|------------|----------|------------|-----------|-----------|
| 1 | 2 | 3 | 4 | 5 |
| Not at all | Slightly | Moderately | Very Much | Extremely |

How do you feel about the pain you have felt in your sport so far?

| | | | | |
|-------------------------|------------|------------|---------|----------------------|
| 1 | 2 | 3 | 4 | 5 |
| Dislike it very much | Dislike it | No opinion | Like it | Like it very much |

Any further comments?

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Faculty of Education, Health and Sciences
SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH INJURY PAIN IN MIND

Injury pain relates to pain you would feel if you sustained tissue damage (such as a tear, sprain, strain, fracture etc.)

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my injury pain is bad | | | | | |
| When injured, I feel that it's never going to get better. | | | | | |
| When in injury pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I am injured, I just go on as if nothing happened. | | | | | |
| When injured, I worry all the time about whether it will end. | | | | | |
| When injured, I tell myself to be tough and carry on. | | | | | |
| Pain from my injuries is awful and I feel overwhelmed. | | | | | |
| When injured, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |
| I hardly ever notice my heart pounding and I am seldom | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| short of breath. | | | | | |
| When injured, I just ignore the pain. | | | | | |
| I can't seem to keep injury pain out of my mind. | | | | | |
| I do not allow injury pain to interfere with my performance. | | | | | |
| I often worry about being injured. | | | | | |
| I very seldom have spells of the blues when thinking about injuries | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH CONTACT PAIN IN MIND

Contact pain relates to pain you would feel if you came into contact with other people or objects.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my contact pain is bad | | | | | |
| When in pain through contact, I feel that it's never going to get better. | | | | | |
| When in contact pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have contact pain, I just go on as if nothing happened. | | | | | |
| When hurting through contact, I worry all the time about whether it will end. | | | | | |
| When I have contact pain, I tell myself to be tough and carry on. | | | | | |
| Pain from contact is awful and I feel overwhelmed. | | | | | |
| When hurting through contact, I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|---|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath. | | | | | |
| When I experience contact pain, I just ignore it. | | | | | |
| I can't seem to keep contact pain out of my mind. | | | | | |
| I do not allow contact pain to interfere with my performance. | | | | | |
| I often worry about being contacted in sport. | | | | | |
| I very seldom have spells of the blues when thinking about contact pain | | | | | |

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SPORTS INVENTORY FOR PAIN

PLEASE ANSWER THIS QUESTIONNAIRE WITH EXERTION PAIN IN MIND

Exertion pain relates to pain you would feel through training or fatigue.

Below is a list of statements that describe the way an athlete often feels about discomfort and it's influence on performance. Please read each statement, and fill in one circle to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|--|--------------------------|-----------------|----------------|--------------|-----------------------|
| I owe it to myself and those around me to perform even when my exertion pain is bad | | | | | |
| When I experience exertion pain, I feel that it's never going to get better. | | | | | |
| When in exertion pain, I tell myself it doesn't hurt. | | | | | |
| I seldom or never have dizzy spells or headaches. | | | | | |
| When I have exertion pain, I just go on as if nothing happened. | | | | | |
| When having exertion pain I worry all the time about whether it will end. | | | | | |
| When feeling exertion pain, I tell myself to be tough and carry on. | | | | | |
| Pain from exertion is awful and I feel overwhelmed. | | | | | |
| When experiencing exertion pain I tell myself I can't let the pain stand in the way of what I want to do | | | | | |

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| | | | | | |
|--|--|--|--|--|--|
| I hardly ever notice my heart pounding and I am seldom short of breath | | | | | |
| When fatigued, I just ignore the pain. | | | | | |
| I can't seem to keep exertion pain out of my mind. | | | | | |
| I do not allow exertion pain to interfere with my performance. | | | | | |
| I often worry about being fatigued. | | | | | |
| I very seldom have spells of the blues when thinking about injury pain | | | | | |

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
DEBRIEF SHEET – Time point 3
Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to explore experiences of pain in sports settings and to examine how pain responses may change over a season. The questionnaires and pain tasks you have completed will allow us to analyse changes in both your views to pain and your reaction to pain over the season. Your pain tolerance levels will be compared to the start and the end of the season to see if there were any changes. In addition the questionnaires will be used to see if your views of pain and how you cope with it have changed. We chose people new to contact sports to try to establish how reactions to pain may change when it is first experienced. Your participation is much appreciated.

If any aspect of the process has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will only be held as long as necessary to write up and publish the study (up to 1 year).

If you think of any further information that you think would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences
Disengagement Questionnaire

Why did you choose to drop out of the sport? (circle one answer)

- It was too time consuming
- It cost too much
- I didn't feel I was good enough
- I didn't feel I was improving
- I didn't like the contact
- I didn't like the coach
- I didn't like my team mates
- I didn't like the pain I felt

Any further comments?

Please circle any of these answers which apply to you:

I did not enjoy:

- Contact pain
- Injury pain
- Exertion pain
- Feeling sore during participation
- Feeling sore after participation
- The threat of injury
- Unpredictable nature of pain in the sport
- Other (please state)

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Faculty of Education, Health and Sciences

If you did not enjoy the sport, please state why:

Cold Pressor

The equipment consists of a water tank which contains iced water. The water is circulated using a fish tank pump.

A bath of tap water (\approx 25 litres) is cooled down to a given temperature (between 7°C – 3°C) the temperature of the water is then kept constant. The participant fits a non-latex glove onto their hand before submerging it into the water just above wrist level keeping it submerged until the participant wishes to remove it.

The purpose of the cold water is to induce a pain sensation in the participant. The test involves immersion of the body part in cold water and there are no side effects, thus, there is no safer alternative that can induce this type of pain.

The following risk assessment is for the basic use of the aforementioned equipment only, any deviation in its basic use or any use of the aforementioned equipment in conjunction with any other equipment will require an additional risk assessment.

Review Date:

Next Review Date:

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Faculty of Education, Health and Sciences

Cold Pressor

Review Date:
 Next Review Date:

Faculty:
 Location:

Assessment N^o
 Assessed by:

| | Activity/Process/Machines | Hazard | Persons Danger | in | Severity 1-10 | Likelihood 1-10 | Risk Rate | Measures/Comments | Result |
|---|---|--|-------------------|----|------------------|--------------------|-----------|---|--------|
| 1 | Placing hand in water (Multiple users) | Microbiological growth in the water tank | Participants | | 4 | 2 | 8 | <p>All participants will wear vinyl or nitril gloves on the submerged hand.</p> <p>The water tank is emptied, cleaned, and refilled with fresh water after each session.</p> <p>Participants will wash their hands before participating.</p> <p>Participant with cuts or scratches to their hands will not take part.</p> | T |

Key to result **T** = Trivial Risk **A** = Adequately Controlled **N** = Not Adequately Controlled **U** = Unable to decide (further information required)

I have read and understand the above: Signed (Student)..... Date..... Print Name.....
 Signed (Supervisor)..... Date..... Print Name.....

Cold Pressor

 Review Date:
 Next Review Date:

 Faculty:
 Location:

 Assessment N^o
 Assessed by:

| | Activity/Process/Machines | Hazard | Persons in Danger | Severity 1-10 | Likelihood 1-10 | Risk Rate | Measures/Comments | Result |
|---|---|---|---|------------------|--------------------|-----------|--|--------|
| 3 | Placing hand in cold water, keeping hand submerged for a period of time | Numbing of the hand | Participants with Reynaud's disease or poor circulation because of the possibility of more severe but reversible pain reactions | 6 | 2 | 12 | <p>All participants are to be questioned as to whether they have the symptoms of Reynaud's disease.</p> <p>People with heart conditions and poor circulation will not be allowed to take part.</p> <p>Experimenters will be instructed that there is a maximum time limit as to how long a participant is allowed to keep their hand submerged for, these are as follows:</p> <p>3°C = 3.0 minutes 4°C = 3.5 minutes 5°C = 4.0 minutes</p> | A |
| 6 | Placing hand in cold water, keeping hand submerged for a period of time | May make the participant feel faint or sick | Participant | 4 | 2 | 8 | <p>Participants must report that they have had something to eat and drink in the past 4 hours before taking part.</p> <p>Participants will be sitting down for the duration of the experiments.</p> <p>Participants can remove their hand at any time during the experiments.</p> | T |

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Key to result **T** = Trivial Risk **A** = Adequately Controlled **N** = Not Adequately Controlled **U** = Unable to decide (further information required)

I have read and understand the above: Signed (Student)..... Date..... Print Name.....

Signed (Supervisor)..... Date..... Print Name.....

Cold Pressor

Review Date:

Faculty:

Assessment N^o

Next Review Date:

Location:

Assessed by:

| | | | | | | | | |
|---|------------------------------|-----------------------------|--------------|---|---|---|---|---|
| 4 | Removing hand from the water | Slight swelling of the hand | Participants | 4 | 2 | 8 | Bracelets, rings etc will be removed from participants prior to submerging their hand in the water. Participants will be told to keep their jewellery off for a period of one hour after the experiment. | T |
|---|------------------------------|-----------------------------|--------------|---|---|---|---|---|

Other special conditions specified as part of the permission to carry out the work/ procedure and actions needed to minimise risk.

All participants must read, understand and fully complete the appropriate consent form (sign, date, print name or ID code) before participating.

All participants must read, understand and obey the safety guidelines for laboratory work (SAF: 006) before participating.

All accidents or near misses shall be reported to the supervisor or technician and the appropriate forms completed.

Operator will to be trained up to a competent level by an experienced member of staff before being allowed to use the equipment.

Operator must read and obey operations manual.

The participant will be monitored by the operator either in person at all times.

Undergraduates may use the equipment on an individual basis i.e. dissertation work, thus will have individual training and supervision.

