Social contextual influences on the experience of pain in men and women

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Abstract

Progress has been made in our understanding of the biological and psychological mechanisms involved in reporting pain, but there is limited research on the social influences on pain. Pain rarely occurs in isolation and the Social Communication Model of Pain emphasises the complexity of pain communication, and how social and contextual influences can have an impact on pain reporting. Over recent years, there has been an increase in the number of experimental and clinical studies focusing on how pain is reported when there is an observer present, but there have been inconsistent results. Furthermore, most studies do not control for sex differences, despite sex differences in pain being widely accepted and disseminated.

This PhD thesis focused on the social and contextual influences on pain. Initially I 1) explored whether presence of someone else can have an impact on pain reporting, 2) considered whether the dyadic relationship can have an impact, and 3) whether there were any sex differences present. Previous research in the social influences on pain has considered sex differences, but not sex differences in the observer. Building on the results from Chapters 3, 4, and 5, the second part of this thesis focused on the characteristics of friendship, and whether specific aspects such as competitiveness play a role in pain.

The first part of this thesis (Chapters 3, 4, and 5) adopted an experimental pain-induction approach, and recruited dyads along a continuum of closeness (strangers, opposite-sex friends, same-sex friends, and romantic partners). Overall, this series of studies highlighted that when an observer is present, pain threshold and tolerance increased. In addition, the nature of the dyadic relationships was found to impact on pain tolerance; pain is most tolerated when a friend is present, especially when the friend is the same-sex. Across all three experimental studies, men had a higher pain threshold and tolerance than women, which supports previous research investigating sex differences in pain. Based on these findings, the characteristics of friendship were explored further in Chapters 6 and 7.

Two key components of friendship are competitiveness and cooperativeness, which were explored amongst same-sex and opposite-sex friends (Chapter 6), and same-sex and opposite-sex strangers (Chapter 7). Using a similar experimental pain-induction design as before, competitiveness and cooperativeness were manipulated

using a virtual tennis game. Participants competed against one another in a singles match (competition) or together in a doubles tennis match against the games console (cooperation). For the same-sex and opposite-sex friends study, few differences were found. However, for the same-sex and opposite-sex strangers study, pain tolerance was higher for female participants with a male observer in the competitive condition. This highlights the importance of both dyadic relationships and context, in understanding responses to pain. The link between competitiveness and masculinity is highlighted in this study with women having biggest increase in pain tolerance, suggesting that the masculine gendered context resulted in women suppressing their pain. However, there is more research that needs to be conducted before a complete understanding can be gained.

The significance of this work is that it contributes to our understanding about how and why other people can have an impact on the pain of others. Pain reporting is the initial stage required to alleviate the pain, and a greater understanding of how pain is reported to others can help researchers understand more about the social influences on pain. This work suggests that the communication of pain may depend on the nature of relationship with others, including health care professionals, as well as the impact of gender-related contextual factors. Future investigations need to expand this research theme to clinical acute and chronic pain settings, and explore variation in pain reporting within naturally competitive environments.

Chapter 1: Introduction and Literature Review

1.1. Introduction

Pain is frequently experienced in everyday life and is the body's way to warn us of potential or actual harm, encourage us to stop what we are engaging in and to take immediate action (Engel, 1959). Pain is a complicated phenomenon that is still largely misunderstood (Watson, 2013). Pain is complex, and multiple factors contribute to a painful experience.

Pain has historically been considered as a neurophysiological response to a stimulus, until it was reconceptualised by Melzack and Wall (1967) as a bottom-up and top-down process, which incorporated psychological experiences. Melzack and Wall's Gate Control Theory of Pain was one of the first theories to incorporate the psychological aspects of pain; Melzack and Wall considered pain to be more than a sensory experience. From this, pain is now explained using a biopsychosocial approach, due to the development of the psychosocial aspects, which highlights its complexity.

The biopsychosocial approach of pain illustrates that there are many aspects that need to be considered, and emphasises that pain does not occur in isolation and is more than a sensory experience. Whilst research has explored the biological and psychological mechanisms, less is known about social processes. This is despite recent proposals that the social context, and in particular how we communicate pain in front of observers (Herr, Bjoro, & Decker, 2006), is critical to ensuring effective management of pain (Craig, 2009). In recent years, the social influences of pain have been developed, and the presence of someone else has been considered to have an analgesic effect on pain reporting's (Krahe, Springer, Weinman, & Fotopoulou, 2013). In some cases, the relationship between the person experiencing pain and the person present has also been considered. However, there are mixed results; some studies report that knowing the observer will increase pain threshold, whereas others conclude that knowing the observer has an analgesic effect. The focus of this PhD thesis is to investigate the social influences on reporting pain, by specifically focusing on how the presence of an observer and the dyadic relationship between people can impact on how pain is reported, within healthy adults.

Additionally, there are clear sex differences identified in the reporting of pain, with women having a higher sensitivity and more pain than men, and consequently reporting more pain than men (Bartley & Fillingim, 2013; Racine et

al., 2012a; Racine et al., 2012b). However, even though there is a growing interest in the social influences on the reporting of pain, there are still gaps in our knowledge, particularly regarding the following three areas; 1) whether the presence of another person can impact on pain, 2) whether the relationship between the person observing and the person experiencing pain matters, 3) whether the sex of the person observing can impact pain interpretation of another, and 4) whether there are any contextual influences on the reporting of pain. Therefore, this thesis will focus on bridging the gap between the impact a male or female observer can have on pain, and the whether the nature of the dyadic relationship present between the person experiencing pain and the observer can impact on pain.

In this chapter, I will outline the theories underpinning the research within this PhD and highlight the importance of considering pain within a social context, before establishing what is already known about interpersonal effects on pain, including sex and gender differences. I will then focus the review on everyday dyadic relationships, and how they are relevant contextual factors in pain.

1.2.The definition, prevalence and cost of pain

Before focusing upon a definition, it is important to understand the different types of pain that a definition has to accommodate. Pain can be categorised in to three different types: transient, acute and chronic pain (Loeser & Melzack, 1999). Transient pain is generally assumed to be incidental and rarely requires medical treatment (Loeser & Melzack, 1999); for example, removing a hand immediately from a hot hob plate. Low intensity aches and pains (e.g., dental treatment, a paper cut, stomach pain, and muscle pain (Perquin et al., 2000)) are frequently reported but also result in temporary disruption to everyday life. Pain that is considered to have a higher pain intensity, such as surgical pain, is also considered to be temporary; thus, all pain which is considered to be temporary is known as acute pain. Despite this type of pain temporarily being disruptive for an individual, acute pain has a minimal long-term impact on an individual's life, and the person recovers from the pain they have experienced. Acute pain often promotes problem solving behaviours to alleviate the pain, for example, to stop engaging in an activity to ensure a full recovery, or taking pain relief.

However, for some individuals, their pain persists for longer than twelve weeks and impacts on their life in many different ways (Palermo et al., 2014). This type of pain is labelled 'chronic' and is not considered helpful or part of a recovery process. Chronic pain is considered any pain that has been persistent for longer than 12 weeks. Twelve weeks is considered the threshold for when pain goes from acute to chronic as the body is able to repair itself typically within 12 weeks (e.g. a broken limb typically heals within 12 weeks), so a pain lasting longer than 12 weeks is considered chronic. Chronic pain may arise from an injury, surgery, a disease or illness, but there may also be no clear cause for the chronic pain. Often chronic pain is highly correlated with additional health problems such as disturbed sleep, chronic fatigue, and lower mobility (Mease et al., 2008). However, in some individuals, the pain they experience is more persistent and can significantly impact on personal and family life, social support, and leading to disability (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006).

Chronic pain isn't only experienced in adults; it can also be prevalent in childhood too, and can have similar debilitating effects on children and adolescents, particularly in regards to their development. Children with chronic pain often miss a lot of their education and, similarly to adults with chronic pain, have a lower social functioning (Kashikar-Zuck et al., 2008). Thus, chronic pain can be experienced across the life pain and irrespective of age, chronic pain can be disruptive, can impair attention, and be distracting (Eccleston & Crombez, 1999).

The above descriptions of transient, acute and chronic pain highlight that pain is multifaceted. Thus, it is unsurprising that defining pain is problematic, as it has to encompass such variability. However, the International Association for the Study of Pain (IASP) defined pain as "… an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (Merskey & Bogduk, 1994) (p. 210). This definition highlights the complexity of pain experiences and is a broad definition which covers chronic and acute pain.

The IASP definition was first published over 20 years ago, and given that there have been advancements in our understanding of pain, the definition appears a little dated. For example, the definition refers only to the emotional and sensory qualities, failing to identify other important features of pain such as pain not

occurring in isolation, and that it can be influenced by social and cognitive factors (McClelland & McCubbin, 2008). Thus, more recently, Williams and Craig (2016) called for a revised definition for pain that reflects a biopsychosocial approach; "a distressing experience associated with actual or potential tissue damage with sensory, emotional, cognitive, and social components" (p. 2420). This updated definition recognises and accounts for the cognitive and social components of pain that the previous IASP (1994) definition does not account for. Williams and Craig's (2016) definition has replaced 'unpleasant' with 'distressing', which emphasises the impact pain can have on individual lives, which for some people is an everyday occurrence. However, since the revised definition has been published, others have argued that not all pain is distressing (Aydede, 2016) as acute pain is known to help with recovery, and there is a need for a more neutral word to describe pain.

As mentioned in the introduction section, pain can negatively impact on individuals' lives, and can often be a debilitating experience. In addition to the impact pain can have on individuals and their families, pain is costly for society. In European adults, just under twenty percent reported experiencing pain over a six month period (Breivik et al., 2006), and between 31-37% of individuals report chronic pain (Bridges, 2012). In the UK, approximately 7.8 million people live with severe chronic pain, and chronic pain was found to be more prevalent in females (Van Hecke, Torrance, & Smith, 2013), older aged individuals (Elliott, Smith, Penny, Smith, & Chambers, 1999), and associated with lower social economic status and unemployment (British Pain Society, 2012). A more recent statistic from a meta-analysis has shown that the percentage of people living with chronic pain in the UK may be as high as 51% (Fayaz, Croft, Langford, Donaldson, & Jones, 2016), but this astonishing statistic is yet to be replicated.

The cost of treating back pain alone in the UK is approximately £10 billion, which accounts for twenty percent of the healthcare expenditure in the UK annually (Maniadakis & Gray, 2000). This is likely to be considerably higher when other chronic pain conditions and inflation are accounted for. Interestingly, chronic pain is prevalent during puberty, and is a common complaint that increases as children develop in to adolescents (King et al., 2011). Treating pain in children costs the UK National Health Services an estimates £3.5 billion a year (Sleed, Eccleston, Beecham, Knapp, & Jordan, 2005) and the USA $19.5 billion a year (Groenewald,

Essner, Wright, Fesinmeyer, & Palermo, 2014), which highlights the financial implications of living with pain, and treating pain across the lifespan. Therefore, treating pain effectively across the lifespan is a priority for the NHS in the UK, and healthcare organisations around the world (Goldberg & McGee, 2011).

To be able to treat pain effectively, there needs to be good theoretical explanations into how and why pain occurs and can be managed. The following section will consider different models that can be used to explain difference components in pain, with a particular focus on those that combine a biological, psychological, and social approach.

1.3. Models of Pain

The above sections have identified that pain is diverse and can be experienced in many different ways, including transient, acute, and chronic states. However, there is still a lot to understand about the mechanisms behind pain and how pain can be treated. Historically, pain was thought to be a purely physical, sensory process and solely a biological mechanism. Theories of pain date back as far as the 1700's, at which point it was considered to be a sensory experience. Descartes created the 'Pain Pathway' model of pain (Melzack & Katz, 2004) which focused upon the receptors that are on the skin which detect a painful stimulus. The model describes how the detection of a painful stimulus can cause an instinctive action to withdraw from the painful stimulus. From this early explanation of pain, there was more of an understanding of the biological mechanisms behind pain. In the mid-20th century, Melzack and Wall (1967) proposed the Gate Control Theory of Pain, which was a new pain model that acknowledged the cognitive factors that can influence pain. Melzack and Wall built upon the historical description of pain, and offered a top-down explanation, whilst also incorporating bottom-up processes, through the opening and closing of neural gates. The Gate Control Theory of Pain was one of the first models to facilitate the explanations of pain from a purely biological explanation, to incorporate the psychological and, to a certain extent, social experience (Asmundson & Wright, 2004). From the proposed Gate Control Theory of Pain, researchers and clinicians understanding of pain improved, especially as the focus moved away from a purely biological explanation, towards a more cognitive,

psychological, and social phenomenon. Thus, pain is now considered a biopsychosocial experience.

1.3.1. The Biopsychosocial Approaches of Pain

Engel's biopsychosocial model

Building upon Melzack and Wall's (1967) Gate Control Theory of Pain, a biopsychosocial model was proposed by Engel (1977). Engel viewed pain as an experience comprising of biological, psychological, and social components, with a greater focus on the psychosocial factors that affect pain experiences. This was an advancement on previous pain models, particularly as Engel acknowledged that pain was also a social experience. Engel described pain to be an experience that can be altered depending on behaviours, feelings and the thoughts of the individual experiencing the pain and the social environment (Engel, 1989). For example, pain has psychological and social components as it is more than a sensation. Pain has emotional aspects, and the context in which pain is experienced also has an impact on the overall experience (Hansen & Streltzer, 2005). Engel argued that pain was more than biological mechanisms, and that psychological and social factors can also have an impact on pain.

Gatchel et al.'s biopsychosocial model

A more specific biopsychosocial model was proposed by Gatchel et al., (2007), with the main focus of the model centred around chronic pain. Chronic pain is often a result of other illnesses and diseases of which can change over time; chronic pain patients often display different symptoms, or differing intensities of pain, over time and some the factors that contribute to these changes may be due to biological changes, psychological changes, or changes in the social and contextual environment in which the pain is experienced (Crook, Weir, & Tunks, 1989; Turk & Monarch, 1996). Over time, chronic pain can change, and so the relationship between the primary care giver or the healthcare professional can have an impact on pain reporting's and treatment (Leong, Cano, Wurm, Lumley, & Corley, 2015). Chronic pain patients also report their pain to other people they communicate with, for example, partners, friends, and other relatives. Thus, it is important to consider the social influences on pain over time; the patient may develop new relationships

with people while experiencing pain, which could ultimately shape their intrapersonal experiences of pain and how they go on to communicate it. Gatchel, Peng, Peters, Fuchs, and Turk (2007) builds on this further and states that when focusing on chronic pain, the context and social should be considered as one of the most important factors. Gatchel and colleagues built upon previous work (Gatchel, 2004) that initially showed how the biological, psychological and social mechanisms of pain worked. The adapted model explicitly highlights the importance of the social mechanisms, to include the wider context such as relationships, environmental stressors, treatment experiences, and cultural factors (Gatchel et al., 2007). The social mechanisms are presented as a separate mechanism for patients with chronic pain, and the biological and psychological mechanisms are interlinked; this adapted model shows how pain experiences can differ over time, and especially in chronic pain patients as their pain experiences can alter as the contextual influences change (Gatchel et al., 2007).

One of the main limitations to Gatchel et al's biopsychosocial model is that the social aspects, and in particular communication, were not considered in great detail. Gatchel and colleagues (2007) approach was built upon further by Hadjistavropoulos et al. (2011), with Hadjistavropoulos et al. adopting a broader approach in the understanding of pain. The novel aspect of Hadjistavropoulos et al.'s work was it did specifically focus on the communication of pain, while considering the biological and psychological influences within the social and contextual determinants. Therefore, this newer and broader approach highlights that the social and contextual influences can have an impact on pain, irrespective of whether the pain is acute or chronic.

Hadjistavropoulos et al.'s biopsychosocial model

Engel and Gatchel et al's biopsychosocial models have been expanded on by Hadjistavropoulos et al. (2011), but with more of a social focus and with specific reference to pain communication. Pain is rarely experienced alone, even though it is subjective and private (Eccleston & Crombez, 1999), and it also captures the attention of other people within the social environment (Hadjistavropoulos & Craig, 2002). Hadjistavropoulos et al.'s biopsychosocial model incorporates multiple interpersonal and intrapersonal factors that are linked to psychological (e.g. attitudes,

beliefs, and perceptions) and social aspects (social networks, family circumstances, access to healthcare), and should be considered when treating pain (Derebery & Anderson, 2002). Therefore, biopsychosocial models of pain (Gatchel et al., 2007; Hadjistavropoulos et al., 2011) combine previously known biological mechanisms with more of a psychological and social approach, with the aim of understanding pain on an interpersonal level by considering the perspective of the person experiencing the pain and any observers, for example, friends, family and bystanders.

Hadjistavropoulos et al.,'s biopsychosocial model highlights the internal experience of pain through an encoding and decoding process. Pain communication draws on Rosenthal (1982) three-step model of communication, whereby observers decode and react to the psychological states encoded in the person experiencing pain. This process can be described as an internal experience (Step A) that is encoded into varying levels of communicative expressions (Step B), which is then responded to by an observer and decoded with varying levels of accuracy (Step C). Steps B and C are predictors of how the observer will respond to the pain experience, whereby reactions can vary in accuracy and may appear more neutral, accommodating or malicious. By combining Steps A, B, and C, we can begin to understand how communication is a social component of pain as it requires more than the person experiencing pain.

The three-step model of communication was used by Hadjistavropoulos et al., in their biopsychosocial model. The biopsychosocial model suggests that immediately after experiencing a pain stimulus the individual behaves in a specifc way in order to respond to the pain, for example, withdrawing from the activity that caused the pain to occur. To a certain extent, this basic process is involuntary (Step A). The next stage of the model then accounts for the encoding process (Step B), specifcally the communication as an action. This forms part of the automatic processing of pain, and accounts for the use of lanuage to express pain, the memory of the pain, and a verbal or non-verbal response. These responses then combine to form a clear message that is then communicated as part of an interaction with another individual. This is where Hadjistavropoulos et al.'s biopsychosocial model acknowledges that pain does not occur in isolation and once the pain has been encoded by the person experiencing the pain, the painful experience is then ready to

be decoded by another individual (Step C). The decoding process is also referred to as the communication as part of a transaction. During the decoding process, observer attitudes, abilites, characteristics, and other social determinants all have a role in how the pain is decoded by the individual present. Therefore, in this biopsychosocial model of pain, the impact intra and interpersonal factors, along with social determinants, can all affect pain.

Intra and interpersonal factors will be frequently referred to throughout this chapter and thesis. From this point onwards, intrapersonal can be defined as the communication an individual has with themselves; i.e. the thoughts a person has in their mind. This type of communication is continuous and revolves around the thoughts a person has. The opposite of this type of communication is interpersonal. Interpersonal is the communication that occurs between two of more people, but can be verbal and/or non-verbal. This type of communication can occur regularly, and is associated with the sharing of information, concerns, or ideas. The intra and interpersonal factors can have a large impact on pain, especially as there is a huge variation in physical and emotional responses towards pain (Turk & Monarch, 1996). For example, patients often draw upon different interpersonal factors during their pain experience, specifically in the way they communicate their symptoms and respond to treatment.

The biopsychosocial approaches mentioned in this section (Gatchel, 2004; Gatchel et al., 2007; Hadjistavropoulos et al., 2011) provides us with an explanation of how pain is more than a biological and sensory experience by focusing on the psychological and social aspects. As previously mentioned in this chapter, the psychological aspects of pain are becoming increasing better understood, however, there is still a lot to learn about the social and contextual influences on pain. Gatchel et al., began by devising a biopsychosocial model specific to chronic pain, but the latest approach by Hadjistavropoulos et al. (2011) highlights that the social and contextual influences encapsulate the biological and psychological mechanisms behind pain in a broader context. There are multiple different aspects that contribute to the social influences of pain, starting with two broad areas: interpersonal and intrapersonal factors. Both of these factors have been addressed by Hadjistavropoulos et al., and Gatchel et al., and both show variation of the

biopsychosocial approach to highlight that the social influences may change over time, especially in individuals who experience pain over longer periods of time, as the relationships, environment, and context where pain is experienced may change (Gatchel et al., 2007).

1.3.2. The Social Communication Model of Pain

Building upon the biopsychosocial models presented above, one of the important social factors to consider is how the pain is communicated, as this is what helps to alleviate the pain an individual experience. Craig (2009) devised a model, the Social Communication Model of Pain, which specifically focused on the interpersonal and intrapersonal influences on pain and how it is communicated between individuals.

Firstly, pain can be communicated for multiple reasons; individuals may communicate their pain for help seeking purposes, or as a warning to others to flee the environment. At this point, there is an extra layer of information which should be considered which builds upon the three-step model of communication, and the encoding and decoding of pain outlined above; Craig (2009) developed the Social Communication Model of Pain which focuses more specifically on the encoding and decoding processes of pain communication, and the intra- and interpersonal influences that can impact on how pain is communicated.

The Social Communication Model of Pain (Craig, 2009) considers how social processes and environments play a role in an individual's pain experience (outlined in Figure 1.1.). The model integrates different aspects of the social influences on how pain is reported. The key difference between Craig's Social Communication Model and other models of pain, is that Craig's Model explicitly acknowledges that pain communication requires another person to be present. Figure 1.1. explicitly shows this as the person experiencing pain considers the intrapersonal and interpersonal influences on how they are going to communicate the pain, and then how the caregiver relies on the intra- and interpersonal influences to dictate how they are going to decode the communication of pain.

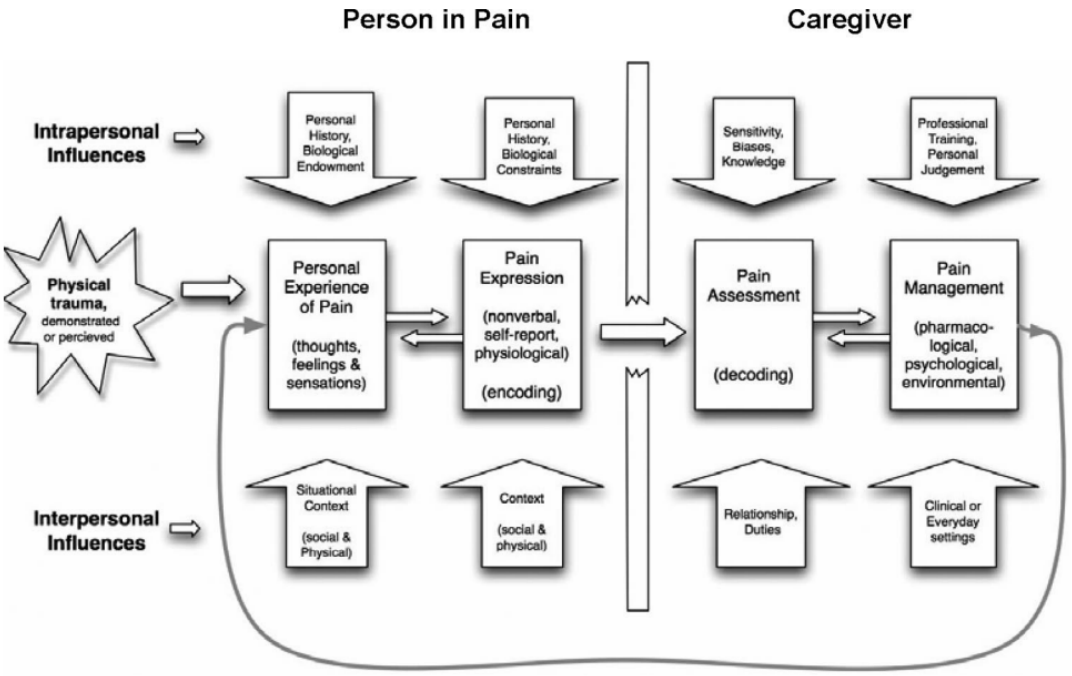

Figure 1.1. The Social Communication Model (Craig, 2009), taken from the original article: Craig, K. (2009). The social communication model of pain. *Canadian Psychology/Psychologie canadienne, 50*(1), 22-32. Replicated with permission.

Within Craig's model, importance is placed on how the person in pain and the caregiver communicate. Effective communication in the context of pain can help alleviate the painful experience. For example, if the pain experience is communicated effectively to a caregiver, the caregiver can adjust and tailor their helping behaviours which can help to alleviate the person's pain, and prevent under-treatment of pain (Stevens, 1992). Such communication can occur via both verbal and nonverbal channels but both forms of communication include self-reporting to another person when something hurts. Verbal communication includes the use of language to articulate the pain. Non-verbal methods of communication can include non-words such as screaming and shrieking, and changes in body posture or facial expressions. There are multiple factors that contribute to how pain is communicated; for example, in a quiet environment, non-verbal methods of communicating pain may be more appropriate. Alternatively, in a threatening environment, high volume vocalisations as a warning signal may be an appropriate method of communicating pain. The Social Communication Model of Pain, therefore, accounts for both verbal and non-verbal methods of communication.

Craig's model also focuses on the dyadic relationship between caregivers and patients but can be applied to other dyadic relationships (e.g., parent-child, spouses, experimenter-participant, strangers) as it considers multiple intra- and interpersonal factors that contribute. As highlighted above, intrapersonal refers to the thoughts a person has which is internalised, but interpersonal refers to the communication between two more people via verbal and non-verbal cues. Many intrapersonal factors can contribute to pain communication via the encoding of pain and pain expression, and these include personal history, mood, perceived social support from the observer present, and biological or physical factors. All of these factors can be internalised and can have an influence on how pain is expressed. Some of the interpersonal factors include social context, the relationship between the people present, and the environment. Similar to the intrapersonal factors, these interpersonal factors can also have an impact on how pain is expressed, whether that is verbal or non-verbal.

Both the intrapersonal and interpersonal factors can contribute to encoding process. The encoding process is all about the influences on the person, which naturally contributes to how the pain is expressed. Once pain is projected, another person decodes this information to be able to form a pain assessment (see Figure 1 for a visualisation of how this process works). The decoding process refers to the recognition that another individual is in pain, and in a similar way to the encoding process, there are intra- and interpersonal influences present. The intrapersonal influences that impact on the decoding process include prior knowledge of the person in pain, biases, and training received. This combined with the interpersonal influences that include the relationship the person has with the individuals experiencing pain contribute to pain assessment. The assessment process is dependent on the role of the observer (e.g., caregiver, partner, stranger, healthcare provider), and their knowledge. Therefore, the encoding and decoding of pain is vital for effective communication and there is evidence to suggest the social contextual influences between the person experiencing pain and the decoder does have an impact on pain communication.

To support the model, there is evidence to suggest that the interpersonal factors that contribute to pain communication can have a large overall impact on pain experience. Pain thresholds increase after observing another person tolerating pain (Craig & Weiss, 1971), and also the presence of an observer can result in an

increase in pain threshold and tolerance (Gijsbers & Nicholson, 2005; Levine & De Simone, 1991; Vigil & Coulombe, 2011). In addition to the physical presence of another person, the type of dyadic relationship should also be considered. For example, a spouses response to a headache can negatively impact on pain; pain intensity scores increased when a spouse expressed concern (Pence, Thorn, Jensen, & Romano, 2008). In addition to research on spouses and the influences on pain (Cano, Gillis, Heinz, Geisser, & Foran, 2004a), parental effects (Vervoort et al., 2011a) and other social networks including strangers (Vigil et al., 2013) have also been identified as contextual influences that can have an impact on how pain is reported.

As will become apparent, the role of dyadic relationships on the reporting of pain is one of the key research questions in the PhD thesis, so the nature of the dyadic relationship and the impact it can have on pain experiences will be discussed in detail later in this chapter.

1.3.3. Appraising the social models of pain

To summarise, it has been argued that a biopsychosocial approach needs to be adopted to understanding the various mechanisms that impact on pain experiences; pain is not a purely biological phenomenon, and there is a need to consider psychological and social factors. While the biological and psychological aspects of pain are well understood, there is less known about the social mechanisms behind pain, and in particular how we communicate pain to one another. Craig's (2009) Social Communication Model of Pain specifically recognises that pain does not happen in isolation, and that it is a social experience. The model explicitly focuses on the communication of pain between an individual experiencing pain and the caregiver. The model also allows for other dyadic relationships to be considered, which highlights how the intra- and interpersonal mechanisms behind pain can be considered widely.

While the Social Communication Model of Pain recognises the importance another person has, two major limitations to this model, and to biopsychosocial approaches more generally; firstly, it does not directly acknowledge the impact different types of dyadic relationships which may have on pain. The Social Communication Model does specifically focus on patient-caregiver dyads, but there

are many different dyadic relationships whereby pain may by experienced, for example, parent-child, spouses, friends, and strangers. A lot of the intrapersonal and interpersonal factors highlighted by Craig (2009) can be applicable to other dyadic relationships, however, the impact of different relationships is still relatively unknown.