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Key to result **T** = Trivial Risk **A** = Adequately Controlled **N** = Not Adequately Controlled **U** = Unable to decide (further information required)

I have read and understand the above: Signed (Student)..... Date..... Print Name.....

Signed (Supervisor)..... Date..... Print Name.....

Psychology Research Ethics Committee (PREC)
Faculty of Education, Health and Sciences

Approval Letter: Psychology Research Ethics Committee

University of Derby

Date: 22nd August 2013

Dr Frances A. Maratos
Chair, Psychology Research Ethics Committee, University of Derby

Dear Claire,

Ethics Ref No: 092-13-CT

Thank you for submitting this revised application to the Psychology Research Ethics Committee.

I have now reviewed the revised documents you sent following the feedback you received on your initial application, and I am satisfied that all of the issues raised have been dealt with. The application can now therefore be approved.

If any changes to the study described in the application or supporting documentation is necessary, you must notify the committee and may be required to make a resubmission of the application.

Good luck with the study.

Yours sincerely

F. A. Maratos

Frances A. Maratos

Appendix K - Study 3, data checks for enjoyment and attendance pain

| Measure | Engagement Type | D | df | P |
|-----------------------------------|-------------------|------|----|---------|
| Enjoyment Mid-point | Participating | 0.26 | 47 | <0.0001 |
| | Non-participating | 0.26 | 55 | <0.0001 |
| Feelings about pain mid-point | Participating | 0.26 | 47 | <0.0001 |
| | Non-participating | 0.22 | 55 | <0.0001 |
| Attendance Mid-point | Participating | 0.17 | 47 | <0.0001 |
| | Non-participating | 0.15 | 55 | <0.0001 |
| Enjoyment End of season | Participating | 0.29 | 47 | 0.001 |
| | Non-participating | 0.25 | 55 | 0.002 |
| Feelings about pain end of season | Participating | 0.24 | 47 | <0.0001 |
| | Non-participating | 0.22 | 55 | <0.0001 |
| Attendance end of season | Participating | 0.14 | 47 | 0.019 |
| | Non-participating | 0.51 | 55 | <0.0001 |

Skewness and kurtosis z score values were calculated using 1.96 as an indicator of significant skewness or kurtosis values. The following were significantly non-normal regarding skewness after calculation: Non-participating athletes enjoyment at the mid-point of the season, $z = -2.0$; Participating athletes attendance mid-point of the season, $z = -2.6$; Participating athletes enjoyment at the end of the season, $z = -2.0$; Participating athletes attendance the end of the season, $z = -2.43$; Non-participating athletes attendance at the end of the season, $z = 9.6$. Levene's test revealed that all scales met the assumption of homogeneity of variance apart from attendance at the end point of the season $F_{(1,100)} = 31.0$, $p = <0.0001$. Hartley's F_{\max} ratio was calculated for this scale, $F_{\max} = 5.0$, meaning that these data cannot be treated as homogenous.

Therefore non-parametric Spearman correlations were conducted alongside the parametric equivalents, these yielded the same results.

Appendix L – Study 3, data checks for cold pressor tolerance

Cold pain tolerance data were checked for normality using the Kolmogorov-Smirnov test. The Non-participating group's pain tolerance was found to be normally distributed at the mid and end season points ($p = 0.2$). All other pain tolerance measures were significantly non-normal ($p = <0.001$). As recommended by Field (2009), skewness and kurtosis values were calculated for each non-normal scale. Z scores were calculated and the value of 1.96 was used to indicate significant skewness and kurtosis. The only scale which remained significantly negatively skewed after this procedure was cold pain tolerance for participating athletes at the end of the season ($z = 2.0$). Transformations using square root and natural log did not normalise the data and created further skewness in other scales.

K-S Test statistics

| Cold Pain Tolerance Measurement | D | Df | P |
|--|-------|----|----------|
| Start of season – participating athletes | 0.19 | 47 | < 0.0001 |
| Start of season – Non-participating athletes | 0.205 | 38 | <0.0001 |
| Middle season – participating athletes | 0.174 | 47 | 0.001 |
| End of season – participating athletes | 0.194 | 47 | <0.0001 |

Non-parametric tests were therefore carried out alongside the parametric equivalents to check that less powerful tests would also yield similar results. Freidman's ANOVAs followed by post-hoc Wilcoxon tests were conducted and found the same results as the parametric equivalent.

Appendix M – Study 3, data checks for ischemic pain tolerance

Ischemic pain tolerance data were checked for normality using the Kolmogorov-Smirnov test. The Non-participating group's pain tolerance was found to be normally distributed at all points during the season ($p = >0.05$). The participating athletes' pain tolerance was significantly non-normal at the start of the season ($D(47) = 0.215$, $p = <0.0001$), at the middle point of the season ($D(47) = 0.18$, $p = 0.001$) and at the end of the season ($D(47) = 0.209$, $p = <0.0001$). As recommended by Field (2009), skewness and kurtosis values were calculated for each non-normal scale. Z scores were calculated and the value of 1.96 was used to indicate significant skewness and kurtosis. The start of the season ischemic pain tolerance was still significantly negatively skewed for participating athletes ($z = -4.38$), it was also significantly leptokurtic ($z = 3.5$). Ischemic pain tolerance was also still negatively skewed at the middle point of the season ($z = -2.97$) and also at the end of the season ($z = -2.7$). Transformations using square root and natural log did not normalise the data and created even greater skewness.

Levene's test revealed that all variances were equal for ischemic pain tolerance at the start of the season ($p = >0.98$). However at the middle point of the season variances were unequal, $F_{(1,83)} = 11.63$, $p = 0.001$. This was also the case at the end of the season, $F_{(1,83)} = 35.69$, $p = <0.0001$. Field (2009) states that Levene's test can be significant with large sample sizes and as such should always be interpreted alongside the variance ratio. As such Hartley's F_{\max} or variance ratio was calculated using 2.4 as the F_{\max} value threshold (Field, 2009). For mid-season pain tolerance the F_{\max} ratio was less than 2.4 and therefore this can be treated as homogenous. However for end of season pain tolerance the F_{\max} ratio was 6.8, meaning that these data cannot be treated as homogenous.

Non-parametric tests were therefore conducted alongside parametric tests to explore differences in ischemic pain tolerance across the season. Results were similar to the parametric equivalents. A Friedman's ANOVA revealed there was no difference in pain tolerance between the three time points regardless of whether the athlete was participating or Non-participating, $X^2(2) = 2.0$, $p = 0.36$. To explore any differences between groups, Mann-Whitney tests were used with a Bonferroni correction applied so all effects are reported at a 0.0167 level of significance. Participating athletes had significantly higher ischemic pain tolerance at the start of the season compared to the Non-participating athletes, $U = 847$, $z = -3.06$, $p = 0.002$, $r = -$

0.29, a small effect size. Participating athletes also had higher ischemic pain tolerance than Non-participating athletes at the middle of the season, $U = 746.5$, $z = -3.71$, $p = <0.0001$, $r = -0.3$, a small effect size. Participating athletes also had higher ischemic pain tolerance at the end of the season, $U = 387.0$, $z = -4.54$, $p = <0.0001$, $r = 0.49$, a medium effect size. These results suggest that there was no significant change in pain tolerance with each athlete group over the season, however the participating athletes had higher pain tolerance than the Non-participating athletes at all three time points in the season.

Appendix N – Study 3, data checks for physical bothersomeness

Non-parametric tests were conducted to examine differences in bothersome scores across the season regardless of athlete type. Results yielded were similar to the parametric equivalents. Wilcoxon tests revealed that only exertion pain bothersomeness was significantly lower at the end of the season compared to the mid-point, $T = 98$, $z = -3.2$, $p = 0.001$, $r = -0.32$. There were no other significant differences between time points.

Differences in physical bothersomeness of pain only within the participating group were also explored using Wilcoxon tests. All three pain types were significantly less bothersome at the end of the season compared to the mid-point for this group. Contact pain was significantly less bothersome at the end of the season compared to the mid-point, $T = 0$, $z = -4.33$, $p = <0.0001$, $r = -0.63$. Injury pain was also significantly less bothersome for this group at the end of the season compared to the mid-point, $T = 14$, $z = -2.5$, $p = 0.013$, $r = -0.36$. The same effect was observed for exertion pain, $T = 38$, $z = -2.91$, $p = 0.004$, $r = -0.42$.

The same tests were conducted only for the Non-participating athletes. Contact pain was significantly more bothersome at the end of the season compared to the mid-point, $T = 18$, $z = -2.06$, $p = 0.039$, $r = -0.33$. Injury pain was also significantly more bothersome at the end of the season compared to the middle point, $T = 17.5$, $z = -2.25$, $p = 0.022$, $r = -0.36$. There were no differences in bothersomeness for exertion pain.

Finally, Mann-Whitney tests were conducted to examine differences between the two groups at each point in the season, for each pain type. Only two differences were found; at the mid-point of the season the participating athletes found exertion pain to be more bothersome than the Non-participating group, $U = 915.5$, $z = -2.7$, $p = 0.006$, $r = 0.26$. In addition at the end of the season the participating athletes found contact pain to be less physically bothersome than the Non-participating group, $U = 500$, $z = -3.6$, $p = <0.0001$, $r = -0.35$.

Parametric tests were also conducted and these yielded the same results as the non-parametric tests. In order to assess differences in physical bothersomeness of each pain type, regardless of whether the participant was participating to the sport or Non-participating, paired samples t-tests were conducted. Results indicated that there was a significant difference between exertion pain bothersomeness at the mid-point of the season compared to the end, $t(84) = 3.95$, $p = 0.001$, $r = 0.34$, a medium effect size. Exertion pain was significantly more bothersome at the mid-point in the season ($M = 1.92$, $SD = 0.86$) compared to the end ($M =$

1.68, SD = 0.71). This suggests that as the season progressed, exertion pain did not bother them as much physically. No other significant differences were found.