Secondly, the biopsychosocial approach to pain, and the Social Communication Model of Pain both highlight that pain is social, but neither model specifically addresses known sex differences that are present. Within both clinical and experimental research, sex differences have been established; men have a higher tolerance than women, and women have a great sensitivity to pain than men (Riley, Robinson, Wise, Myers, & Fillingim, 1998). In addition to this, pain is more prevalent in women than in men (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley, 2009). However, the models that emphasise the social mechanism behind pain do not currently account for sex differences. Sex (and gender) are important components of dyadic relationships, and also have an impact on pain. Therefore, this PhD thesis will aim to bring together the difference in dyadic relationships, and sex differences, with the aim of gaining a better understanding on the social influences on the reporting of pain.

The following section of this chapter will therefore focus upon sex and gender differences in a greater detail, with the aim of emphasising the need to address the differences between men and women in the social context of pain. To begin, I will establish the differences between sex and gender differences, before going on to review the sex differences present in pain. Sex and gender are closely linked, so the end of the next section will review the evidence for gender differences in the context of pain by specifically focusing on stereotypical pain behaviours.

1.4. Sex and gender differences in pain

In the section above, the social influences of pain were highlighted. However, there is still limited information available that aids the understanding of how and why pain experiences can be influenced by others. One of the things that can influence how pain is reported is the sex of the person present. There is evidence to suggest that the presence of someone else can impact on pain, and there is also evidence to suggest the sex and gender of the person in pain should also be

accounted for (Melchior, Poisbeau, Gaumond, & Marchand, 2016). For the purpose of this thesis, sex can be defined as the biological difference between men and women (Unger, 1979). These biological differences include internal and external sex organs, hormonal profiles, and chromosomes. Sex is different to gender, although, occasionally the terms are used interchangeably. Gender refers to the sociocultural and the psychological attributes associated with the sex of an individual. Gender is often considered to be contextually influenced and incorporates the social processes that can influence the social behaviours, relationships, and stereotypes norms within society (Ritz et al., 2014); some situations an individual may appear to be more masculine in some situations, when compared to others, and vice versa.

Sex and gender differences in pain have a presence in experimental work (Boerner, Birnie, Caes, Schinkel, & Chambers, 2014; Fillingim et al., 2009; Mogil, 2012; Racine et al., 2012a), and are slowly bridging the gap to more applied and clinical research too (Fayaz et al., 2016; Johannes, Le, Zhou, Johnston, & Dworkin, 2010; Kennedy, Roll, Schraudner, Murphy, & McPherson). The amount of research acknowledging sex differences is increasing, but there is still a limited understanding of gender differences. However, occasionally, the purely physiological mechanisms behind sex differences don't always provide enough of an understanding when investigating the social influences on pain. Masculinity, femininity, and gendered approaches are often more appropriate to consider why the differences occur, especially when gender is heavily influences by context. However, there is less of an understanding behind gender differences in pain. Thus, there is still a long way to go before both sex and gender are fully understood on the context of pain.

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1.4.1. Sex differences in pain

Sex is an important factor to consider as men and women interact differently in many situations; for example, emotions are expressed differently between men and women, and men and women perceive social support differently (Eagly, 2013). These differences are also evident in pain; between sexes there is a difference in pain threshold and tolerance, but also within sex differences there are also variations that should be accounted for, including emotional factors, the age of the person, and empathy (Melchior et al., 2016; Moriguchi et al., 2007; Vervoort et al., 2008).

In addition to sex differences in pain reports, there are also sex differences in pain experience. Differences in the way men and women respond to treatment techniques, report their pain, and experience their pain (Bartley & Fillingim, 2013). Women report pain more frequently and more severe than men, and pain often occurs in multiple sites and for longer periods of time for women (Bartley & Fillingim, 2013; Fillingim, Edwards, & Powell, 1999; Pieretti et al., 2016). Thus, unsurprisingly, across different cultures chronic pain conditions are generally more prevalent in women than in men (Berkley, 1997; Blyth et al., 2001; Lipton, Stewart, Diamond, Diamond, & Reed, 2001). Contrasting this, Hastie et al. (2012) concluded that within chronic pain patients, sex differences are a little more uncertain which is due to the differences in prevalence rates of specific pain conditions, which may have an effect on sex differences (Racine et al., 2012b). Therefore, some of the evidence on sex differences is conflicting, and this requires further attention.

Within clinical studies, pain conditions are more prevalent in women than men (Lipton et al., 2001; Unruh, 1996). In addition to clinical studies, epidemiological studies also support the evidence that pain is more prevalent in women (Berkley, 1997; Mogil, 2012). These sex differences are particularly seen in migraine; where nearly 18% of females report having a migraine more than once a year, compared to only 6% of males having the same experience (Stewart, Shechter, & Liberman, 1992). Large sex differences are also seen in irritable bowel syndrome (Heitkemper, Jarrett, Bond, & Chang, 2003), and individuals with fibromyalgia with approximately 10% of the patients are male, and the rest are female (Wolfe, Ross, Anderson, & Russell, 1995). In addition to women having higher prevalence rates of chronic pain, they also have more pain symptoms that last for longer periods of time, when compared to men. For example, in individuals with irritable bowel syndrome, women experience longer and more painful episodes than men (Heitkemper et al., 2003). Additionally, in fibromyalgia patients, women experience more tenderness in their muscles than men, and also suffer from fatigue more (Wolfe et al., 1995). Another chronic pain condition whereby large sex differences can be observed is in musculoskeletal pain; women report more pain than men, and it is more widespread across multiple sites on the body (Leveille, Zhang, McMullen, Kelly-Hayes, & Felson, 2005).

Building upon the consistent sex differences observed in clinical pain, sex differences have also been considered in experimental, laboratory based settings too. Within experimental pain induction, there are typically two outcome variables measured; pain threshold and pain tolerance. Experimental studies allow for a standardised approach to be adopted, and the environment is more controlled, which reduces a lot of the variability observed in clinical studies. In the context of experimental research, pain threshold refers to the first point the participant experiences the painful sensation, but pain tolerance refers to the boundaries the person is willing to push in order to tolerate the pain, until they can no longer stand the pain. Thus, there is a lot more subjectivity when measuring the pain tolerance of a person, and this is where the social influences, such as sex and gender, can have a role.

Within experimental paradigms, consistent sex differences have been identified; males report higher pain threshold and tolerance levels than females, suggesting that females are more sensitive to pain compared to males (Fillingim et al., 2009; Keogh & Birkby, 1999). Typically, men have a higher tolerance to pain than women, and women are more sensitive to pain than men (Keogh & Birkby, 1999). When considering pain tolerance only, there have been consistent findings that men have a higher tolerance than women across different methods of pain induction, including the cold pressor task (Alabas, Tashani, & Johnson, 2012; Fowler, Rasinski, Geers, Helfer, & France, 2011; Keogh, Hatton, & Ellery, 2000; Myers, Robinson, Riley, & Sheffield, 2001), thermal heat pain (Defrin, Shramm, & Eli, 2009; Fillingim et al., 1999), electrical stimulation (Pool, Schwegler, Theodore, & Fuchs, 2007b), and pressure pain (Ayesh, Jensen, & Svensson, 2007; Bartley & Fillingim, 2013; Fillingim et al., 2009).

In addition to the consistent sex differences in pain tolerance, there is also evidence to suggest there are consistent sex differences present at a pain threshold level. Men have a higher pain threshold on the cold pressor task (Alabas et al., 2012; Keogh, Bond, Hanmer, & Tilston, 2005), thermal heat pain (Fillingim et al., 1999), and pressure pain (Chesterton, Barlas, Foster, Baxter, & Wright, 2003). Despite there being consistent sex differences found for pain threshold in those studies, others have failed to identify such differences in threshold levels (Defrin et al., 2009; Nie, Arendt-Nielsen, Andersen, & Graven-Nielsen, 2005; Pool et al., 2007b). This

highlights the differences in measuring pain threshold and tolerance, and emphasises the need to address both separately.

This section has highlighted that consistent sex differences are present in both clinical studies and experimental studies, with men reporting less pain than women, and women experiencing high prevalence rates of pain than men. The consistent findings across both research areas highlight the importance of considering sex differences in research, and it is more than a demographic variable to controlled.

1.4.2. Gender differences in pain

Over recent years, gender has been offered as a possible explanation for why sex differences are found, and why there may be mixed results regarding experimental studies. Gender refers to societal norms and conformity, which may provide an explanation as to why men have a higher tolerance than women, and why women report a greater sensitivity to pain than men. Gender differences have stemmed from societal stereotypes and have shaped what are considered as male or female norms. These gendered stereotypes can be learnt from a young age via the media, television programmes, and family environments. Masculinity refers to the expression of physical strength and resilience, and femininity refers to the expression of emotions and informed decisions (Beal, 1994). However, these stereotypical expectations can be mediated culturally (Robinson et al., 2001) and by parental modelling (Cunningham, 2001). There are gender differences in the way that social behaviours are expressed, for example, aggression is highly correlated with masculinity (Eagly & Wood, 1991). Gender differences can also be observed in the context of pain; for example, more masculine behaviours are associated with a decrease in willingness to report pain (Robinson et al., 2001).

When combining social psychology literature based on gender differences and literature on pain, the relationship between gender differences and pain can be observed. Western societal norms consider feminine gender roles to include pain expression and a greater sensitivity to pain. By drawing upon social support (Robinson & Wise, 2003), women who have high feminine gender characteristics express their pain more and have more noticeable pain behaviours (Koutantji, Pearce, & Oakley, 1998). When considering males who display masculine gender

roles, there is an increase in stoic behaviours, more self-reliance and a greater independence; thus, masculine men are less likely express their pain or to seek help to alleviate their symptoms (Keogh, 2015). The gender role that is associated with masculinity is an explanation as to why there is such variation in pain experiences between men and women who display more masculine and feminine characteristics, respectively. For example, masculinity is associated with stoicism, which in the context of pain is perceived to have a high pain tolerance, and to not express any vulnerability regarding the pain. Thus, if men want to appear to be more stoic, they are less likely to express their pain in fear of being perceived of being 'unmanly' (Cialdini & Trost, 1998; Galdas, Cheater, & Marshall, 2007; White & Johnson, 2000). Interestingly, when gender roles are manipulated in the context of pain, pain sensitivity differs; men who are primed with feminine gender roles have a higher pain sensitivity to pain when compared to men primed with masculine gender roles, and women who have not been primed (Fowler et al., 2011). This highlights that gender roles can be manipulated and socially constructed, and gender is considered not as categorical as sex.

Within experimental pain induction research, gender role expectations have been found to impact on the reporting of pain (Abetkoff, Karlsson, & Chiou, 2015; Myers et al., 2006; Robinson et al., 2001; Wise, Price, Myers, Heft, & Robinson, 2002a). When the expectations of the participants are manipulated, an increase in threshold and tolerance is observed (Fillingim, Browning, Powell, & Wright, 2002) particularly in relation to perceived masculinity increasing pain tolerance (Mogil & Bailey, 2010). However, Myers et al. (2001) found that once sex differences are controlled for, masculinity and femininity are not directly related to pain experiences. Pain is considered a threatening experience and when this is also combined with gender-threatening feedback, a higher pain tolerance can be observed, specifically in men (Berke, Reidy, Miller, & Zeichner, 2016). Overall, both men and women believe that the average men should suppress their pain more than the average woman, and men who are considered to identify with more stereotypical masculine norms are considered to have a higher pain tolerance (Pool, Schwegler, Theodore, & Fuchs, 2007a).

In contrast to this, men who are primed with more feminine gender-threatening feedback reported a much lower pain threshold, when compared to men

who received masculine gender-threatening feedback (Fowler et al., 2011). Alternatively, women are more willing to report their pain than the typical man (Robinson et al., 2001), and women report their pain as more intense in comparison to the typical man (Robinson et al., 2004). Overall, stereotypical gender related norms are still present in the context of pain, and also impact on how pain is perceived by others (Bernardes, Keogh, & Lima, 2008), typically men are perceived as able to tolerate more pain than a woman, and this norm predicted pain tolerance in the extent to which participant's identified with the respective sex (Pool et al., 2007b).

Unsurprisingly, both males and females think that the typical man would be less willing to report a painful experience than a typical female, and men have higher levels of pain endurance and lower sensitivity levels, when compared to females (Robinson et al., 2001). This suggests that expectations are present in pain, as well as in social behaviours (Eagly & Wood, 1991). Gender Role Expectations of Pain (GREP) (Robinson et al., 2001) have been used in experimental pain research, and the GREP has been noted to be a significant predictor of pain threshold and tolerance; men are expected to be less willing to report their pain than women, and have the ability to endure more pain than women (Wise, Price, Myers, Heft, & Robinson, 2002b). Further, gender role expectations in the context of pain have been linked group congruity (Eagly & Karau, 2002), and how a group of individuals will be evaluated in a positive manner when the group characteristics are coherent with the social role of the group (Eagly & Diekman, 2005).

Men appearing more stoic is often apparent in groups of friends, and within these social group comparisons against gender norms are often (Mahalik, Burns, & Syzdek, 2007). If a man who identified himself as masculine was to not suppress his pain, he may fear that other men would perceive him to be weaker and less socially desirable (Cialdini & Trost, 1998), which is not what more masculine men desire when placed in an environment increasing their vulnerability, such as a painful stimulus (Galdas et al., 2007; White & Johnson, 2000). Thus, when considering the most extreme stereotypes for men and women, and applying them to pain expression, a greater understanding can be gained as to why men feel suppress their pain more than women.

Within pain experiences, gender differences are considered to be constructed with regards to the context and situational influences. For example, in specific situations such as a competitive or threatening environment, masculine traits are more likely to observed (Berke et al., 2016). Despite there being clear gender differences in pain experiences, to my knowledge, only a few studies focus on gender and sex together. This may be due to the limited knowledge researchers have about sex differences, and this is a dichotomous variable; it is important to understand where and when sex differences in pain occur, before moving on to gender differences which can be manipulated and are context dependent.