Paired samples t-tests were then conducted only for the participating athletes to assess any differences in physical bothersomeness of the three pain types at the mid and end point of the season. Results showed that there were significant differences in pain bothersomeness for all three types of pain, between the mid and end point of the season. Contact pain was found to be more physically bothersome at the mid-point of the season (M = 2.29, SD = 0.99), compared with the end of the season (M = 1.82, SD = 0.89); $t(46) = 5.49$, $p < 0.0001$, $r = 0.6$, a large effect size. Injury pain was also found to be less bothersome at the end of the season (M = 2.51, SD = 0.92) compared with the mid-point (M = 2.7, SD = 0.97); $t(46) = 2.65$, $p = 0.01$, $r = 0.36$, a medium effect size. Exertion pain was found to be significantly less bothersome at the end point of the season (M = 1.8, SD = 0.79) compared with the mid-point (M = 2.14, SD = 0.95); $t(46) = 3.19$, $p = 0.003$, $r = 0.42$, a medium effect size. Taken together these results indicate that all pain types were significantly less physically bothersome by the end of the season for the participating athletes.

Paired samples t-tests were also conducted for the Non-participating athlete group only. Cases were excluded listwise to account for the 17 participants who did not return for final data collection. Results indicated that bothersomeness of exertion pain was not significantly different between the mid and end points of the season ($p = 0.16$). However contact pain was significantly more bothersome at the end of the season (M = 2.57, SD = 0.91) compared to the mid-point (M = 2.31, SD = 0.9); $t(37) = -2.13$, $p = 0.039$, $r = 0.32$, a medium effect size. Injury pain was also significantly more bothersome at the end of the season (M = 2.8, SD = 0.93) compared to the mid-point of the season (M = 2.44, SD = 1.0); $t(37) = -2.48$, $p = 0.017$, $r = 0.37$, a medium effect size. Taken together these results indicate that the Non-participating athletes found contact and injury pain to be more physically bothersome by the end of the season compared to the middle of the season, however there were no differences for bothersomeness of exertion pain.

Independent samples t-tests were also conducted to examine differences between the participating and Non-participating athletes to establish if there were any differences in physical bothersomeness of the three types of pain. Differences were observed between groups for exertion pain at the midpoint of the season, $t(83) = 2.68$, $p = 0.009$, $r = 0.28$, a small effect size, with participating athletes finding it more bothersome (M = 2.14, SD = 0.95) than Non-

participating athletes ($M = 1.65$, $SD = 0.66$). In addition participating athletes found contact pain to significantly less bothersome physically ($M = 1.82$, $SD = 0.89$) at the end of the season compared to Non-participating athletes ($M = 2.57$, $SD = 0.91$); $t(83) = -3.79$, $p = <0.0001$, $r = 0.38$, a medium effect size. These results suggest that by the end of the season the participating group found contact pain less bothersome than the Non-participating group. They also found exertion pain to be more bothersome at the mid-point of the season.

Appendix O – Study 3, data checks for psychological bothersomeness

Psychological bothersomeness scores were tested for normality using the Kolmogorov-Smirnov test and all were found to be significantly non-normal. Z-scores were therefore calculated and the following scales still remained skewed: contact pain bothersomeness at the mid-point of the season ($z = 2.47$) and at the end of the season ($z = 3.17$). As such, non-parametric tests were conducted. To assess differences in psychological bothersomeness of each pain type, regardless of whether the participant was participating to the sport or disengaged, t-tests were conducted alongside non-parametric equivalents. To examine differences in pain bothersomeness across the season, regardless of whether the athlete was participating or engaged, Wilcoxon tests were carried out, yielding similar results to the parametric tests. Exertion pain was significantly less bothersome psychologically at the end of the season compared to the mid-point, $T = 10.5$, $z = -3.64$, $p = < 0.0001$, $r = -0.39$. There were no other significant differences.

Wilcoxon tests were also conducted only for the participating athlete group to examine whether bothersomeness of each pain type changed over the season. Results indicated that psychological bothersomeness of contact pain was significantly lower at the end of the season compared to the mid-point, $T = 20$, $z = -3.44$, $p = 0.001$, $r = 0.51$. In addition exertion pain was significantly less bothersome at the end of the season compared to the mid-point, $T = 7.5$, $z = -3.49$, $p = < 0.0001$, $r = -0.51$. The same tests were repeated for the Non-participating group only. Contact pain was significantly more psychologically bothersome at the end of the season compared to the mid-point, $T = 24$, $z = -2.71$, $p = 0.007$, $r = 0.39$. There were no other significant differences.

Mann-Whitney tests were then conducted to establish if non-participating athletes and participating athletes found any of the pain types significantly more or less bothersome psychologically. Contact pain was found to be significantly more bothersome at the mid-point of the season for the Non-participating group, $U = 976.6$, $z = -2.24$, $p = 0.025$, $r = -0.22$. Exertion pain was less psychologically bothersome for the Non-participating group compared to the participating athletes at the middle of the season, $U = 1008.0$, $z = -2.06$, $p = 0.039$, $r = 0.2$. Contact pain at the end of the season was more psychologically bothersome for the Non-participating group, $U = 78.2.0$, $z = -4.92$, $p = < 0.0001$, $r = -0.48$.

Psychological bothersomeness data were checked for normality and non-parametric tests were conducted. Parametric tests yielded the same results as the non-parametric tests; Paired samples t-tests indicated that exertion pain was significantly more bothersome psychologically at the mid-point of the season ($M = 1.98$, $SD = 0.89$) compared to the end ($M = 1.72$, $SD = 0.71$); $t(84) = 3.97$, $p = <0.0001$, $r = 0.39$, a medium effect size. These results suggest that regardless of whether an athlete participating to the sport or Non-participating from the sport, exertion pain psychological bothersomeness reduced significantly at the end of the season.

Paired samples t-tests were then conducted only for the participating athletes to assess any differences in psychological bothersomeness of the three pain types at the mid and end point of the season. Results indicated that contact and exertion pain were significantly less bothersome at the end of the season compared to the mid-point. Contact pain was significantly lower at the end of the season compared to the mid-point, $t(46) = 3.93$, $p = <0.0001$, $r = 0.5$, a large effect size. Exertion pain was also significantly less bothersome at the end of the season compared to the middle, $t(46) = 4.07$, $p = <0.0001$, $r = 0.51$. There were no differences between time points for injury pain. These results perhaps suggest that as these athletes became fitter, exertion pain became less bothersome. Contact pain also became less bothersome by the end of the season, suggesting a conditioning effect.

Paired samples t-tests were also conducted only for the Non-participating athletes to assess differences in psychological bothersomeness of the three pain types at the mid-point and end of the season. Cases were excluded listwise to account for the 17 participants who did not return for the final testing session at the end of the season. The only significant difference was observed for contact pain, with Non-participating athletes finding this pain more bothersome at the end of the season ($M = 2.76$, $SD = 0.81$) compared to the mid-point ($M = 2.42$, $SD = 0.82$); $t(37) = -2.97$, $p = 0.005$, $r = 0.43$, a medium effect size. This suggests that contact pain became more bothersome towards the end of the season, perhaps a reason for disengagement.

Independent samples t-tests were also conducted to examine differences between the participating and Non-participating athletes to establish if there were any differences in psychological bothersomeness of the three types of pain. Exertion pain was significantly more psychologically bothersome for the participating athletes at the mid-point of the season ($M = 2.17$, $SD = 0.86$) compared to the Non-participating athletes ($M = 1.76$, $SD = 0.67$); $t(83) = 2.36$, $p = 0.02$, $r = 0.25$, a small effect size. These athletes also found exertion pain to be more

physically bothersome at the mid-point in the season. In addition, contact pain was significantly less psychologically bothersome for participating athletes ($M = 1.74$, $SD = 0.89$) compared to Non-participating athletes at the end of the season ($M = 2.76$, $SD = 0.81$); $t(83) = -5.41$, $p < 0.0001$, $r = 0.51$, a large effect size. This also agrees with the contact pain physical bothersomeness findings. At the mid-point of the season contact pain differences were approaching significance, with Non-participating athletes finding this pain more bothersome than the participating athletes; $t(100) = -1.96$, $p = 0.052$, $r = 0.19$.

Appendix P – Study 3, data checks for SIP15

All SIP15 subscales were assessed for normality using the Kolmogorov-Smirnov test and a number of scales were found to be significantly non-normal ($p < 0.0005$). Z scores were therefore calculated and all scales were found to be normal using the z score of 1.96 as the boundary for non-normal distribution (Field, 2009).