1.4.3. Summary of sex and gender differences

In summary, gender and gender roles have an impact on how pain is reported, and depending on the social environment, these gender effects will impact in different ways. A limitation of research conducted into gender differences is the complexity of defining gender and sex, and little research has investigated how the two concepts may impact on each other in the context of pain. This area is under researched and little is known about why and how there are sex and gender differences between men and women, in the context of pain. Therefore, overall, there is a need for future research to consider sex differences, before considering gender differences. Therefore, given the complexity of incorporating both sex and gender differences, I will begin by focusing on gaining a better understanding of sex differences in pain. Thus, sex differences will be primarily focused upon in the first three experimental studies in this thesis. In the latter part of this PhD thesis, I will draw upon theory based on gender differences to explain potential discrepancies in pain experiences between men and women.

1.5. Pain considered in a social context: reviewing the evidence

The above section has highlighted how sex and gender differences are present in pain, and it is important for them to be considered in research. Typically, men have a higher pain tolerance than women, and women have a greater sensitivity to pain than men, but how this connects to the social impact of pain is still relatively under researched. The following sub-sections will focus on several aspects of social influences of pain; to begin, I will review the role of social support and pain, before

highlighting the sex differences in communicating pain. I will then end this section by specifically focusing on interpersonal effects on pain, specifically focusing on the role of an observer. Sex differences will be considered throughout this subsection.

1.5.1. Social support and pain

Although pain is a private and subjective experience (Lowe, 2002), the Social Communication of Pain Model (Craig, 2009) emphasises that pain rarely occurs in isolation, and individuals interact with others when in pain. Therefore, the social context of pain, and our interpersonal interactions, needs to be considered further.

A small amount of research investigating role of social support and the impact it can have on an individual's pain experience has been conducted (Porter, Keefe, Lipkus, & Hurwitz, 2005; Vigil & Coulombe, 2011; Vigil et al., 2013). The link between pain and quality of relationships can be bidirectional; chronic pain can have a negative impact on interpersonal relationships, and in some cases, the type of relationship can impact on chronic pain (Porter et al., 2005). Within the chronic pain literature, a lot of the research has primarily focused upon marital partners and significant others (Boothby, Thorn, Overduin, & Ward, 2004; Cano, Barterian, & Heller, 2008; Cano et al., 2004a; Cano, Weisberg, & Gallagher, 2000; Leonard, Cano, & Johansen, 2006; Sullivan et al., 2001). Generally, if an individual perceives their marital partner to be concerned about their pain, the individual with the pain is more likely to report pain and disability (Flor, Turk, & Berndt Scholz, 1987; Romano, 1995). Marital distress and pain are also positively correlated with symptoms of depression and poor mental health (Kerns, Haythornthwaite, Southwick, & Giller, 1990). Cano et al. (2004a) acknowledged the bivariate relationship between pain and marital satisfaction, and the impact it can have on patient wellbeing.

In addition to the social impact on pain in chronic pain patients, there is also supporting work in experimental lab settings. Experimental pain is considered to be a way of controlling for multiple variables, and through the design of the study, specific social factors such as dyadic relationships, can be directly considered. For example, lab studies have shown that when in the presence of someone else (an observer), the reporting of pain decreases and overall, less pain is reported (Brown,

Sheffield, Leary, & Robinson, 2003; Fontana, Diegnan, Villeneuve, & Lepore, 1999; Hodnett, 2002; Martin, Tuttle, & Mogil, 2014; Niven, 1985). Therefore, social support has a large impact on pain experiences, and should be considered further, by specifically acknowledging the sex differences and types of relationships between the person experiencing pain and the other individuals present. The following two subsections will aim to address this directly.

1.5.2. Sex differences in pain communication

In this PhD thesis, I aim to bridge the gap between sex differences and social influences, such as having an observer present. However, sex differences combined with other social influences on pain are still relatively under-researched and misunderstood. This next section will look at the evidence that brings these two areas together.

As highlighted in above in section 1.3. focusing on the approaches to pain, pain can be communicated in two ways, verbally or non-verbally. Women are typically more expressive than men, and are better at communicating their emotions, and this difference in communication has also been seen in pain. In general, women are more able to combine both non-verbal and verbal communication to understand others' pain experiences more accurately (McBain, Norton, & Chen, 2009; McClure, 2000). Women are more likely to show higher levels of affective emotion during communication due to women seeking more social support when experiencing pain (Vigil, 2009), as opposed to men, who make less use of social support. From the research that is available, it is evident that sex differences in reporting pain occur due to social constructs There is little research available that specifically focuses on sex differences in pain communication, but drawing upon pain expression, communication, and sex differences present in pain experiences, there is sufficient evidence to suggest that the sex differences that are observed can be based on the socialisation of pain communication (Canary & Dindia, 2009). Previously in this chapter (section 1.3.), sex differences were explored in greater detail, and in this subsection we can see some of the reasons why there are consistent sex differences present. However, the sex and relationship of the other person present is rarely considered, but should be as the observer is part of the context in which pain is experienced. Thus, the next subsection will review the effect an observer can have

on pain. There is limited information on how the sex of the observer can impact on pain, but sex differences have been weaved throughout the next sections, where applicable.

1.5.3. Are there observer effects on pain?

There is limited research that has directly addressed the effects of an observer within an experimental pain induction setting but there is evidence to suggest that the presence of an observer can have an analgesic effect on pain (Aslaksen, Myrbakk, Hoifodt, & Flaten, 2007; Levine & De Simone, 1991). In an early study, Kleck et al. (1976) found that adults are cautious in how they express their emotions when in pain, especially when others were present; individuals are more likely to suppress their expression of pain in the presence of an observer. More recently, it has been shown that just having awareness, but not necessarily the physical presence of an observer may be enough to have an impact on how pain is reported (Badali (2000). Additionally, self-reported pain ratings are, on average, lower when the participant is aware of an observer's presence, when compared to completing a pain induction task alone (Badali, 2000). Therefore, the presence of an observer may have an analgesic effect on pain. Below are three examples of different dyadic relationships whereby pain is experienced by one of the dyad; experimenter-participant dyads, child-parent dyads, and adult-healthcare professional dyads. These three examples have more established research highlighting, and emphasising, the importance of considering the dyadic relationship.

Within experimental paradigms, the characteristics of an observer and audience may also be an important factor to consider. For example, the sex of the observer is a logical next step. One of the first studies to focus on the sex of the observer was Levine and De Simone (1991), and they achieved this by looking at the impact the sex of the experimenter has on how pain is experienced. They found that pain was tolerated more when being tested by a female experimenter. This finding has been replicated across the literature (Aslaksen et al., 2007; Gijsbers & Nicholson, 2005), and additionally, the biggest increase in pain tolerance is observed when the experimenter is of the opposite sex to the participant and perceived to be an authoritative figure (Kallai, Barke, & Voss, 2004). However, there have been some studies that have failed to replicate these results, but instead found that purely

having an experimenter present increased pain tolerance in participants (Vigil, Rowell, Alcock, & Maestes, 2014a). Despite not all studies replicated the initial results from Levine and De Simone (1991), there is evidence to suggest that the sex of the observer can also have an impact on pain experiences. Since the earlier studies focusing on the social aspect of pain, more research now considers the dyadic relationship between the person experiencing pain and the observer present.

The nature of the real-life dyadic relationships is important to consider, and an initial important dyadic relationship to consider in the context of pain would be between a child and their family members. Children often experience pain, and the child needs to report their pain to a parent in order to seek medical attention. Fortunately, parent-child dyadic relationships have been considered in an experimental environment, so the precise nature of the relationship can be considered carefully. Both the sex of the parent and the sex of the child can have an impact on how the pain is perceived (Moon et al., 2008; Tsao et al., 2006; Vervoort, Huguet, Verhoeven, & Goubert, 2011c). For example, mothers rate their child pain in a similar way, irrespective of the sex of child, but fathers rate the pain in their sons higher than the pain in their daughters (Moon et al., 2008), and fathers are more likely to engage in a discouraging response to a child pain, when compared to mothers (Goubert, Vervoort, Ruddere, & Crombez, 2012). In a recent study by (Boerner, Chambers, McGrath, LoLordo, & Uher, 2017), the sex of the parent and the sex of the child was considered. Children were asked to observe their parent complete a cold pressor task, and the parents were either asked to exaggerate their pain or minimise it. Children reported more anxiety when their parent was in the exaggerate condition, and girls in the exaggerate condition rated their pain as more intense than the boys in the same condition. Thus, even though this is the first experimental study to focus on both the sex of the child and parent, it is evident that the dyadic relationship needs to be considered further.

Naturally, everyone grows out of childhood, in to adolescence, and through to adulthood; the differences in pain experiences are still observed in adults. In the context of pain, one of the key dyadic relationships in adults is between the individual experiencing pain and a healthcare professional. Adults can seek medical advice alone, so the relationship between the health care professional and the patient is important to consider. However, irrespective of sex, patients feel their pain

reporting's are overshadowed by the healthcare professional's expectations associated with their illness, which results in the patients feeling misunderstood (Yorkston, Johnson, Boesflug, Skala, & Amtmann, 2010). The sex of the health care professional has been considered, and when the health care professional is female, pain intensity is rated as much higher in both men and women. Often health care professionals perceive women to be in more pain than men (Hirsh, Alqudah, Stutts, & Robinson, 2008), with women often receiving more analgesics than men (Raftery, Smith-Coggins, & Chen, 1995). Additionally, female health care professionals also prescribe more analgesic to women, as opposed to men (Veldhuijzen, Karhof, Leenders, Karsch, & van Wijck, 2013). Therefore, the interpersonal relationship between the patient and the healthcare professional can have an impact on how pain is experienced and also treated, and that sex may play a moderating role also.

1.6. Everyday relationships and pain

The previous section has highlighted how the presence of an observer can have an impact on pain; generally, the presence of someone else results in an increase in pain tolerance. Additionally, it is important to consider different dyadic relationships that are present in everyday life such as parent-child dyads and adult-healthcare professional dyads. Parent-child dyads have been investigated, and both the sex of the child and parent have been found to have an impact on pain experiences. Additionally, in adults, the healthcare professional and patient dyad can also have an impact on how pain is reported. However, there is little evidence which focuses on adults and everyday relationships, within an experimental setting. The next part of this chapter will specifically focus on everyday relationships experienced by adults; the focus is on the closeness of dyads, ranging from strangers to romantic partners, with friends being in the middle of the continuum. I have chosen to focus on the closeness of relationships as adults encounter these types of relationships every day, and closeness of the dyad has previously been shown to have an impact on how pain is reported (Brown et al., 2003; Fontana, Diegnan, Villeneuve, & Lepore, 1999; Hodnett, 2002; Martin, Tuttle, & Mogil, 2014).

1.6.1. The impact of pain on specific everyday relationships; strangers, friends, and romantic partners

In this thesis, I will specifically consider the differences in pain experiences between strangers, friends and romantic partners. These three groups form a continuum of how well an individual knows someone else, ranging from not at all (strangers), to having an intimate relationship with someone (romantic partners), with friendship filling the scale between these two extremes. These everyday relationships have not yet been extensively investigated in the context of pain. Given that sex differences have been observed in pain, the sex of the observer can have an impact on pain, and the nature of the dyadic relationship should be considered, there is a need to address the impact different every day relationships can have when experiencing pain. In the upcoming sections I will review the literature that specifically focuses on strangers, friends, and romantic partners, with the aim of highlighting the importance of considering the full continuum of interpersonal relationships in adults. Within each subsection I will consider what evidence exists for possible sex differences.

1.6.2. Strangers

In everyday life, pain is communicated to strangers, and strangers form a large proportion of the people we come in to contact with on a daily basis. For example, if you experience pain when alone in a public place, you will experience pain in front of strangers. This can include tripping over, having an accident, but also an individual such as a health care professional you have not previously visited could also be considered as a stranger. Strangers are considered people who are not known to us, and when considering the psychology behind what it means to be a stranger, they are typically people who don't have shared goals or prior history with, there is little empathy between the individuals, and the likelihood of being empathic towards a stranger decreases over adulthood (Blanke, Rauers & Riediger, 2015). The continuum of how well you know someone is a focus in this PhD thesis, and in order to capture as much of the continuum as possible, this subsection will review the literature focusing on how strangers can have an impact on pain experiences.

Research has indicated that the outcome of an experience involving others can be very different if you do not know the individual, as in the bystander effect

(Darley & Latane, 1968). The bystander effect has been defined as a social phenomenon whereby individuals are less likely to help others when accompanied than when they are alone. However, there are some situations where this is not the case, for example, public self-awareness (van Bommel, van Prooijen, Elffers, & Van Lange, 2012). This theory is interesting in the context of pain, as pain is a threat and has two consequences for the observer; fight or flight (Williams, 2002). Thus, when a stranger observes another person in pain, they can either respond to alleviate the pain, or flee the environment as there is a stimulus in the environment to cause the pain. However, when reviewing the literature, it was highlighted that the impact strangers can have on pain experiences has not been investigated within chronic pain patients, but instead it has focused upon experimental paradigms.

Firstly, if someone is aware of someone else being present it can often alter their expression of pain and participants suppress their reporting of pain (Block, Kremer, & Gaylor, 1980). In addition to the expression changing, pain is also perceived differently by strangers; overall, pain is underestimated by stranger observers, than the individuals experiencing the pain induction (Sullivan, Martel, Tripp, Savard, & Crombez, 2006b). When considering sex differences, male observers rate other people's pain to be at lower levels than female observers (Vigil & Coloumbe, 2011), especially when the person experiencing the pain was female. Furthermore, when providing participants with additional information about the people they are observing can also have an impact on how observers perceive strangers pain; when observers know the participant has chronic pain, they rate the pain as more painful, the more the participant moves (Martel, Thibault, Roy, Catchlove, & Sullivan, 2008). Following on from this research, Martel, Wideman, and Sullivan (2012) conducted a similar study recruiting patients with diagnosed chronic back pain. Martel et al., found that the individuals in pain who expressed protective behaviours or facial expressions when in pain were perceived to have the highest level of pain, when compared to those who did not show any pain expression or behaviours. Sex differences in the individual experiencing pain were accounted for, however, there were no significant differences between the rating provided by men or women.

In summary, pain ratings by stranger observers can differ, depending on how the pain is expressed, and prior knowledge. The above has indicated that men and

women perceive pain differently, and there are many factors that contribute to this. In addition to pain being perceived differently, less is known about how pain is expressed to strangers. However, it is worth noting that on some occasions, the experimenter could be considered a stranger. However, there is a potential difference between experimenter-participant dyads, and stranger dyads, in that there is a level of perceived authority in an experimenter, whereas this is not present in stranger dyads. Therefore, there is a growing interest in investigating the impact strangers can have on pain, but it is still an under-researched area.

1.6.3. Friends

Building on the stranger-based literature, and the continuum of how well the observer is known to the person experiencing pain, it is now of interest to investigate the impact of friendship on pain. Friendship can span the continuum from vaguely knowing someone to knowing someone very well. When focusing on the psychological mechanisms of friendships, high levels of friendship satisfaction can be associated with friends having a moderate level of extraversion, higher levels of agreeableness, empathy, conscientiousness, and low levels of neuroticism (Wilson, Harris & Vazire, 2015). In addition to this, friends also have differing levels of shared identity, depending on closeness, but it is these common factors that contribute to successful friendships, and as a whole these psychosocial contexts should be considered in friendship-based research (Akers, Jones and Coyl, 1998).

Similar to the research specifically focusing on strangers, the effect of friendship on pain reporting is largely under researched. Research that has been conducted has produced fairly consistent results; experiencing pain in front of a friend can have analgesic effects. For example, when support is provided by a friend (as opposed to no support), pain reports decrease (Brown et al., 2003; Jackson, Iezzi, Chen, Ebnet, & Eglitis, 2005). Conversely, when the pain is combined with a threatening message from a friend, pain tolerance on the cold pressor task decreases (Jackson, Huang, Chen, & Phillips, 2009).

The sex of the friend observing is also considered important, in that men report less pain when in the presence of a same-sex friend (McClelland & McCubbin, 2008). Reasons for this vary, but it may reflect an interaction between gender role expectations and social reinforcement (McClelland & McCubbin, 2008).

For example, and as previously mentioned, men are typically considered to be more stoic, less likely to express their emotions in an everyday context, and so maybe less likely to be seen drawing on social support (Barbee et al., 1993) – especially from other men (Eagly, 2013). In comparison, female friends may be more likely to focus on friendship around social support and intimacy, and be less inhibited to express signals associated with pain (Fischer, Sollie, & Morrow, 1986; Reis, Senchak, & Solomon, 1985). When drawing upon social psychology to explain differences in pain, it is possible that men and women interact with same and opposite-sex friends in different ways, but this has not yet been observed in the context of pain. Furthermore, of the minimal friend studies that have been reported, few took the sex context of dyads into consideration. Research specifically focusing on the role of friendship in the context of pain is rarely considered and no definite conclusions can be drawn upon at present.

In summary of this subsection, it is plausible to conclude that friendship can have an impact on pain experiences. There is evidence to also suggest that the sex of the friend's dyad can have an impact on pain experiences, with the explanations drawn from gender stereotypes and expectations. Even though there is evidence to suggest that friends have an analgesic response on pain, there is still limited evidence.

1.6.4. Romantic partners

When comparing the literature based on strangers and friends, it is evident that knowing someone can have an impact on how pain is reported and experienced. This next section will review the literature for romantic partners, where it is assumed that the closeness and connections between individuals is strongest. This will also enable a complete understanding of dyadic relationships along the continuum of how well adults can know each other. Romantic partners are at the extreme end of the closeness continuum, and possess specific psychological characteristics such as moderate levels of self-esteem to match their spouses (Conroy-Beam, Goetz & Buss, 2015). In addition to this, partners are empathic towards each other, and often share a lot of the same identity as they work together to achieve goals (Fraley & Shaver, 2000).

Individuals report their pain to many people, some of whom are not known to us, others are family members, children and romantic partners. The impact romantic partners (Flor et al., 1987) can have on pain has been extensively researched within chronic pain patients (Burman & Margolin, 1992; Cano et al., 2008; Cano et al., 2004a; Leonard & Cano, 2006; Leonard et al., 2006) but less is known in healthy adults experiencing acute or experimental pain. Typically, the research is focused around marital satisfaction and social support, and these two components are considered to be fundamental to a person living with chronic pain and their spouse (Cano, Johansen, & Geisser, 2004b). For example, in chronic pain patients, when a spouse doesn't provide high levels of social support, marital satisfaction decreased and pain severity increased, which consequently resulted in more depressive symptoms (Cano et al., 2000). Individuals experiencing the pain perceived their partners response as aggression and frustration towards their pain, which ultimately led to marital dis-satisfaction. Interestingly, no sex differences were present in the individuals who experienced the pain and their perceptions of marital satisfaction, even though women had higher pain sensitivity levels than men (Cano et al.; Bartley & Fillingim, 2013).

Patients' spouses are able to identify the pain being endured, and often rated the pain as more severe than patient did (Cano et al., 2004b). Additionally, when a spouse is living with chronic pain, marital functioning decreased (Leonard, 2006) and symptoms of depression increased, which made it difficult for spouses to accurately rate the pain (Mohamed, Weisz, & Waring, 1978). There is also evidence to suggest that when pain is experienced in lower levels, the individuals' relationship satisfaction also decreased (Flor, Turk, & Rudy, 1989). When there was little or no support shown by a significant other towards the individuals experiencing pain, marital satisfaction was low (Kerns et al., 1990). This suggests that chronic pain, marital satisfaction, and social support are closely linked.

When considering disability and limitations in physical activity in relation to adults with chronic pain, the individual experiencing pain reported their pain to be more intense, when compared to their spouses' pain rating (Cano et al., 2004). A few studies investigated the marital satisfaction of an individual who had a disability associated with their pain. Block and Boyer (1984) and Masheb, Brondolo and Karns (2002) showed that when there was support received from the spouse, the marital

satisfaction for the person in pain was positively related to the disability. Whereas, others show that marital satisfaction can be negatively related, meaning that the marital satisfaction was not directly due to the disability experienced due to the pain (Romano, Turner, & Jensen, 1997; Saarijarvi, Hyyppa, Lehtinen, & Alanen, 1990).

Saarijarvi et al. (1990) investigated sex differences in disability related pain and marital satisfaction; in males, marital satisfaction was not associated with their pain or pain-related distress. In women, disability-related pain was found to be negatively related to the spouse's marital satisfaction in females (Saarijãrvi, Rytökoski, & Karppi, 1990), but the literature specifically focusing on sex differences is limited (Leonard et al., 2006).

1.6.5. Summary of literature focusing on everyday relationships

The research available suggests that more needs to be done to understand how partners can impact on pain. There is evidence available to highlight that chronic pain has huge social components, and the interpersonal relationship chronic pain patients have, can impact on their wellbeing. However, between the different types of dyadic relationship, there are inconsistent methods. For example, the literature on strangers focuses on how strangers perceive pain; in friends, the literature focuses much more on the impact of having a friend present; and, the literature on romantic partners focuses on social support and only chronic pain. Thus, at present, there is little understanding on how partners can impact on temporary pain. It is important to consider acute and temporary pain because acute pain is very prevalent in society, with millions of people experiencing acute pain daily. It would be of importance to address different dyadic relationships in the context of pain by adopting the same methodology to allow for direct comparisons between different interpersonal relationships. The following section will outline the aims, research questions, and provide details of each chapter contained in this PhD thesis.

1.7. Aims, objectives and research questions

The above literature review has highlighted the importance of the social contextual influences on the reporting of pain. Focusing on the theoretical frameworks, in particular, the Social Communication Model of Pain (Craig, 2009)

emphasises how social factors influence how pain is encoded and decoded, which can subsequently have an impact on how the pain is experienced. There is a growing area of interest on the social and contextual influences of pain, especially as it can have an impact on pain perception, tolerance and how pain may be treated in a clinical setting. The current field of literature has focused on general observer effects and the impact others can have on pain, specifically in relation to strangers, friends and in romantic relationships. However, the impact of these everyday relationships has not yet been considered in the context of how pain is reported. Considering this gap in the literature, this thesis will aim to explore the effects of everyday relationships, specifically strangers, friends, and romantic partners on the reporting of pain, and why such differences might occur.

In addition to this, since there are clear sex differences reported in pain, I will also investigate whether there are any sex differences present in the participants experiencing pain, and sex differences present in the observers. Little research has considered the sex of the participant and the sex of the observers when investigating the impact an observer can have on pain. Thus, the presence of someone else can have an impact on pain reporting's and that there are clear sex differences present, and I will aim to bring these two concepts together.

The overall research aim of this thesis is to investigate how social and contextual changes can have an impact on the reporting of pain. In order to achieve this aim, Figure 1.2. and details below show a breakdown of what each chapter will entail.

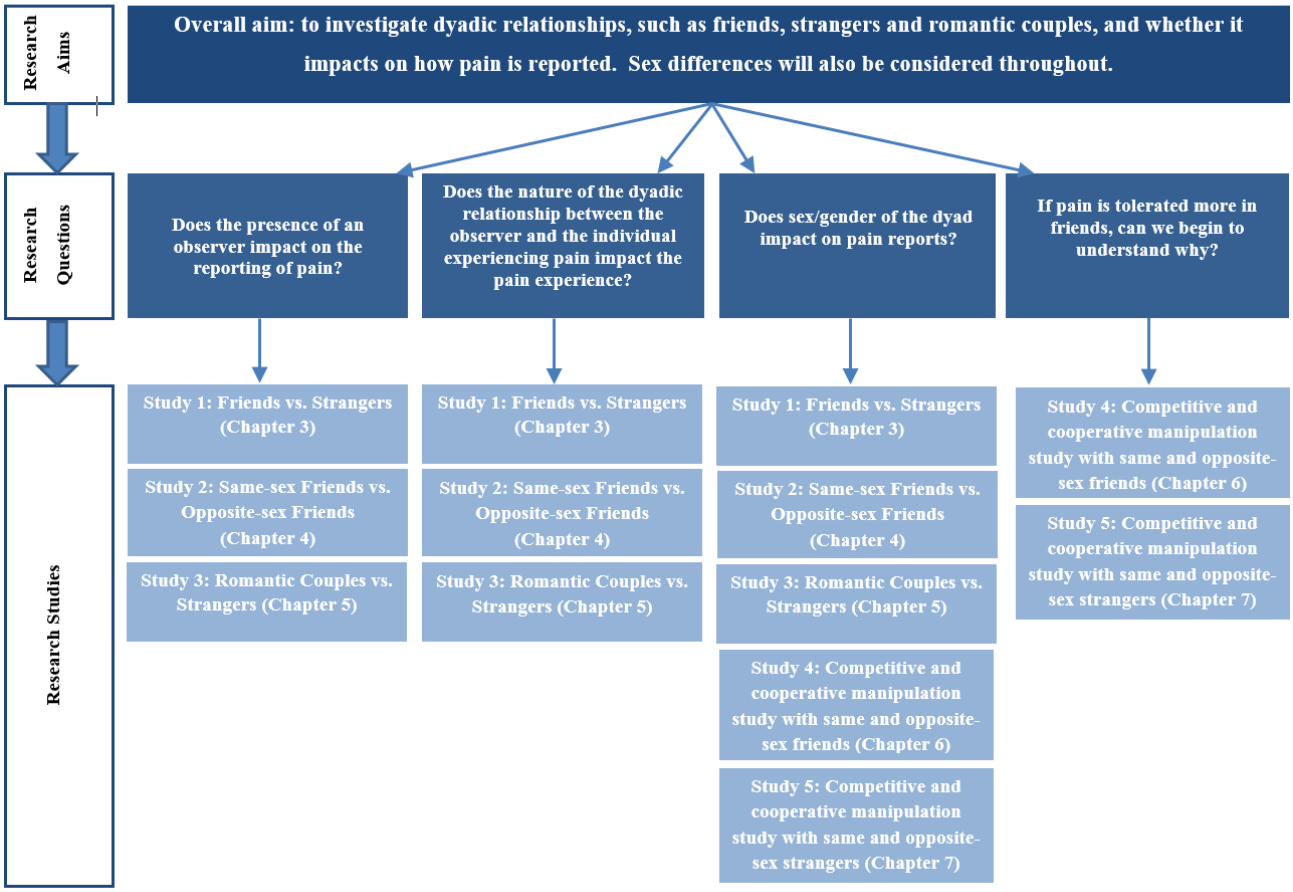

Figure 1.2. An outline of how the chapters will address each research question.

The above flow-diagram begins on Chapter 3, and this is because Chapter 2 will be a review of the methodologies used throughout this thesis. The methods chapter will begin by focusing on how the social mechanisms of pain can be investigated in an experimental setting, before moving on to review the different types of experimental pain induction equipment available.

In Chapters 3, 4, and 5 I will conduct experimental studies to investigate the effect of the role of an observer, including a friend, stranger or romantic partner, can have on the reporting of pain. This primarily makes up the first half of this thesis and will be explored through a series of experimental studies mirroring the same methodology. Each dyad will follow an experimental pain induction protocol, using the cold pressor task and algometer.

Within these three chapters, there are three core research questions that will be addressed:

1. Does the presence of an observer impact on the reporting of pain?

There is sufficient evidence to conclude that the presence of an observer can have analgesic effect of pain experiences, but this is still not well understood. Each of the studies in this thesis will directly consider whether the physical presence of an observer can have an impact on a person's pain.

2. Does the dyadic relationship between the observer and the individual experiencing pain impact on the reporting of pain?

As well as establishing whether or not an observer can have an impact on pain, the nature of the dyadic relationship will also be carefully considered. The dyadic relationship in each chapter will be carefully considered during the recruitment process; i.e. Chapter 3 will specifically look at stranger vs. friend observers, Chapter 4 will focus on same-sex friend vs. opposite-sex friend observers, and Chapter 5 will focus on opposite-sex friend vs. romantic partner observers. By specifically focusing on the different types of relationship in each chapter, a greater understanding of dyadic relationship types in the context of pain can be established.

3. Does the sex of the dyad impact pain reporting by an individual?

Throughout this literature review, it has become evident that there are sex differences in pain experience. Typically, men report less pain than women, and women can be more sensitive to pain than men. However, the sex of the dyads has not been extensively researched yet. Therefore, in each study, the sex of the participant and the sex of the observer will be controlled for. For example, irrespective of the type of dyadic relationship being recruited, half of the participants experiencing pain will be male and half will be female, and the same for the observers. However, this research question is not limited to the first three experimental chapters, and sex differences in participants and observers will be considered throughout all experimental studies in this thesis.