K-S test, Non-normal results for SIP15

| SIP Subscale | Pain Type | Athlete type | D | df | p |
|---------------------|-----------|-------------------|------|----|-------|
| Start of Season | | | | | |
| Direct Coping | Exertion | Non-participating | 0.15 | 38 | 0.02 |
| Catastrophizing | Injury | Participating | 0.15 | 47 | 0.009 |
| | Contact | Non-participating | 0.14 | 38 | 0.032 |
| | Exertion | Participating | 0.13 | 47 | 0.049 |
| Somatic Awareness | Injury | Participating | 0.16 | 47 | 0.002 |
| | | Non-participating | 0.18 | 38 | 0.002 |
| | Contact | Participating | 0.12 | 47 | 0.049 |
| | | Non-participating | 0.15 | 38 | 0.027 |
| | Exertion | Participating | 0.14 | 47 | 0.02 |
| | | Non-participating | 0.14 | 38 | 0.047 |
| Mid-Point of Season | | | | | |
| Direct Coping | Injury | Participating | 0.14 | 47 | 0.01 |
| | Contact | Participating | 0.12 | 47 | 0.049 |
| | Exertion | Participating | 0.13 | 47 | 0.045 |
| Catastrophizing | Injury | Participating | 0.15 | 47 | 0.007 |
| | Contact | Non-participating | 0.18 | 38 | 0.002 |
| | Exertion | Participating | 0.13 | 47 | 0.02 |
| Somatic Awareness | Injury | Participating | 0.16 | 47 | 0.002 |
| | | Non-participating | 0.18 | 38 | 0.003 |

| | | | | | | |
|-------------------|----------|-------------------|------|------|----|---------|
| | Exertion | Participating | | 0.15 | 47 | 0.008 |
| | Contact | Participating | | 0.18 | 47 | <0.0001 |
| | | Non-participating | | 0.16 | 38 | 0.01 |
| End of season | | | | | | |
| Direct Coping | Injury | Participating | Non- | 0.15 | 47 | 0.009 |
| | | participating | | 0.15 | 38 | 0.02 |
| | Contact | Participating | Non- | 0.13 | 47 | 0.03 |
| | | participating | | 0.17 | 38 | 0.007 |
| Catastrophizing | Contact | Participating | | 0.14 | 47 | 0.02 |
| | | Non-participating | | 0.20 | 38 | <0.0001 |
| | Exertion | Non-participating | | 0.18 | 38 | 0.002 |
| Somatic Awareness | Injury | Participating | | 0.15 | 47 | 0.006 |
| | | Non-participating | | 0.15 | 38 | 0.16 |
| | Contact | Participating | | 0.17 | 47 | 0.001 |
| | | Non-participating | | 0.16 | 38 | 0.013 |
| | Exertion | Non-participating | | 0.15 | 38 | 0.02 |

Contact:

For the SIP subscale direct coping, Mauchly's test of sphericity was not significant, meaning that sphericity can be assumed. Levene's test revealed that the SIP15 subscale for contact pain at the start of the season violated the assumption of homogeneity of variance, $F_{(1,83)} = 9.21$, $p = 0.003$. Hartley's F_{\max} or variance ratio was calculated using 2.4 as the F_{\max} value threshold (Field, 2009). The F_{\max} ratio was 3.4, meaning that these data cannot be treated as homogenous. The other subscales were homogenous. Therefore non-parametric tests were conducted for this scale and they yielded the same results as the parametric tests

Mauchly's test was significant for the catastrophizing scale, $X^2(2) = 44.34$, $p = <0.0001$, as such Greenhouse-Geisser is reported. Levene's test revealed that catastrophizing scores were non-homogenous at all three points in the season; start of the season, $F_{(1,83)} = 4.38$, $p = 0.039$; middle of the season, $F_{(1,83)} = 4.35$, $p = 0.04$; end of the season, $F_{(1,83)} = 9.98$, $p = 0.002$. Hartley's

F_{\max} was calculated using 2.4 as the threshold for violation. The F_{\max} ratio was 2.2 at the start, 1.94 at the mid-point and 2.86 at the end meaning that the start and mid-point data can be treated as homogenous, but the end season cannot. As such, non-parametric tests were conducted, finding the same results as the parametric equivalent.

For the SIP subscale direct coping, Levene's test revealed that the SIP15 subscale for contact pain at the start of the season violated the assumption of homogeneity of variance, $F_{(1,83)} = 9.21$, $p = 0.003$. There was no significant main effect of direct coping across the three points in the season $F_{(2,166)} = 0.141$, $p = 0.86$. An interaction effect between direct coping and engagement type was approaching significance, $F_{(2,166)} = 2.93$, $p = 0.056$.

Mauchly's test was significant for the catastrophizing scale, $X^2(2) = 44.34$, $p = <0.0001$, as such Greenhouse-Geisser is reported. Levene's test revealed that catastrophizing scores were non-homogenous at all three points in the season; start of the season, $F_{(1,83)} = 4.38$, $p = 0.039$; middle of the season, $F_{(1,83)} = 4.35$, $p = 0.04$; end of the season, $F_{(1,83)} = 9.98$, $p = 0.002$. There was no significant main effect of catastrophizing across the three points in the season, $F_{(1.41,117.1)} = 0.43$, $p = 0.65$, and there was no significant interaction effect $F_{(1.41,117.1)} = 1.34$, $p = 0.26$.

For the somatic awareness subscale Mauchly's test was significant, $X^2(2) = 16.6$, $p = <0.0001$. Greenhouse-Geisser statistics are therefore reported. Levene's test was non-significant so the data may be treated as homogenous. There was no main effect of somatic awareness of contact pain across the three points in the season $F_{(2,166)} = 0.004$, $p = 0.99$, and there was also no interaction effect, $F_{(2,166)} = 0.174$, $p = 0.80$.

Injury:

For the SIP subscale direct coping, Mauchly's test of sphericity was significant ($X^2(2) = 63.7$, $p = < 0.0001$), meaning that sphericity cannot be assumed, therefore the Greenhouse-Geisser statistic is reported in subsequent analysis. Levene's test revealed that the only scale which did not meet homogeneity of variance assumptions was direct coping at the start of the season, $F_{(1.29,107.7)} = 16.4$, $p = <0.0001$. There was no significant main effect of direct coping on injury pain throughout the time points, $F_{(1.29,107.7)} = 0.80$, $p = 0.45$. There was also no interaction effect amongst the participating and Non-participating athletes, $F_{(1.29,107.7)} = 1.85$, $p = 0.17$.

For the Somatic Awareness scale, there was a significant main effect of somatic awareness on injury pain over the three points in the season, $F_{(2,166)} = 10.9$, $p = <0.0001$. This

indicates that regardless of engagement type there was a difference in somatic awareness over the season. Paired samples t-tests, using a Bonferroni adjusted alpha of $p = 0.016$ revealed that there were significant differences between the scores at the start of the season ($M = 8.74$, $SD = 1.15$) and the middle of the season ($M = 9.28$, $SD = 1.37$); $t(84) = -3.8$, $p = <0.0001$, $r = 0.3$, a medium effect size, with scores being significantly higher at the middle of the season compared to the start. Scores were also significantly higher at the end of the season ($M = 9.49$, $SD = 1.41$), compared to the start, $t(84) = 4.2$, $p = <0.0001$, $r = 0.4$, a medium effect size. There was no significant interaction effect however, meaning that there were no differences according to whether the athletes were participating or Non-participating, $F_{(2,166)} = 0.32$, $p = 0.72$.

For the catastrophizing subscale, Mauchly's test of sphericity was significant ($X^2(2) = 99.6$, $p = < 0.0001$), and as such Greenhouse-Geisser is reported in the analysis. There was a significant main effect of catastrophizing on injury pain across the time points, $F_{(1.17,97.4)} = 17.2$, $p = <0.0001$. This indicates that there was a significant difference in catastrophizing scores over time points, regardless of whether the athletes were participating or Non-participating. Paired samples t-tests, using a Bonferroni adjusted alpha of $p = < 0.0167$, revealed that catastrophizing scores were significantly higher at the start of the season ($M = 17.82$, $SD = 2.66$) compared to the mid-point ($M = 16.2$, $SD = 4.52$), $t(101) = 3.52$, $p = 0.001$, $r = 0.32$. In addition, catastrophizing was also significantly higher at the end of the season ($M = 15.51$, $SD = 4.65$) compared to the start, $t(84) = 3.68$, $p = <0.0001$, $r = 0.37$. This indicates that both groups catastrophized more about injury pain as the season progressed.

There was also a significant interaction between engagement type and catastrophizing scores, $F_{(1.17,97.4)} = 63.9$, $p = <0.0001$, $r = 0.31$, indicating that there was a difference in catastrophizing scores according to whether the athlete was participating or Non-participating. Independent samples t-tests, employing a Bonferroni correction were conducted and revealed that the Non-participating athletes catastrophized more than the participating athletes at the mid-point of the season, $t(100) = -9.6$, $p = <0.0001$, $r = 0.69$; and at the end of the season, $t(83) = -9.13$, $p = <0.0001$, $r = 0.7$.

For the SIP subscale direct coping, Mauchly's test of sphericity was significant ($X^2(2) = 63.7$, $p = < 0.0001$), meaning that sphericity cannot be assumed, therefore the Greenhouse-Geisser statistic is reported in subsequent analysis. Levene's test revealed that the only scale which did not meet homogeneity of variance assumptions was direct coping at the start of the

season, $F_{(1.29,107.7)} = 16.4$, $p = <0.0001$. Hartley's F_{\max} was calculated using 2.4 as the threshold for violation. The F_{\max} ratio was 1.3, meaning that these data can be treated as homogenous.

Exertion:

Levene's test revealed that the following scales violated the assumption of homogeneity of variance: catastrophizing at the start of the season, $F_{(1,83)} = 4.7$, $p = 0.03$, and catastrophizing at the mid-point of the season, $F_{(1,83)} = 6.1$, $p = 0.015$. Hartley's F_{\max} ratio was therefore calculated for each scale using 2.4 as the threshold for violation of the assumption of homogeneity. Both scales had an F_{\max} ratio of less than 2.4 (1.7 and 1.9 respectively), meaning that they can be treated as homogenous (Field, 2009).

For the somatic awareness scale Mauchly's test was significant, $X^2(2) = 27.1$, $p = <0.0001$, as such the Greenhouse-Geisser statistic was used. There was no significant main effect of somatic awareness on exertion pain across the three points in the season, $F_{(1.56,129.5)} = 4.03$, $p = 0.21$. There was also no significant interaction effect, $F_{(1.56,129.5)} = 1.14$, $p = 0.31$. These results suggest that somatic awareness did not change over the season.

For the subscale direct coping Mauchly's test of sphericity was non-significant. There was no significant main effect of direct coping on exertion pain over the season, $F_{(2,166)} = 1.06$, $p = 0.34$. There was also no significant interaction effect, indicating that there were no differences in exertion pain direct coping according to whether the person was participating or Non-participating, $F_{(2,166)} = 1.6$, $p = 0.20$.