The results from the first three studies informed the latter half of this PhD thesis; it will be reported that having an observer present can decrease pain reporting. However, pain is reported differently, depending on who is present. Chapters 6, 7, and 8 will focus on why pain may be reported differently by men and women,

depending on the dyadic relationship involved. Drawing upon gender-based norms and stereotypes, studies 4 and 5 will consider competitiveness and cooperativeness as potential moderators. Competitiveness and cooperativeness are considered to be contributing components to a successful friendship, but they can also have an impact on how different emotions are expressed. Competitiveness and cooperativeness in the context of pain will be reviewed at the beginning of Chapter 6. The final studies in this PhD thesis will experimentally manipulate competitiveness and cooperativeness, to investigate whether there is an impact on pain.

4. If pain is tolerated more in friends, can we begin to understand why? *Competitiveness and cooperativeness may provide an explanation as to why pain threshold and tolerance levels differ, depending on the sex of the observer, and nature of dyadic relationship. Therefore, Chapter 6 will manipulate competitiveness and cooperativeness in friends, and Chapter 7 will focus on strangers. In both of these empirical studies, the sex of the participant and observer will be used in the analysis. In each of these studies, sex differences in the participant and observer will continually investigated.*

The next chapter will focus on the different methodologies available and adopted throughout this thesis.

Chapter 2: Methodologies adopted in this thesis

In Chapter 1, I began by defining pain and looking at the different models of pain, before then reviewing the literature on sex and gender differences, and how pain can be considered within a social context. The literature review has already shown how pain can be viewed as an interpersonal exchange (Craig, 2009), and that the presence of an observer has an effect on pain reports (Aslaksen et al., 2007; Badali, Pillai, Craig, Giesbrecht, & Chambers, 2000; Kallai et al., 2004; Levine & De Simone, 1991; Vandenbroucke, Crombez, Loeys, & Goubert, 2014; Vigil & Coulombe, 2011; Vigil et al., 2014a; Vigil, Rowell, & Lutz, 2014b). However, as I have argued, little is known about how specific everyday relationships in adults can have an impact on how pain is experienced, i.e. does the impact of a stranger differ from that of a friend or romantic partner. There are also unanswered questions about whether sex-related factors impact on such dyadic effects.

The aims and objectives of this PhD thesis were presented at the end of Chapter 1, and highlight how different dyadic relationships will be considered in the context pain, while also acknowledging sex differences throughout. During the last section of Chapter 1, there is a detailed overview of how each research question will be addressed, and there was a strong emphasis on experimental methodologies. The reason for an experimental methodology will be covered in this chapter.

In light of the research questions presented at the end of Chapter 1, this chapter will intend to: 1) review different ways in which the social context can be examined before concluding the approach that will be taken in this PhD thesis, and 2) identify how will pain be measured throughout this PhD thesis. Therefore, the chapter will be split into two respective sections, and will be presented in two slightly different formats; for the first section, a complete review of different methods will be performed, and then I will justify why I have chosen the method regarding the manipulation of social context. The second section will tabulate the possible types of experimental pain induction, and then the rest of the section will provide more details on the specific type of pain induction selected. In order to fully answer each of the research questions presented in the previous chapter, both of these points are important to consider, and I will start by reviewing how the social context will be manipulated in this PhD.

2.1. Types of methodology to manipulate the social context

As highlighted above and in the previous chapter, I am drawing together two independent fields of psychology; social-contextual psychology, and experimental pain induction. The justification for experimental pain induction will be outlined later in this chapter, and I will start by specifically considering social contextual psychology, and how it can be applied to pain. There are a number of different ways to approach research investigating social context, and the following subsection will consider some examples of the way in which context can be considered. I will start by appraising different methods for measuring social context, for example, with the use of vignettes; manipulation of internal environment; manipulation of the external environment; and manipulating sex differences. This section will conclude by focusing on the social context methodology adopted in this thesis.

2.1.1. Vignettes

2.1.1.1. Description

Vignette methodologies are popular in psychological research, particularly in experimental studies, for focusing on hypothetical situations whereby the internal or external environment may be manipulated. Vignettes present a hypothetical situation, and the manipulation part of vignette methodology focusing upon participants how they might respond in that situation. The key approach is that they can be experimentally manipulated, changing the content in some subtle way to consider whether they affect decisions made by particulates. For example, vignettes have successfully been used in pain research with adolescents, specifically focusing on how pain can conflict with a goal such as doing well academically (Fisher, Keogh, & Eccleston, 2016). The vignettes provided adolescents with hypothetical situations regarding their pain, and were asked to rate how likely they were to approach or avoid the situation; this was shown to be a good method to provide both typically-developing and chronic pain adolescents with hypothetical situations (Fisher et al., 2016). Additionally, vignettes have been successfully used in pain research conducted in adults (Hirsh et al., 2008; Ingadottir, Blondal, Jaarsma, & Thylen, 2016; MacLeod, LaChapelle, Hadjistavropoulos, & Pfeifer, 2001). For example, MacLeod et al., (2001) found that vignettes was a good methodology for predicting outcomes based on pain experienced by accidents, and how the individual

would then go on to cope with the pain, and found that this was an advantageous methodology for assessing coping mechanisms for pain (MacLeod et al., 2001). Overall, vignettes are a diverse, experimental manipulation methodology which is effective in assessing outcomes to hypothetical situations.

2.1.1.2. Appraisal

Vignettes have been widely used in medical-based research, as they often provide a good opportunity to explore potential outcomes without major ethical dilemmas about testing in real world situations (Aguinis & Bradley, 2014; Gould, 1996). Building upon this, vignettes provide researchers with the opportunity to also examine someone's knowledge on a particular area (Heverly, Fitt, & Newman, 1984); for example, the response to a simulated hypothetical medical emergency can be assessed via a vignette (Gould, 1996). Finally, one of the other major advantages of using a vignette methodology, is that it reduces the impact of observer effects; thus, can often provide researchers with an unbiased, and more accurate response to a hypothetical situation (Gould, 1996).

Vignette methodologies are considered to be a hybrid of traditional experimental methods and a traditional survey, which can provide high internal and external validity (Evans et al., 2015). There is a wealth of research focusing on clinicians; responses to specific scenarios presented as vignettes, particularly when focusing on the diagnosis of mental and behavioural disorders (Evans et al., 2015; Ross, Moffat, McConnachie, Gordon, & Wilson, 1999). When considering using vignette methodologies within a clinical environment, the social context described to participants can be varied or controlled(Evans et al., 2015). By controlling how much contextual information is given in the vignettes, this method is particularly good method of assessing how much of an influences context may have on an individual's diagnosis.

Vignette methodologies are a popular and well-utilised method for assessing hypothesised clinical practice (Bachmann et al., 2008; Peabody & Liu, 2007; Peabody, Luck, Glassman, Dresselhaus, & Lee, 2000; Peabody, Luck, Glassman, & et al., 2004; Veloski, Tai, Evans, & Nash, 2005), and have been used to inform researchers about social and contextual influences in the context of pain. For example, when considering vignettes as a methodology in pain research, parent-child

interactions have been considered (Caes, Vervoort, Eccleston, & Goubert, 2012; Goubert, Vervoort, Sullivan, Verhoeven, & Crombez, 2008; McMurtry, Chambers, McGrath, & Asp, 2010). In the Goubert et al. (2008), study, parents examined vignettes regarding hypothetical pain situations their child may experience, and were asked to rate the emotion responses they would experience. The responses the parents gave were dependent on a myriad of cognitive, emotional, and behavioural responses, but overall, observing a child in pain was considered distressing. Building upon this further, Caes et al., (2012) found that parents prioritised the pain control more when the pain was considered to be chronic; highlighting an additional level of complexity between chronic and acute pain. Both of these examples show the benefits of using vignettes, as opposed to creating pain situations.

Vignette methodologies have also been used to examine social contextual effects on pain, by manipulated information provided (Chibnall & Tan, 1999; MacLeod et al., 2001). Chibnall, Tait and Ross (1997) focused on the contextual influences that can impact on how chronic back pain is diagnosed by focusing on the healthcare professional-patient relationship. Healthcare professionals were asked to read numerous hypothetical situations that chronic pain patients were presenting, which varied in pain intensity, emotional distress, and pain-related disability. The judgements of pain were higher for the patients who had a clear pain-history, and when their pain intensity was higher. However, these findings were also described in the context of whether the healthcare professional was known to the chronic pain patient or not. Thus, this shows the relationship between the healthcare-professional and the chronic pain patient is important, and may have an impact on how pain is diagnosed. Chibnall and Tan (1999) built on this work further and found that when social variables such as ethnic stereotypes were present, more judgements about pain behaviours were formed. Other factors such as race and ethnicity were also considered, and when combined with strong medical evidence, the pain was perceived to be less legitimate.

2.1.1.3. Weaknesses

Despite vignettes being a popular methodology for both children (Fisher et al., 2016), and adults (MacLeod et al., 2001), there are some weakness of the method that warrant further discussion. One of the main limitations to this methodology is

that it is an artificial method for assessing outcomes; vignettes provide participants with hypothetical situations, whereas in reality the outcome may be very different to what the participant indicates via a vignette methodology. Therefore, despite vignettes being a reliable method for assessing outcome behaviours, when considering the research questions for this PhD thesis, this method is not be most appropriate. For example, this PhD thesis aims to identify differences between different dyadic relationships in the context of pain; vignettes produce a hypothetical situation but I am investigating the physical social context.

2.1.1.4. Conclusion about method

Together this section shows that vignettes can be used to target various specific social and contextual influences within the context of pain, many of which may not be controlled for in a real-world setting. However, this method is not appropriate to use in this PhD, as the main research questions are focused around the physical social context and the environment.

2.1.2. Manipulation of internal environment

2.1.2.1. Description of approach

The contextual influences on pain can also be considered by adopting an internal social goal manipulation methodology, to vary the pain context. This is a different type of methodology to vignettes as goal manipulation methodologies do not create hypothetical situations, and they typically adopt a more experimental approach. When considering research outside of the field of pain, the manipulation of the internal environment is a popular methodology that enables situations to be manipulated, and behavioural outcomes to be measured in a controlled, experimental manner. For example, in social psychology, competition is a popular psychological concept that can be manipulated through a video game manipulation task (Mason & Clauset, 2013) or a cognitive task (Parise & Rollag, 2010). In most manipulation tasks, there is a high motivation towards a specific goal, and it is often this goal motivation which makes the manipulation task successful, i.e. winning a game is the goal motivation that makes the manipulation of competitiveness successful. Goal motivation can be perceived as an important part of a manipulation task. An alternative type of manipulation task that is also effective is distraction.

Goal manipulation methods include varying the attentional context of pain, by asking participants to focus or distract away from pain. Distraction can be considered a manipulation of social context because the internal environment of the individual is still changing; distraction and engaging in something else is still considered a change in context. There have been some studies that have focused on distraction in the context of pain, which can be considered a manipulation task (Van Damme, Crombez, Van De Wever, & Goubert, 2008; Verhoeven et al., 2010). In Van Damme et al's (2008) study, participants performed a cognitive distraction task, and when combined with verbal manipulation of low threat, lower pain ratings on the cold pressor task were noted. Conversely, in Verhoeven et al., (2010) study, the distraction task did not result in differing pain ratings on the cold pressor task. However, a combination of a distraction task and low catastrophizing did result in less pain being reported. Thus, the intensity of the pain did not alter, but the pain tolerance did. These two studies are examples of how a manipulation task can be applicable to pain research, specifically when focusing on the social contextual influences of pain. When manipulating an individual's cognition towards pain, the amount of pain experienced differs.

2.1.2.2. Appraisal

One of the main advantages to this methodology is the way the manipulation tasks can be carried out in controlled environments. By having a task, such as manipulating competitiveness, that can manipulate how the participant feels, it can allow for a specific investigation in to how the manipulation can have an impact on pain. An additional advantage to using this methodology is that manipulation tasks have been used successfully in social psychology research, and is becoming increasingly popular within pain. For example, for the last two decades, attentional biases have grown in interest in the context of pain, which are typically studied by manipulating the internal environment by an attention based task which individuals who are and are not in pain. This method allows for accurate and precise manipulation in order for specific effects to be identified.

The manipulation of the internal environment can also be used as an experimental paradigm before recruiting participants in to a more real-life

environment. By completing a laboratory based study, experimental data can be collected and interpreted before replicating the research in a more clinical setting.

2.1.2.3. Weaknesses

Above I have mentioned that an advantage to using manipulation studies is that is can be conducted in a controlled environment, however, this can also be a major weakness in this methodology. While the manipulation tasks are useful in identifying the initial effects of concepts such as competition or distraction, within a pain context, the manipulation tasks can provide limited information with regards to what happens in the real-world. Manipulation of the internal environment can also produce hypothetical results; the results observed after a laboratory manipulation may not be the same as the results observed in a real-life competitive environment, whereby the goal motivation may be a lot higher.

2.1.3.4. Conclusion

This subsection, and the subsection above focusing on vignettes, has shown that the social context of pain can be controlled in an experimental setting, and when manipulated, there is a change in how pain is experienced and reported. However, what these sections haven't considered yet is how the physical presence of someone else can have an impact on pain. Next, I will focus on this, by specifically considering observer effects and dyadic methodologies.

2.1.3. Manipulation of external environment of participants

2.1.3.1. Description of approach

In addition to manipulating the internal context a person finds themselves in, it is also possible to vary the external (social) environment. The impact of different observers on pain was extensively reviewed in Chapter 1 (section 1.4.3.). However, as this is a type of methodology, it is important for it to be considered here within this methodological chapter also.

In recent years, there has been an increase in the number of studies accounting for other people present during a pain task (Brown et al., 2003; McClelland & McCubbin, 2008; Vigil & Coulombe, 2011). Observer effects broadly refers to the impact others can have on a pain experience, and this has been

considered within clinical (Leonard & Cano, 2006) and experimental settings (Goodman & McGrath, 2003). Typically, research focusing on observer effects focuses on the impact the audience can have on how pain is reported (Brown et al., 2003). The following subsection will address this approach.

2.1.3.2. Impact others can have on pain experiences

When considering the impact others can have on pain experiences, a popular approach is to adopt an experimental paradigm, often using pain-free adults as participants who then complete a pain induction task whilst accompanied by an observer (Brown et al., 2003; Vigil & Coulombe, 2011; Vigil et al., 2013) (the types of pain induction tasks are explored in more detail later on in this chapter). Different people can be recruited to adopt the role of an observer; for example, the experimenter can also fulfil the role of an observer and impact on pain experiences (Aslaksen et al., 2007; Kallai et al., 2004; Vigil et al., 2014a). A basic approach to this method is to simply have an observer present during the pain task, the presence of another person can create a dynamic social environment that can be measured in the context of pain. The participant completes the pain task whether or not an observer is present; i.e. in some approaches, the participant can physically see the observer (Brown et al., 2003), and in others the participant is just aware there is someone else in the environment (Badali, 2000). This allows for the social context to be manipulated, but only by having an observer present or not. The advantage to this method, is it does then allow the method to be built upon, for example, different contexts can be created.

Another way to examine the impact of an observer, is to allow communication between the person experiencing pain and the observer. A study by Brown et al. (2003) is a good example of how this paradigm works; Brown and colleagues wanted to investigate the role of social support (via a context manipulation: a friend or stranger were present) and the impact it can have on pain reporting's. The observers were present during the cold pressor task, and provided different levels of support when interacting with the person experiencing the pain. As part of the analysis, the dyadic relationship and level of social support was considered, which highlights that investigating the role of an observer can be

adapted to different paradigms which focus on social and contextual influences on pain.

2.1.3.3. Appraisal

One of the main strengths of this methodological approach is that it is versatile and can be adapted to fit many different experimental paradigms. For example, the initial steps of this methodology require the experimenter to note the external environment; whether there is an observer present or not. This can then be built upon further by considering who the observer is, and whether the dyadic relationships can be manipulated. For example, in this thesis, I will address the role of strangers, friends, and romantic partners on pain, so this methodology allows for the dyadic relationship to be considered. Further to this, this approach also allows for the audience to be manipulated further; there may be one observer present, who a whole audience (Vigil & Coulombe, 2011).

Used in different settings; the external environment can be considered in experimental work, clinical populations, and in acute pain settings. This methodology can be adopted in controlled, experimental studies, which have been mentioned previously. For example, the size of the audience can be increased in increments during a pain task, which results in clear sex differences; men suppress their pain intensity scores with the more people that are present (Vigil & Coulombe, 2011). In addition to this approach being adopted in an experimental setting, it can also be considered within clinical research too; the external social context is important in all pain settings, as the presence of someone else can impact on clinical research (Hurter et al., 2014).

2.1.3.4. Weaknesses

One of the key limitations to this methodology, is that this approach can become complex, very quickly. By controlling for the sex of the observer, how many observers present, and the dyadic relationships present can make experimental paradigms complicated. However, in order of preventing the paradigm becoming unmanageable, I will split the dyadic relationships down into individual studies, i.e. I will recruit specific dyadic relationships in specific studies which will mirror the same methodology.

2.1.3.5. Summary of this method

As highlighted above, the manipulation of the external environment is a popular, robust methodology for focusing on the social context of pain. This methodology also allows for experimenters to carefully control specific characteristics of the observer too, such as their sex, and the dyadic relationship present. This methodology will be adopted throughout this thesis as it is the most suitable method to fit with the research questions; the research questions outlined in Chapter 1 highlight that the area to be researched is the physical presence of someone else, while noting whether the dyadic relationship can have an impact on pain. In addition to this, this methodology also allows for sex differences of both the participant and the observer to be focused upon.

2.1.4. Manipulation of social context - methods to be used in this PhD thesis

The above sections have reviewed the different methodologies for measuring pain in a social context, including the use of vignettes, through context manipulation, observers, and accounting for sex differences. These four different types of methods emphasise that pain does not happen in isolation, and it is a social phenomenon that most individuals experience during their life. When considering vignettes, context manipulation, and observer effects in particular, the impact of someone else and the dyadic relationship needs to be considered. For example, vignettes add context and often target a specific dyadic relationship, e.g. parent-child, healthcare professional-patient. This is similar in context manipulation; there is a reason for the context to be manipulated and it often requires someone else to either physically be present or hypothetically be present. Finally, and obviously, the dyadic relationship is important to consider when specifically focusing on the effect of an observer. Interestingly, all of the methods typically adopt an experimental paradigm at present, and this may be for two reasons; measuring the social influences on pain is a new area of research, so it is often better to start in a controlled environment such as a laboratory. Secondly, it is difficult to adopt these methodologies in a real-world setting as often the precise dyadic relationships need to be considered, which is difficult to control for outside of a laboratory environment. Thus, throughout this

PhD thesis, I will adopt an experimental paradigm that will specifically focus on the presence of an observer and how they dyadic relationship can impact on pain. This also allows the sex of dyad to be considered.

I have decided to specifically focus on the presence of an actual observer as a method as it provides a basis to explore many different additional experimental paradigms. For example, the beginning part of this PhD thesis focusing on the physical presence of someone else and the impact it has on the person experiencing pain (research questions 1 and 2, from Chapter 1), before specifically focusing on the dyadic relationship and whether we can begin to understand more about differences observed (research questions 3 and 4). There are many advantages to using this methodology that include the adaptability of the method; the method can be slightly adapted for different research questions, for example, the same method can be used but different relationships can be focused upon. It's a reliable method that has been previously used when investigating the social and contextual influences on pain.

2.2. How can pain be measured?

The above section(s) have highlighted how pain can be considered in a social context. The next part to address is how pain is measured. There are multiple different experimental pain induction methods that could have been adopted for this thesis, and in the next section I will review different types of self-report pain induction, and then provide a detailed review of the pain induction methodologies adopted in this thesis.

When considering paradigms of empirical studies, there are many different types of pain to consider; for example, surgical, clinical, and experimental pain. However, this PhD thesis is going to focus on experimental pain induction. This are many reasons for this, including that the paradigm adopted throughout this thesis is novel, so to begin with healthy adults experiencing experimental pain indication is the best way to investigate the effects of an observer. Additionally, one of the other reasons for adopting an experimental pain induction methodology is due to the previous literature in the area; the previous findings focusing on social and contextual influences on pain, and more specifically the impact an observer can have on pain, has been explored using an experimental pain induction. Thus, by using the

same method, the studies in this PhD can be interpreted in the same way as previous literature, which builds on the information already know, before exploring the impact observers have on other types of pain, e.g. more chronic pain.

Often experimental settings are favourable as they can provide a more controlled environment which can allow specific focus on an aspect of pain being considered, for example the difference between pain threshold and pain tolerance. While chronic pain has been considered within an experimental setting, more often, healthy pain-free individuals are recruited to complete a method of pain induction. Pain-free individuals are often used for ethical considerations; it would be highly unethical to administer more pain to a chronic pain patient; thus, by using pain-free individuals in a laboratory setting provides a good foundation for research which is then conducted in a more applied setting, e.g. in a pain clinic. There is evidence to suggest that pain induction methodologies are a robust and reliable method, and have recently increased in popularity when considering the social and contextual influences on the reporting of pain. Given this, the main decision to be made is the type of induction to be used in this PhD.

2.2.1. Types of experimental pain induction

There are multiple types of pain induction available including, mechanical, chemical, electrical, and thermal pain induction. Each of these have been used in differing amounts, and Table 2.1. below provides more details of each method.

Table 2.1. *An appraisal of the different types of experimental pain induction, and how they have previously been adopted in research investigating the social influences on pain*

Modality	**Populations used in (e.g. clinical, child)**	**Examples of specific pieces of equipment**	**Key findings relating to social context of pain**	**Positive appraisal of using this method of pain induction**	**Negative appraisal of using this method of pain induction**
Mechanical pain (external)	Healthy adults, chronic pain patients	An algometer, measuring pressure pain in kPa. Von Frey hairs (calibrated filaments) that measure pain sensitivity	- Used in sex differences research. Overall, females have a consistently lower pressure-pain threshold than males - Limited research in a broader social context	- Simple, non-invasive, - Not time consuming - Has been used in social contextual paradigms - Reliably identifies sex differences	- some studies disregard sex differences in this type of methodology
Mechanical pain (internal)	Healthy adults	Oesophagus and colon distension	This methodology has not been used in the social and/or contextual influences on pain.	- Clinical relevance as it linked to sensations experienced by individuals with Irritable Bowel Syndrome	- Not yet been used in a wider pain context
Chemical pain	Healthy adults, individuals with arthritis	Capsaicin (injection and cream which comes from chilli plants) and mustard oil are used in chemical pain studies. 100 μg	This methodology has not been used in the social and/or contextual influences on pain.	- Capsaicin can be used in multiple ways; an injection just under the skin, and as a moisturising cream which can provide multiple variations in methods	- Not been used in social pain literature - Not a reliable method of pain induction due to mixed results. The results of both

		capsaicin evokes a burning sensation that is short-lasting			Capsaicin and mustard oil fail to show effects when applied to a neuropathic pain model
Electrical pain	Pain-free adults; chronic pain patients	This piece of equipment is used by placing multiple electrodes on the skin which evoke an electrical stimulation. Depending on the paradigm, the electrical stimulation can differ in waveforms, frequencies and duration	This methodology has not been used in the social and/or contextual influences on pain.	- a very controlled methodology which allows for close observation of different variables	- Electrical stimulation bypasses the receptors and activates the nerve fibres directly, and the method is not a specific activation of the nociceptors - A very unique pain sensation that is not experienced in everyday life - An artificial pain experience
Thermal: heat	Healthy pain-free adults, children	Medoc Pathway Advanced Thermal Stimulator is designed primarily used for in clinical and research settings, and has approved built-in safety restrictions. The Medoc can reach temperatures of up to	- women have a greater sensitivity to thermal pain than men, however, sex differences using this methodology have been not been consistently considered	- used in a range of paradigms including task switching, understanding the relationship between smoking behaviours and pain intensity, and in fMRI studies detects sensory activity in the context of pain, highlighting the variability for this piece of equipment.	- hasn't been widely used in research in sex and gender differences - Hasn't been used in dyadic methodology

		55ºC, and the temperature can change up to 8ºC/second.	- Specific focus on the social context of pain, apart from sex differences, has not been considered using thermal heat pain		
Thermal: cold	Children (von Baeyer, Piira, Chambers, Trapanotto, & Zeltzer, 2005) and adults (Vigil & Coulombe, 2011).	- the cold pressor task. The water temperature is maintained by a Techne thermoregulator and a dip cooler (Model: RU—200), and the water is also circulated to prevent ice and local warming around the participants hand	- Similar to thermal (heat): women have a greater pain sensitivity and a lower pain tolerance, when compared to men - This method has been previously used when considering the impact of a single observer and a larger audience	- The cold pressor task in considered to cause mild of moderate levels of pain, and the pain experience is always under the control of the participant (i.e. they can withdraw to stop the task). - considered a safe, reliable method in children and adults. - Research has indicated strong sex differences are apparent with this piece of equipment	- this is an example of non-clinical pain induction

2.2.2. Types of pain induction adopted in this PhD thesis

Table 1 shows that there are many different types of pain induction available, and within each type, there are many different pieces of equipment too. As highlighted above, mechanical and thermal (cold) methods of pain induction are two independent reliable methods of pain induction, particularly within experimental paradigms. Both of these methods have been recently used in research focusing on the social and contextual influences on the reporting of pain, and sex differences in the context of pain. For these reasons, this PhD will focus on these two different types of methodologies. The following sub-sections will give a more in-depth review of the literature that has previously adopted these methods within experimental studies.

2.2.2.1. Experimental pain: Mechanical stimulation (external)

2.2.2.1.1. Rationale and appraisal for mechanical stimulation

External mechanical stimulation has been widely used in experimental pain induction, and there is evidence to suggest that it is appropriate methodology for both healthy adults (Balocchi et al., 2005) and individuals with chronic pain (Hidalgo-Lozano et al., 2010; Park, Kim, Park, Kim, & Jang, 2011). External mechanical simulation can also relate to pain that is experienced every day, for example, a cut, bite or a stab. Thus, as the examples suggest, the type of pain is an external influence on the body, and the primarily target for the stimulus is the skin and/or muscular tissue.

Mechanical stimulation, and specifically pressure pain, is a reliable experimental method often used in research identifying sex differences (Chesterton et al., 2003; Riley et al., 1998). Overall, women have a consistently lower pressure-pain threshold than men (Myers et al., 2001), and these findings have also been identified in a more recent review (Bartley & Fillingim, 2013). However, pressure-pain has not been considered in a wider social context; to my knowledge, no studies have focused on pressure-pain as a method for investigating the effects of an observer, audience, with sex differences. Despite the lack of evidence in using pressure-pain in contextual pain research, this PhD will still continue to use this method as part of the experiential paradigm in the empirical chapter. There is sufficient evidence to suggest this method is robust, and has been used for decades in

sex differences research; given one of the research questions throughout this PhD is to focus on sex differences, it is evident that this methodology should be employed to replicate the methodologies previously conducted in this area of research.

As with any methodology, there are multiple advantages and disadvantages for each modality; the main advantages and disadvantages have been identified in Table 1. For example, as this PhD thesis will adopt two different types of pain induction methodology, it is important to consider the reliability of the method, along with how invasive it is; external mechanical pain is considered to be non-invasive and a simple method of pain induction. The additional advantage of adopting mechanical pain stimulation is that the procedure is relatively short, and not too time consuming.

Aside from the more practical appraisals of this method, there is also an increase in its popularity to be used in sex differences research. There have been multiple reviews and empirical studies that have considered mechanical stimulation as a reliable method of identifying sex differences in the context of pain (Bartley & Fillingim, 2013; Fillingim et al., 2002; Fillingim et al., 1999; Fillingim et al., 2009; Racine et al., 2012a; Riley et al., 1998). However, despite there being well documented sex differences in mechanical stimulation, many studies that include pressure-pain as a method of pain induction disregard potential sex differences present (Isselée, Laat, Bogaerts, & Lysens, 2001).

As previously outlined in the above section, despite there being some limitations to mechanical stimulation, I do believe that this method is highly relevant to the research questions presented in Chapter 1 in this thesis. The following subsection will focus on the use of an algometer, a specific piece of equipment used in external mechanical pain stimulation, and will also be used in this thesis.

2.2.2.1.2. Overview of apparatus and approach

The algometer allows the researchers to probe the skin which enables a pressure pain threshold reading to be taken (the unit for measuring pressure pain is kilopascals [kPa]), and is considered to be more of a natural pain stimulus, which includes similar sensations that are experienced in everyday life, like a cut or bite, as previously mentioned (Lautenbacher & Fillingim, 2004). Pressure is applied by the experimenter at a constant rate, and the pressure can be applied to many different

sites on the body including the forearm (Hastie et al., 2012), knee (Wylde, Palmer, Learmonth, & Dieppe, 2011), neck (Marini et al., 2012), the web of the hand (Nie et al., 2005), the temple (Jensen, Bendtsen, & Olesen, 1998), and sternum (Melia et al., 2015). (Melia et al., 2015). Image 2.1. (below) shows how pressure is applied to the inside of the forearm by the algometer; the algometer can be set to apply pressure at a specific rate, and the researcher can apply the pressure to the participant using the screen on the algometer as a guide (for example, pressure can be applied at a rate of 30 kPa/sec).