For the catastrophizing scale Mauchly's test was significant ($X^2(2) = 27.9$, $p = <0.0001$) and therefore the Greenhouse-Geisser statistic is reported. There was no significant main effect of catastrophizing on exertion pain, indicating that regardless of whether the athlete was participating or Non-participating, there were no differences in catastrophizing over the three time points, $F_{(1.55, 128.8)} = 2.54$, $p = 0.096$. There was however an interaction effect which approached significance, $F_{(1.55, 128.8)} = 3.13$, $p = 0.059$, $r = 0.15$, indicating that a difference according to whether the athlete was participating or Non-participating was reaching significance. Independent samples t-tests revealed that there were no difference between the two groups using a Bonferroni correction.

Appendix Q – Ethical approval documents for study 4

Request For Ethical Approval For Individual Study / Programme Of Research

This form is for University members of staff and PhD students making applications to the Psychology Research Ethics Committee (PREC). Complete this form and submit it by email to the Chair *and* Deputy Chair of PREC. Information about submission and approval processes, deadlines, and meeting dates is given at <http://www.derby.ac.uk/science/psychology/psychology-ethics-committee/>

Once approval has been given, you will be eligible to commence data collection.

| | | |
|---|---|---|
| 1. Name: | Claire Thornton | 2. School/ Research centre (if internal applicant) |
| | | Life and Natural Sciences |
| 3. Contact Information | [REDACTED] | |
| 4. Position: | PhD student | |
| If applicable: | | |
| 5a. Name of supervisor (Director of Studies) if you are PhD student: | Professor David Sheffield | |
| 5b. Supervisor (Director of Studies) signature of consent: | | |
| | <i>I have reviewed this application and approve its submission:</i> | |
| 6. Title or topic area of proposed study | | |
| | Performance in pain: manipulating challenge and threat states in experienced and novice athletes | |
| 7. What are the aims and objectives of your study? | | |
| | <p>The aim of this study is to manipulate challenge and threat states in athletes whilst examining performance in pain. Athlete groups will be compared based on the contact level in the sport (high contact versus non-contact) and also their level of experience (new recruits to the sport (<6 months), and experienced athletes (>3 years))</p> <p>The objectives are:</p> <ul style="list-style-type: none"> To measure performance of a motor task during painful and non-painful conditions. To examine the role of challenge and threat states by manipulating instructions given to participants. To test differences between athletes according to their experience level and sport played. | |
| 8. Brief review of relevant literature and rationale for study | | |
| | <p>High contact athletes have a higher pain tolerance than low or non-contact athletes (Ryan & Kovacic, 1966). Researchers have suggested that experience of pain may moderate responses to it (Manning & Fillingim, 2002), as such, high contact athletes may cope with pain differently than other athletes who have less experience of pain within sport. Direct coping (a coping style measured by the SIP15, Bourgeois, Meyers & LeUnes, 2009) reflects a tendency for athletes to "tough out" pain and see it as something to be overcome. In study 2 and 3 of my PhD, it was noted that high contact athletes and experienced high contact athletes in particular, demonstrated the use of this coping style more than others. This suggests that this population view pain differently to non-contact athletes and less experienced high contact athletes. Direct coping links to mental toughness and resilience in sports situations because both are associated with a tendency to overcome stressful (or painful) situations. There have been virtually no studies into developing and manipulating mental toughness in athletes. This is because it is difficult to distinguish mental toughness interventions from "normal" psychological skills training and, mental toughness is more of a long-term process, which requires development over time (Bell, Hardy & Beattie 2013). Kaiseler, Polman and Nicholls (2009) however suggested that mental toughness and perception of situations as challenging or threatening are linked and these can be manipulated in experimental settings. It was proposed that individuals high in mental toughness would perceive stressful situations as a challenge rather than a threat. Therefore stressful events would be met with more emotional stability and higher perceptions of control. Challenge and threat states can be manipulated via the provision</p> | |

of instructions about coping resources (e.g. Turner, Jones, Sheffield & Cross 2012), however to date no research has actually explored this in relation to mental toughness and performance whilst in pain.

Challenge and threat states have been manipulated in studies to examine their effects on performance of motor tasks however, (e.g. Moore, Wilson, Vine, Coussens & Freeman, 2013; Turner et al, 2012). Moore et al. manipulated challenge and threat situations by providing instructions to expert golfers that aimed to influence perceived task demands and coping resources. In the challenge condition participants were told to see the task as a challenge and it was emphasized that they were the type of person to be able to meet the demands of the task. In the threat condition participants were informed that the task was difficult and that previous participants had struggled to meet the demands of the task. Using a competitive golf putting task as a performance measure, results showed that the challenge group reported less anxiety and had superior performance compared to the threat group. These findings echo another study by Moore, Vine, Cooke, Ring and Wilson (2012) that used novices rather than experts. Therefore challenge states still enhance performance regardless of experience level.

This study will examine performance whilst in pain according to athlete type and challenge or threat state. This will answer the overarching question: can manipulating challenge and threat resources appraisals influence performance whilst in pain? Other questions will also be answered: Do athletes perform differently when in pain according to whether the situation is seen as a challenge or a threat? Does experience influence performance in challenging and threatening situations? Do high contact athletes perform differently to non-contact athletes in pain? Answering these questions will allow sports psychologists and coaches to potentially use instructions and feedback to induce states where athletes are able to perform better in pain. This would aid athletes who participate in painful activities such as contact sports or athletes who suffer with injury pain before, during or after performance.

9. Outline of study design and methods

Design:

Research will take place in Newcastle College biomechanics lab. Participants will undergo a baseline pressure pain test using an algometer to measure maximum tolerance (Newtons). This will be used to determine 75% of their maximum pain tolerance which will be applied during pain conditions, as recommended by Brewer, Van Raalte and Linder (1990), who defined this as moderate pain, using a gross pressure device.

Participants will then complete a baseline motor task without pain. Following this they will complete a brief perceived effort questionnaire. They will then be divided into two groups and repeat the motor task again whilst in pain; one group will receive challenge instructions before the motor task in pain, and the other will receive threat instructions. There will be three groups of participants: High contact experienced athletes, high contact novice athletes and a group of non-contact athletes. The study will therefore adopt a between subjects 3 (athlete groups) x 2 (no pain vs. pain) x 2 (challenge and threat pain condition performance) design.

Procedure: The motor task will involve the participant being asked to hit 10 targets with a tennis ball. Twenty numbered targets will be placed on a wall in a random order and at different heights. Participants will not be told the sequence of targets to hit before the test takes place. Rather, they will be told which target to aim for, by the researcher, during the test immediately before each target. The sequence for the 10 targets will be completely random (i.e. not sequential), but will actually be the same for each participant to ensure that the task is consistent for all. Only one attempt at each target will be allowed. Success will be measured based on how many targets are successfully hit (and also how long it takes to complete 10 targets – to account for decision making and to ensure there is no trade-off for time vs accuracy). All targets will be placed in the same way on the wall for all participants and will be occluded until the test starts so participants cannot memorise the positions of the targets. Participants will be seated throughout each task at a distance of five metres from the targets.

During the pain condition participants will be allocated to either a challenge or a threat group. Challenge and threat will be manipulated via the instructions that are given before the task commences. The instructions are derived from the wording of questions related to direct coping on the SIP15. During the pain condition participants will complete a visual analog scale (VAS) to indicate the intensity of the pain.

Challenge condition instructions: You will be asked to perform the task whilst you are in pain. You should be able to cope with this, many people do. You **should not let the pain stand in the way of completing the task** and you should be able to **tough it out**. You have the ability to be successful at this task and the pain should **not interfere with your performance**. You can therefore be confident that you will score highly. The protocol is set up in a way to allow you complete the task without any complications. (bold highlight indicates where instructions were taken from the SIP15).

Threat condition instructions: You will be asked to perform the task whilst you are in pain. You may not be able to cope with this, many people do not. **The pain may stand in the way of completing the task** and you may not be able to **withstand it**. You may fail at this task and the pain **may interfere with your performance**. You therefore can't be confident that you will score highly. The protocol is set up in a way which may hinder your performance in the task.

Pain will be induced using a Wagner FPX™ pressure algometer which will induce pain in the non-dominant hand, which will be placed on a table with the elbow flexed at 90 degrees, with the forearm resting flat on the surface with the palm of the hand facing down. The pressure creates a dull pain that intensifies with time, but causes no tissue damage (Hezel, Riemann & McNally, 2012) Pressure algometry is a reliable measure of pain in muscle, joints, tendons, and ligaments (Chesterton, Sim, Wright & Foster, 2007). The procedure involves applying pressure to the site at a constant rate, measured in Newtons, using a 1 cm rubber tip. The algometer is hand held and will be operated by the researcher.

Following testing all participants complete the SIP15 and a brief bothersomeness, cognitive appraisal and effort questionnaire. All will receive a debrief sheet.

Timescale: Participants will attend for testing on one occasion only. They will complete the demographic questionnaire and then undergo testing. Test conditions will be randomised. Participants will be given at least 1 hour rest period between testing conditions.

10. Sample: Please provide a detailed description of the study sample, covering selection, number, age, and if appropriate, inclusion and exclusion criteria.

Selection: Participants will be drawn from university and college teams and clubs and will be invited to participate via social media, notices and word of mouth. The sample will be made up of: 40 experienced contact athletes (athletes taking part in sports such as rugby or American football who have been participating in this sport for over 3 years). 40 novice contact athletes (athletes taking part in sports such as rugby or American football who have been participating in this sport for less than 4 months). 40 non-contact athletes (athletes who take part in team sports where contact is not allowed within the rules, for example netball, tennis, cricket).

Participants will be randomly allocated to a threat or a challenge condition for the pain task.

Age: all participants will be over the age of 18.

Exclusion criteria: Athletes with any injury to the site of the pain stimulus area will not be allowed to participate.

11. Are payments or rewards/incentives going to be made to the participants? If so, please give details below.

No

Do you intend to give *Participation Points* for taking part in your study? **No** (Delete as appropriate)

12. What resources will you require? (e.g. questionnaires, equipment, for example video camera, specialised software; if questionnaires are to be used please give full details here).

Pressure Algometer

Targets for motor task

Demographic questionnaire (age, gender, sport played, years of experience)

Bothersomeness and effort questionnaire (measure of bothersomeness of the pain, physically and mentally, and perceived effort put in during the pain condition and the non-pain condition)

VAS

SPSS for data analysis

13. References Give the references for any sources cited in the sections on rationale, methods etc.

- Bell J.J., Hardy L. & Beattie S. (2013). Enhancing mental toughness and performance under pressure in elite young cricketers: A 2-year longitudinal intervention. *Sport, Exercise and Performance Psychology, 2*(4), 281-297
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- Brewer B.J., Van Raalte J.L. & Linder D.E. (1990). Effects of pain on motor performance. *Journal of Sport and Exercise Psychology, 12*, 353-365
- Chesterton L.S., Sim J., Wright C.C. & Foster N.F. (2007). Interrater reliability of algometry in measuring pressure pain thresholds in healthy humans, using multiple raters. *Clinical Journal of Pain, 23*, 760-766
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- Kaiseler M., Polman R. & Nicholls A. (2009). Mental toughness, stress appraisal, coping and coping effectiveness in sport. *Personality and Individual Differences, 49*, 728-733
- Manning E.L. & Fillingim R.B. (2002). The influence of athletic status and gender on experimental pain responses. *The Journal of Pain, 3*, 421-428 doi:10.1054/jpai.2002.128068
- Moore, L. J., Vine, S. J., Cooke, A., Ring, C., & Wilson, M. R. (2012). Quiet eye training expedites motor learning and aids performance under heightened anxiety: The roles of response programming and external attention. *Psychophysiology, 49*, 1005–1015. doi:10.1111/j.1469-8986.2012.01379.x
- Moore L.J., Wilson M.R., Vine S.J., Coussens A.H. & Freeman P. (2013). Champ or chump?: Challenge and threat states during pressurized competition. *Journal of Sport and Exercise Psychology, 35*, 551-562
- Ryan E.D. & Kovacic C.R. (1966). Pain tolerance and athletic participation. *Perceptual and Motor Skills, 22*, 383-390
- Turner M.J., Jones M.V., Sheffield D. & Cross S.L. (2012). Cardiovascular indices of challenge and threat states predict competitive performance. *International Journal of Psychophysiology, 86*, 48-57

14. Ethical Considerations Please indicate how you intend to address each of the following in your study. Points a-i relate particularly to projects involving human participants. Guidance to completing this section of the form is provided at the end of the document.

kk. Consent All participants will sign a consent form before any testing takes place. All potential participants will be provided with a participant information sheet which outlines the purposes of the study and the potential risks involved. They will also be informed via this sheet that: They are free to withdraw from the actual testing procedure at any time without prejudice, that data will be kept securely and confidentially and that they will remain anonymous when the research is written up. In addition participants can withdraw their consent to participate in the study up to four weeks after data collection has taken place. All participants will be over the age of 18 so no parental consent is required.

ll. Deception Participants will be blind to the hypothesis and aim of the study, and they will be fully debriefed at the end

mm. Debriefing All participants will be fully debriefed at the end of testing. All participants will be provided with a debrief sheet outlining their right to withdraw, the purpose of the study and how data will be treated.

nn. Withdrawal from the investigation All participants will be informed via the information sheet and the debrief sheet, of their right to withdraw at any time without prejudice. A time limit of 4 weeks will be set for withdrawal post testing. Any data generated from a withdrawn participant will be destroyed.

oo. Confidentiality participants will only provide basic demographic information regarding their gender, age, sport played and years of participation. No names will be taken but participants will be provided with a unique number which will be used to identify data collected. All questionnaires and data collected will remain confidential and will only be shared with the research team.

pp. Protection of participants During the pain task participants will feel discomfort, however this is acute and non-dangerous. The pain task may be stopped at any time at the request of the participant. Participants will be informed of this via the information sheet and will be reminded of their right to withdraw or stop the test at any time when instructions for the pain task are provided. Participants will be advised to have eaten and had something to drink at least 2 hours before testing takes place.

qq. Observation research [complete if applicable] N/A

rr. Giving advice No advice is provided to participants within this study

ss. Research undertaken in public places [complete if applicable] N/A

tt. Data protection This research will comply with the Data Protection Act and the University of Derby's Good Scientific Practice. All information pertaining to participants will be stored securely. Consent forms and other paper based records will be stored separately in different locked cupboards at Newcastle College. Participants will be informed via the information sheet that data will be destroyed if they withdraw from the study.

uu. Animal Rights [complete if applicable] N/A

vv. Environmental protection [complete if applicable] N/A

| |
|---|
| <p>15. Have/do you intend to request clearance from any other body/organisation ? No (please circle as appropriate)</p> <p>If Yes – please give details below.</p> |
| <p>16. All projects have an element of risk which should be assessed before any project is undertaken.</p> <p>Have the activities associated with this research project been risk assessed? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p> |

17. Declaration: The information supplied is accurate to the best of my knowledge and belief. I understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Ethical Policy for conducting research with human participants.

Place a √ in the box above to confirm your agreement with the declaration

Date of application: 07/12/15

Appendices to the ethics application

Attach on further pages below, but *all in one document*, the text of materials that will be used for the project. These should include all the information that participants receive, in the order that they receive it, from the invitation to participate through to the debriefing.

Please place a ✓ in the boxes below to indicate the material that has been included or explain why it is not available.

- Invitation to participate [✓]
- Consent forms for participants [✓]
- Instructions to participants once they have agreed to participate [✓]
- Questionnaires [✓]
- Interview schedules [N/A]
- Test materials [✓]
- Debriefing information [✓]

Advice on completing the ethical considerations aspects of a programme of research

Consent

Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

Covert or Deceptive Research

Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

Debriefing

How will participants be debriefed (written or oral)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

Withdrawal from investigation

Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

Protection of participants

Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

Observational research

If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

Giving advice

Staff should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

Research in public places

You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

Confidentiality/Data Protection

You must comply with the Data Protection Act and the University's Good Scientific Practice <http://www.derby.ac.uk/research/uod/promotinggoodscientificpractice/>. This means:

- It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
- You must not do anything with the personal information you collect over and above that for which you have consent.
- You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
- Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
- You must store data securely. Consent forms and data should be stored separately and securely.
- You should only collect data that is relevant to the study being undertaken.
- Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
 - The data is not being used to take decisions in respect of any living individual.
 - The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
- You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
- All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

Animal rights.

Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

Environmental protection

The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.

Appendix – Supplemental information

- 1. Notice/invitation to take part**
- 2. Consent form**
- 3. Demographic questionnaire**
- 4. Effort and Bothersomeness Questionnaire and VAS**
- 5. SIP15**
- 6. Participant information form**
- 7. Debrief sheet**
- 8. Instructions to participants**

1. Notice/invitation to take part

Volunteers Needed! Please Read.

I am recruiting volunteers to take part in a study which examines pain in sport. You will be required to attend one testing session at Newcastle College biomechanics lab and full instructions will be given before you agree to take part.

Please consider taking part if you are:

- An athlete who plays high contact sports (e.g. rugby, American football)
- An athlete who plays non-contact sports (e.g. netball, badminton, cricket)

I am looking for people who are NEW to contact sports and also people who have played for 3 years or more.

If you fit the bill please contact me: Claire.thornton@ncl-coll.ac.uk or 0191 2004638.

Thanks.

2. Consent form

Pain and Athletes

University of Derby

Statement of Informed Consent

Please tick each box to indicate you have read the statement:

I understand that I have agreed to participate in this study exploring pain in athletes

I have received a copy of the project information sheet and have been given an opportunity to ask questions about my participation in the study.

I understand that my participation in the study is entirely voluntary, and that if I wish to withdraw from the study at any time I may do so at any point, and that I do not have to give any reasons or explanations for doing so. I understand that if I wish to withdraw after participating that I should inform the researcher within 4 weeks and that my information will not be used.

I understand that the data I provide will not be linked to me in any way.

I have read and understood this information and consent to take part in the study.

Signed (Participant)

Date.....

Unique participant Number: _____ (to be completed by the researcher)

3. Participant information

Pain and Athletes

I would like to invite you to take part in a research study. Before you decide whether you would like to take part, it is important to understand why the research is being done and what it would involve for you. Please take some time to read the following information carefully and speak to the researcher if you have any questions or concerns. If there is anything that is not clear or you would like further information please speak to the researcher.

Why is this research being done?

We have a limited understanding of how pain affects athletes and how athletes perform whilst in pain. Doing this research will give us an insight into how pain may influence performance, which could help athletes and coaches to put strategies in place to cope with pain.

Who is doing the research?

Claire Thornton is conducting the research as part of a PhD at the University of Derby. You can contact her supervisor at any time if you need further information: Professor David Sheffield, Ph.D., Associate Head of Centre for Psychological Research, Faculty of Education, Health and Sciences, University of Derby, Kedleston Road, Derby, DE22 1GB, Tel: 01332-592038, d.sheffield@derby.ac.uk

Why have I been invited to take part?

You are being invited because you responded to an advertisement asking for participants and you have met the criteria to participate. That is, you are either a high contact athlete (you experience a lot of contact in your sport), a non-contact athlete (you play a sport which involves minimal contact and contact is not permitted within the rules) and if you are a high contact athlete you have either participated for under 6 months or over 3 years.

Do I have to take part?

No – it is up to you. If you decide to take part, you will be asked to sign a consent form and you will be given a copy of this information sheet and the consent form to keep. You are free to stop taking part at any time without giving a reason.

What will happen to me if I take part?

If you are happy to take part, you will be required to attend a testing session at Newcastle College biomechanics lab. You will take a baseline pain test using a pressure algometer which will apply pressure to your non-dominant hand. This will determine your pain tolerance. This will feel uncomfortable but you are able to stop the test at any time. You will then undertake a task which involves hitting targets with a ball. You will do this twice, once not in pain and again whilst experiencing a pressure pain stimulus on your non-dominant hand, as outlined above. You will also be asked to complete some short questionnaires about yourself and your experience. You will not have to provide your name, only some basic information about your sport, experience and age. If you do take part please ensure you have had something to eat and drink at least 2 hours before you attend the testing session.

What are the possible disadvantages and risks of taking part?

The pain stimulus will cause you pain and discomfort. Whilst this will cause you acute (brief and passing) pain, there are no long term dangers from going through this experience and this is the safest way to induce such pain. You can be reassured that your safety is the first priority. You are free to stop the task at any time by informing the researcher, at which point the test will be stopped. You can also withdraw from the study as a whole at any time without explanation.

What are the possible benefits of taking part?

It is hoped that you will find it interesting taking part in the research and that thinking about your experiences of pain may make you more aware of how you cope/deal with it.

What if there is a problem?

If you have a concern or complaint about any aspect of this study, you should ask to speak to the researcher and she will do her best to answer your questions (please telephone Claire Thornton on (0191) 2004638). If you remain unhappy and wish to complain formally, you can do so through the University of Derby ethics committee chair: Dr Frankie Maratos (f.maratos@derby.ac.uk). You can also contact Student Services at Newcastle College who will be able to refer you to appropriate support should you feel distressed. You can call in to see them at Rye Hill House, Newcastle College or telephone them on (0191) 2004611.

Will my information be kept confidential?

Your information will be treated with the strictest confidence by the research team and we will stress the importance of confidentiality before beginning data collection. All information will be stored securely then it will be destroyed. Data and personal information will be stored securely for 6 years and will only be used for the purposes of this study. No personal reference to you will be made once the research is written up as you will not have to provide your name.

What will happen if I don't want to carry on with the study?

You are free to stop taking part at any time, without giving a reason and without prejudice.

What will happen to the results of the research study?

The results of the study will be written up for publication in an academic journal. Results will also be included as part of a PhD thesis. You will not be identified in any report or publication and any quotes will be anonymous. Claire will send all participants a copy of the results, if you would prefer not to receive this please let her know. Your data will be stored securely for 6 years.

Who has reviewed the study?

This research has been approved by the Research Ethics Committee at the University of Derby. This means that it has been agreed by an independent panel that this research will not negatively impact your safety, rights or well-being.

Further information and contact details

If you would like any further information please contact Claire Thornton on (0191) 2004638 or Claire.thornton@ncl-coll.ac.uk. Or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk

If you decide to participate you will be given a copy of this information sheet and a signed consent form to keep.

4. Demographic questionnaire

Thank you for taking part in this study. Please complete the questions below.

Participant Number (researcher to complete):

Gender: Male/Female (please circle)

Age: _____

Sport played: _____

Level (e.g. county, recreational, university): _____

How many years have you played this sport?: _____

5. Effort and Bothersomeness questionnaire and VAS

Please indicate how bothersome the pain was for you physically (i.e. how much did it affect your physical feelings)

| | | | | |
|-----------------------------|---|---|---|-------------------------|
| 1 | 2 | 3 | 4 | 5 |
| Not bothersome at all | | | | Extremely bothersome |

Please indicate how bothersome the pain was for you mentally (i.e. how much did it affect your mental state)

| | | | | |
|-----------------------------|---|---|---|-------------------------|
| 1 | 2 | 3 | 4 | 5 |
| Not bothersome at all | | | | Extremely bothersome |

Please indicate how much effort you put into the task

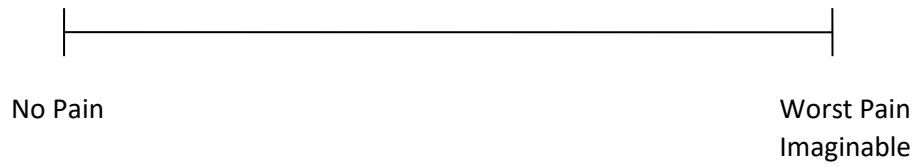
| | | | | |
|------------------|---|---|---|---------------------------|
| 1 | 2 | 3 | 4 | 5 |
| No effort at all | | | | A great deal of effort |

Please consider your thoughts and feelings about test you have just completed, and indicate on the scale below how you felt immediately prior to completing the final test:

| | | | | | | | | |
|------------|----|----|----|---------|----|----|----|------------|
| Threatened | | | | Neither | | | | Challenged |
| -4 | -3 | -2 | -1 | 0 | +1 | +2 | +3 | +4 |

VAS

Please indicate on the line how intense the pain was.



Unique participant Number: _____ (to be completed by the researcher)

SPORTS INVENTORY FOR PAIN

Michael C. Meyers, Ph.D., FACSM, Anthony E. Bourgeois, Ph.D., Arnold LeUnes, Ed.D.

Below is a list of statements that describe the way an athlete often feels about discomfort and its influence on performance. Please read each statement, and fill in one square to the right of each statement that best describes your feelings at this time. There are no right or wrong answers.

| Strongly | Strongly Disagree | Neutral | Agree | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| Disagree | | | | |
| | | | Agr ee | |
| 1. I owe it to myself and those around me to perform even when my pain is bad. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. When injured, I feel that it's never going to get better. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. When in pain, I tell myself it doesn't hurt. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I seldom or never have dizzy spells or headaches. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. When I am hurt, I just go on as if nothing happened. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. When hurt, I worry all the time about whether it will end. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. When injured, I tell myself to be tough and carry on. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Pain from my injuries is awful and I feel overwhelmed. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. When hurt, I tell myself I can't let the pain stand in the way of what I want to do. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. I hardly ever notice my heart pounding and I am seldom short of breath. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. When injured, I just ignore the pain. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. I can't seem to keep pain out of my mind. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

13. I do not allow pain to interfere with my performance.
14. I often worry about being injured.
15. I very seldom have spells of the blues.

Unique participant Number: _____ (to be completed by the researcher)

DEBRIEF SHEET

Pain and Athletes

**Thank you for taking part in this study
your participation is much appreciated.**

The aim of this research study is to measure performance of a task whilst in pain and not in pain, based on instructions given. You will have been provided instructions before the task in pain which either aimed to place you in a challenge situation (where you received positive instructions) or a threat situation (where you received negative instructions). These were given to manipulate the way you approached and perceived the situation. It was felt that challenge instructions would help performance whereas the threat instructions would hinder performance. The study also aims to compare experienced contact athletes to “new” contact athletes and non-contact athletes to see if there are any differences in performance in pain and according to whether there was a threat or challenge condition. Being exposed to the pain stimulus should not have caused you any long term damage or ill-effects, however if you feel unwell or the site of the pain stimulus continues to be sore, please consult your GP.

If any aspect of the process has raised issues for you or has caused any upset please speak to the researcher who will be able to provide some support or facilitate access to appropriate support. You can also contact student services at Newcastle College on (0191) 2004611; they will be able to direct you to support services. If you wish to withdraw from the study you should inform the researcher within 4 weeks of you participating. Your data and information will be held for 6 years.

If you think of any further information that you consider would be useful you are very welcome to contact Claire Thornton directly on 0191 2004638 or Claire.thornton@ncl-coll.ac.uk or Professor David Sheffield on (01332) 592038 or d.sheffield@derby.ac.uk.

Thank you once again for your participation in this research.

8. Instructions to participants

Instructions for motor task

Using the tennis balls provided please attempt to hit the targets the researcher asks you to. You should try to complete this task as quickly as possible but you also should aim to be as accurate as possible too. The researcher will tell you which target you should aim for.

Instructions for pain condition

Using the tennis balls provided please attempt to hit the target the researcher asks you to. You should try to complete this task as quickly as possible but you also should aim to be as accurate as possible too. The researcher will tell you which target you should aim for. Pain will be induced by using a pressure algometer which will apply pressure to your non-dominant hand. You may stop the test at any time and the pain stimulus will be removed.

Challenge condition instructions: You will be asked to perform the task whilst you are in pain. You should be able to cope with this, many people do. You **should not let the pain stand in the way of completing the task** and you should be able to **tough it out**. You have the ability to be successful at this task and the pain should **not interfere with your performance**. You can therefore be confident that you will score highly. The protocol is set up in a way to allow you complete the task without any complications. (bold highlight indicates where instructions were taken from the SIP15).

Threat condition instructions: You will be asked to perform the task whilst you are in pain. You may not be able to cope with this, many people do not. **The pain may stand in the way of completing the task** and you may not be able to **withstand it**. You may fail at this task and the pain **may interfere with your performance**. You therefore can't be confident that you will score highly. The protocol is set up in a way which may hinder your performance in the task.

Approval Letter: Psychology Research Ethics Committee

University of Derby

Date: 20th January, 2016

Dr Christopher Barnes
Deputy Chair, Psychology Research Ethics Committee, University of Derby

Dear Claire,

Ethics Ref No: 14-15-CT

Thank you for submitting this revised application to the Psychology Research Ethics Committee.

I have now reviewed the revised documents you sent following the feedback you received on your initial application, and I am satisfied that all of the issues raised have been dealt with. The application can now therefore be approved and is valid for a period of 5 years from the date of this letter.

The following documents have now been re-reviewed:

1. Ethics application form

If any changes to the study described in the application or supporting documentation is necessary, you must notify the committee and may be required to make a resubmission of the application.

Good luck with the study.

Yours sincerely

Chris Barnes

Christopher Barnes

Appendix R – Study 4, data checks for targets hit

| Pain Condition | Athlete Type | D | p |
|----------------|--------------------------|------|---------|
| No Pain | High contact novice | 0.17 | 0.006 |
| | High contact Experienced | 0.22 | <0.0001 |
| | Non-contact | 0.18 | 0.001 |
| Pain | High contact novice | 0.16 | 0.009 |
| | High contact Experienced | 0.28 | <0.0001 |
| | Non-contact | 0.26 | <0.0001 |

*df = 40

Z scores for skewness and kurtosis were calculated using 1.96 as the threshold as recommended by Field (2009). All z scores were below the 1.96 threshold and therefore the data were treated as normal.

Appendix S – Study 4, data checks for HRV

The following were found to be non-normal; HRV following pain task instructions for non-contact athletes ($p = 0.03$); HRV following no pain task instructions for the non-contact athletes ($p = 0.04$). The no pain task z scores were below the 1.96 threshold and therefore were treated as normal, however $z_{\text{kurtosis}} = 4.06$ for HRV following pain task instructions, meaning this group was non-normal. Transformations using square root and natural log did not normalise the data and therefore original data are used in analysis.

Appendix T – Study 4, data checks for bothersomeness

Z scores were calculated for each group and the following were still considered non-normal; Physical bothersomeness at baseline for high contact experienced athletes $Z_{\text{skewness}} = 2.27$; Psychological bothersomeness at baselines for high contact experienced athletes $Z_{\text{skewness}} = 2.89$; Physical bothersomeness during pain condition for high contact experienced athletes $Z_{\text{kurtosis}} = 2.61$; Psychological bothersomeness during pain condition for high contact experienced athletes $Z_{\text{skewness}} = 2.81$. Both non-contact and high contact novice athletes were normally distributed in all conditions. Transformations using square root and natural log did not normalise the data. As such untransformed data were used in the analysis.

Non parametric tests were therefore carried out as a precaution; these yielded similar results. A Kruskal-Wallis non-parametric test was conducted. This revealed that there were significant differences between the athletes groups for physical bothersomeness at baseline, $H_{(2)} = 48.81$, $p < 0.0001$. There was also a significant difference between groups for psychological bothersomeness at baseline, $H_{(2)} = 35.52$, $p < 0.0001$. There was also a significant difference between groups for physical bothersomeness during the pain task, $H_{(2)} = 74.75$, $p < 0.0001$. There was also a significant difference between groups for psychological bothersomeness during the pain task, $H_{(2)} = 75.00$, $p < 0.0001$.

Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied and therefore all effects are reported at a 0.012 level of significance. High contact experienced athletes found pain to be less bothersome than non-contact athletes at baseline for physical bothersomeness, $U = 180.00$, $p < 0.0001$, $r = -0.69$, baseline for psychological bothersomeness, $U = 266.00$, $p < 0.0001$, $r = 0.60$, physical bothersomeness during the pain condition, $U = 40.00$, $p < 0.0001$, $r = 0.84$ and psychological bothersomeness during the pain condition, $U = 33.00$, $p < 0.0001$, $r = 0.86$.

High contact novices also found pain to be less physically and psychologically bothersome at all four measurements compared to the non-contact athletes; physical bothersomeness at baseline; $U = 260.00$, $p < 0.0001$, $r = 0.61$; psychological bothersomeness at baseline; $U = 388.00$, $p < 0.0001$, $r = 0.46$; Physical bothersomeness during the pain task, $U = 124.00$, $p < 0.0001$, $r = 0.76$; psychological bothersomeness during the pain task, $U = 174.00$, $p < 0.0001$, $r = 0.71$.

High contact experienced athletes found pain to be less bothersome at all four times compared to the high contact novice athletes; physical bothersomeness at baseline, $U = 584.00$, $p = 0.02$, $r = 0.25$; psychological bothersomeness at baseline, $U = 577.00$, $p = 0.009$, $r = 0.29$; physical bothersomeness during the pain task, $U = 528.00$, $p = 0.003$, $r = 0.32$; psychological bothersomeness during the pain task, $U = 427.00$, $p < 0.0001$, $r = 0.44$.

Appendix U – Study 4, data checks for SIP15

All groups had normally distributed scores for Direct Coping ($p > 0.05$). However for catastrophizing, high contact novice athletes and high contact experienced athletes were not normally distributed ($p = 0.01$ and 0.001 respectively). Z score calculations revealed that skewness and kurtosis values for high contact novice athletes were below the 1.96 threshold, however high contact experienced athletes had scores of $z_{\text{skewness}} = 3.87$ and $z_{\text{kurtosis}} = 4.06$. As such these cannot be treated as normal. Transformations of the data using square root and natural log did not normalise these scales, as such original untreated data are used in subsequent analysis. In addition, all of the somatic awareness scores were significantly non-normal according to the Kolmogorov-Smirnov test ($p < 0.05$). Z scores were therefore calculated and all fell below the normality threshold of 1.96 meaning they were treated as normal.

Appendix V – Study 4, non-parametric tests for pain tolerance

Data were checked for normality according to athlete group. Using the Kolmogorov-Smirnov test, high contact novices and high contact experienced athletes were found to be normal ($p = 0.2$). However, the non-contact group were found to be significantly non-normal ($p = 0.02$). As recommended by Field (2009), skewness and kurtosis values were calculated for this group, using a z score of 1.96 as the threshold for normality. Both skewness and kurtosis values were below the 1.96 threshold and therefore the data were treated as normal.

Levene's test was significant ($p = 0.008$), therefore as recommended by Field (2009), Hartley's F_{\max} ratio was calculated using 2.4 as the threshold value. Calculations revealed $F_{\max} = 3.19$, meaning that the groups were non-homogenous. Transformations were conducted using square root and natural log. Square root resulted in Levene's test remaining significant ($p = 0.003$) as did natural log ($p = 0.0001$). As such original data are used for analysis and Games-Howell post hoc tests are used, as recommended by Field (2009).

A Kruskal-Wallis non-parametric test was carried out to examine differences between groups for pain tolerance. Results were similar to parametric tests.

There was a significant effect of athlete type on pain tolerance, $H_{(2)} = 52.12$, $p < 0.001$. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied and therefore all effects are reported at a 0.016 level of significance. High contact experienced athletes had a higher pain tolerance than high contact novice athletes, $U = 138$, $p < 0.0001$, $r = -0.71$. High contact experienced athletes also had a higher pain tolerance than non-contact athletes, $U = 184$, $p < 0.0001$, $r = -0.66$. There was no difference between high contact novice and non-contact athletes.

Appendix W – Study 4, non-parametric tests for VAS

High contact novice athletes and non-contact athlete groups were both normally distributed according to the Kolmogorov-Smirnov test ($p > 0.05$), however the high contact experienced group were significantly non-normal ($p = 0.03$). As such z scores were calculated as recommended by Field (2009). Both skewness and kurtosis values were below the 1.96 threshold, so the data were treated as normal.

Levene's test was significant ($p = 0.005$). Hartley's F_{\max} was therefore calculated, using 2.4 as the threshold value. Calculations revealed that Hartley's $F_{\max} = 2.92$, meaning that the groups were non-homogenous. As such transformations using square root and natural log were conducted, however Levene's test remained significant. Therefore, original data are used for this analysis and Games-Howell post hoc tests are used, as recommended by Field (2009). Appropriate non-parametric tests were also conducted and yielded the same results.

A Kruskal-Wallis non-parametric test was carried out to examine differences between groups for pain intensity. Results were similar to parametric tests.

There was a significant effect of athlete type on pain intensity, $H_{(2)} = 28.71$, $p < 0.001$. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied and therefore all effects are reported at a 0.016 level of significance. High contact experienced athletes found the pain to be significantly less intense than high contact novice athletes, $U = 377.50$, $p < 0.0001$, $r = -0.45$. In addition high contact experienced athletes found the pain to be less intense than non-contact athletes, $U = 291.50$, $p < 0.0001$, $r = -0.54$. There was no difference between high contact novice and non-contact athletes.

Appendix X – Study 4, data checks for effort

| Pain Condition | Athlete Type | D | p |
|----------------|--------------------------|------|---------|
| No Pain | High contact novice | 0.27 | <0.0001 |
| | High contact Experienced | 0.22 | <0.0001 |
| | Non-contact | 0.19 | 0.001 |
| Pain | High contact novice | 0.27 | <0.0001 |
| | High contact Experienced | 0.17 | 0.006 |
| | Non-contact | 0.21 | <0.0001 |

*df = 40

Appendix Y – Study 4, data checks for MANOVA analysis

Levene's test was not significant for targets hit not in pain, but was significant for targets hit whilst in pain ($p = 0.03$). Hartley's F_{\max} was therefore calculated using 2.4 as the threshold value. As Hartley's $F_{\max} = 1.28$, the data can be treated as homogenous. Levene's test was not significant for time to complete task in pain, but was significant for time to complete the task whilst not in pain ($p = 0.03$). Hartley's F_{\max} was therefore calculated using 2.4 as the threshold value. Hartley's F_{\max} for time to complete the task not in pain = 4.03, therefore the data cannot be treated as homogenous. Transformations using natural log resulted in the data becoming homogenous ($p = 0.05$), as such transformed data were used in subsequent analysis.

Levene's test was not significant for HRV for the pain task, $p > 0.05$. It was significant for the no pain task, $p = 0.005$. Hartley's F_{\max} was therefore calculated using 2.4 as the threshold. Hartley's $F_{\max} = 1.36$, therefore these data may be treated as homogenous. Levene's test was not significant ($p > 0.05$) for cognitive appraisal. Levene's test revealed that psychological bothersomeness of pain at baseline did not meet the assumption of homogeneity of variance ($p < 0.0001$). Levene's test was significant for effort in the no pain condition, $p = 0.007$. Hartley's F_{\max} was therefore calculated using 2.4 as the threshold value. Hartley's $F_{\max} = 2.19$, as such the data are treated as homogenous.