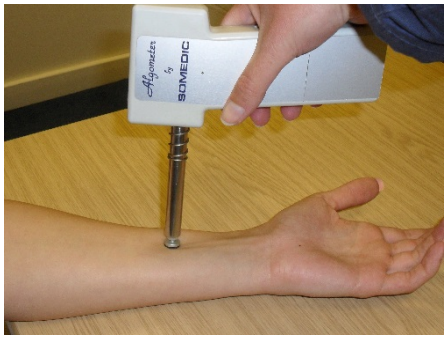

Image 2.1. The Somedic Algometer at Bath Centre for Pain Research. It comprises of a 1cm^2 round rubber surface which comes in contact with soft tissue (Kinser, Sands, & Stone, 2009).

Despite there being multiple sites of stimulation, the procedure in identifying the pressure-pain threshold is the same; participants are asked to indicate the first point they feel a painful sensation (this indicates the pressure-pain threshold) and the device is immediately removed. Once the participant declares that they are experiencing pain and/or discomfort, the researcher can stop applying pressure and the algometer automatically records how much pressure was applied. Typically, multiple readings are taken so an average can be taken to ensure results are reliable (Waller, Straker, O'Sullivan, Sterling, & Smith, 2015), and to also control for any practice effects that may occur with the participants.

This subsection focusing on pressure pain has outlined how it has been used in previous research relating to sex differences, appraising the mechanical pain as a whole, before focusing on a specific type of pain induction equipment, such as the algometer. As outlined in earlier section, the following section will now review

thermal (cold) pain as a method used to investigate social and contextual influences on pain.

2.2.2.2. Experimental pain: thermal pain induction

2.2.2.2.1. Rationale and appraisal for cold thermal pain induction

Cold thermal pain induction as an experimental pain induction task has been used for decades, and in recent years, has been used more when investigating the social and contextual influences in pain. Cold thermal pain is considered to be a mild to moderate method of pain induction, and is a reliable and robust method for assessing pain threshold and pain tolerance. Despite it being an example of a non-clinical pain, and more applicable to pain experienced by ice, this is one of the few methodologies that allows for both threshold and tolerance readings; the other methodology is heat thermal methods. By having the option to record threshold and tolerance, it allows for a closer examination of the effects that may be observed in results; for example, if there is a change in pain experiences, by adopting this methodology, it allows for a closer breakdown of the results, to examine whether the pain experience differed at threshold or tolerance.

To have both threshold and tolerance readings coincides with research focusing on the social and contextual influences on pain well. Often, the social and/or context can have an impact on pain experiences, for example, having someone else present can have an analgesic effect, and by having both threshold and tolerance readings, a greater understanding can be gained of when this analgesic effect happens. This appraisal and rationale fits with the aims and objectives of this PhD thesis, as outlined at the end of Chapter 1; i.e. supporting the overall aim is to investigate whether different dyadic relationships have an impact on how pain is reported.

The investigation of sex differences is another main research question, and will be considered throughout this PhD thesis. With regards to sex differences in experimental pain, the cold thermal pain induction has been a popular method for investigating and identifying differences in men and women. Within adults, overall on the cold pressor task, men typically have a higher cold pressor threshold (Manning & Fillingim, 2002) and tolerance (Nayak, Shiflett, Eshun, & Levine, 2000) than women. Increasingly, over recent years, the cold pressor task has been

used to investigate sex and gender differences in the reporting of pain (Popescu, LeResche, Truelove, & Drangsholt, 2010; Racine et al., 2012a), and the social influences on the reporting of pain (Meredith, 2013; Riva, Wirth, & Williams, 2011; Vigil et al., 2014a). Interestingly, there has not been a recent review on cold pressor methodology in adults, but a review conducted by (Racine et al., 2012a) highlighted 32 studies that had included the cold pressor task and accounted for sex/gender differences. The results of the systematic review indicated that there is not a sex difference in pain threshold levels, suggesting that men and women have similar pain thresholds on the cold pressor task (77% of the studies showed no sex differences) (Racine et al., 2012a). However, over 80% of the studies included in the systematic review concluded that men can tolerate more pain than women. In line with the results from the systematic review, more recent research published after 2012 has also shown than men have a higher pain tolerance than women (Bartley & Fillingim, 2013; Myers et al., 2001; Sullivan, Tripp, & Santor, 2000).

Given that the field of research already considers this as a method of pain induction that is suitable to this research question, is an additional reason as to why this method will be adopted throughout this thesis.

2.2.2.2.2. Overview of apparatus and approach

Cold thermal pain induction methods typically include the use of a cold pressor task (as shown in Image 2.2.). The cold pressor task is a safe and valid method of pain induction and has been seen in research with children (von Baeyer et al., 2005) and adults (Vigil & Coulombe, 2011). The cold pressor task in considered to cause mild or moderate levels of pain (Myers et al., 2006; Trapanotto et al., 2009), and the pain experience is always under the control of the participant (i.e. they can withdraw to stop the task). During the cold pressor task, participants are asked to submerge their hand into the ice water (which is kept at a constant temperature (Brown et al., 2003; Myers et al., 2001)), and are timed from the point of immersion. The participants are asked to indicate when they first experience a painful sensation (which indicates their pain threshold level) and then withdraw their hand when they can no longer tolerate the pain (indicating their pain tolerance level). Typically, for the safety of the participants and to comply with ethical approval, studies adopt an upper limit for the period of time the participants could submerge their hand for; for

example, a maximum of 2 minutes will be used and if this maximum time is reached, the experimenter will ask the participant to remove their hand from the ice water bath (Keogh et al., 2000).

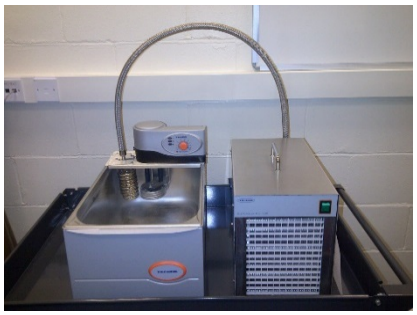

Image 2.2. This a photograph of the cold pressor equipment at the Bath Centre for Pain Research.

In addition to the ice water bath, this methodology also contains an extra water tank at room temperature (not featured in Image 2). The participants submerge their hand in the room temperature tank of water for 2 minutes prior to the ice water tank, and this ensures the temperature of the hand standardised [for example, Vervoort et al. (2011b)]. Additionally, after the pain task, participants are advised to put their hand back in the room temperature water to bring the temperature of the hand up.

This section focusing on cold thermal pain induction as a method has highlighted its suitability for this thesis, and specifically, the cold pressor task is a specific piece of equipment that has also previously been used in experimental methodology focusing on the social influences on reporting pain. For these reasons, along with pressure-pain, the cold thermal pain will be adopted as the two methods for pain induction in this PhD.

2.3. Self-report

As outlined in Chapter 1, pain is a highly subjective experience to each individual, which makes it difficult to make comparison between individuals (and within specific groups). Younger, McCue, and Mackey (2009) reviewed the literature based on pain experiences and emphasised that accurately measuring pain is complicated due to its subjectivity, but accuracy is essential for analgesic-based

outcomes. Since pain is so subjective, it seems that the best way to ascertain insight into the pain that someone is suffering is to ask them. Clinicians and researchers therefore rely on self-report measures of pain as the main method of assessing someone's pain. Asking someone to self-report their pain often involves numerical rating scores and visual analogue scales; both of these are effective in rating pain as they provide a succinct method of measuring pain. One of the key methodological question was therefore to decide on how best to measure the subjective experience of pain through self-report. The next section will briefly outline the main tools, and I will explain which one I have chosen here.

Unidimensional scales are a popular tool to assess pain as they are simple, quick to administer, and are easily understood by patients and participants alike. The most popular unidimensional scales used in pain research and clinics are numerical rating scales (NRS) and visual analogue scales (VAS); both have a similar concept whereby the patient or participant indicates a number between 0-100, or marks on a 10cm line, respectively, how they rate their pain from *no pain* to *worst pain imaginable*. These measures are very similar to each other, and are very useful as they provide an indication of how the patient or participant are experiencing the pain, and are often used in experimental paradigms (Brown et al., 2003; Leong et al., 2015; Vigil & Coulombe, 2011; Younger et al., 2009).

In addition to rating the intensity of the pain, there is often a desire to understand the type of pain the individual is experiencing, as this can help with pain management and treatment (Ferrell, 1991). There are numerous multidimensional scales available for researchers and clinicians to use, with some tailored to a clinical population (Cleeland & Ryan, 1994; Kerns, Turk, & Rudy, 1985; Rogers, Wittink, Wagner, Cynn, & Carr, 2000), more than others (Melzack, 1987). The McGill Short-From Pain Questionnaire (Dworkin et al., 2009) is a reliable and well-validated measure for pain (Gauthier et al., 2014), and has been used within clinical (Dudgeon, Raubertas, & Rosenthal, 1993; Wright, Asmundson, & McCreary, 2001) and experimental research (Geisser et al., 2003).

For the revised version of the Short-Form McGill Pain Questionnaire, the patients/participants rate each of the 22 descriptors of pain from *none* to *severe* over a ten-point Likert Scale. The revised version on the measure allows researchers and clinicians alike to identify neuropathic and non-neuropathic pain in a range on

clinical and non-clinical settings. The four subscales include; continuous pain, which contains six descriptors including throbbing pain, cramping pain, stabbing pain etc.; intermittent pain, which also has six items including shooting pain, piercing pain, electric shock pain etc.; predominantly neuropathic pain, which also has six items and includes hot burning pain, cold pressor pain etc.; affective descriptors, which has only four items and includes sickening, fearful, tiring-exhausting and punishing-cruel (Dworkin et al., 2009). The average for each sub-scale can then be taken, and can provide the health care professional and/or researchers with more of an understanding about the pain experience for the individual. However, alternatively the overall average from the Scale can provide reliable and valid indication of overall pain experience (Gauthier et al., 2014).

Given the reliability and specificity of both VAS and the Short-Form McGill questionnaire, both will be used as methods of assessing self-reported pain experiences. The VAS will allow me to understand how intense the pain is that the participant is experiencing, and the Short-Form McGill questionnaire will allow me to understand more about the pain being experienced.

2.4. Linking the aims and objectives with the methods

This chapter has considered how pain can be measured in a social context, and how pain can be measured within an experimental setting. In the first half of this chapter, the way in which the social context can be manipulated was explored, and adopting a method of external context manipulation has been previously seen in experimental paradigms, thus, this method will be adopted in this PhD thesis. In addition to this, there are many different types of pain to consider, including chronic pain, acute pain, and experimental pain. This PhD thesis will adopt an experimental pain induction approach for many reasons including the opportunity to have a controlled environment whereby the social context can be neatly explored, without too many confounding variables that may occur in a non-laboratory based environment. The final section of this chapter reviewed the need to employ self-report measures in this thesis. Pain is complex, and also an individual experience which can differ between people so there is a need to employ measures that allow each participant to rate their pain, These three subsections are key elements of the

PhD thesis, and will be combined to provide the best method for addressing the research questions outlined at the end of Chapter 1.

The PhD thesis will adopt a methodology to manipulate social context, and will use pressure-pain and cold thermal pain as methods of pain induction. By adopting a social environment approach, I will be able to specifically address the research questions by controlling for different dyadic relationships, and sex differences. The latter half of this thesis will aim to address why pain is tolerated more when with friends, and this will be done through a manipulation task in dyads. Thus, this method is the best one for this thesis as it robust, reliable, and offers the opportunity to be adapted to suit research questions. By continuing with the same methodology throughout the whole thesis, direct comparisons between studies can be made, and potential replication of results may also occur, which allows for a richer interpretation of the results.

The next chapter is the first experimental chapter in this thesis, and will focus on address the first three research questions outlined in Chapter 1.

Chapter 3: Investigating the differences in the reporting of pain in strangers and friends

Please note the methods and results from this study have been published in the journal PAIN, with Dr Ed Keogh and Professor Chris Eccleston as co-authors:

Edwards, R. T., Eccleston, C., & Keogh, E. (2017). Observer influences on pain: an experimental series examining same-sex and opposite-sex friends, strangers, and romantic partners. *PAIN, 158*(5), 846-855. doi: 10.1097/j.pain.0000000000000840

The publication is a multi-study manuscript covering the methods and results from this chapter, Chapter 4, and Chapter 5.

3.1. Introduction

Biological, psychological and social-cultural factors are all thought to play a role in pain experiences (Edwards, Fillingim, & Keefe, 2001; Edwards, Doleys, Fillingim, & Lowery, 2001), leading to calls for an integrated biopsychosocial approach to fully understand such variability (Gatchel et al., 2007). However, whilst progress has been made in our understanding of the biological and psychological mechanisms involved, there is limited research on the social factors that contribute to variability in pain (Keogh, 2014).

Towards the latter end of Chapter 1, it was argued that there needs to be more focus on the social aspect of pain, and in particular, focusing on how observers and different dyadic relationships between men and women can have an impact on how pain is reported and communicated. Fortunately, the effects of social relationships on the reporting of pain have been investigated more generally. For example, children's facial pain expressions are more profound when a family member is present, compared to a stranger (Vervoort et al., 2008). In adults, the role of a significant others (e.g., spouse) on the reporting of patient's pain is known to be relevant (Cano et al., 2004b); when accompanied by a supportive partner, a decrease in pain is reported (Vigil et al., 2013). Collectively, these examples of how dyadic relationship can impact on pain illustrate that the role of observer is important. However, there is significantly less research involving relationships present in adults who experience acute pain, for example, the impact of strangers, friends or partners is relatively unknown still (for a full review of the literature, please refer back to Chapter 1). Building on dyadic relationships further, it is important to also consider the sex differences present in the dyads; Chapter 1 highlighted that men have a higher pain threshold and tolerance than women, and women are more sensitive to pain than men. Whilst extending this approach to incorporate sex differences would seem an obvious extension, there are only a few known studies that have directly considered this within the context of pain (Brown et al., 2003; Gijsbers & Nicholson, 2005). It is for this reason that this PhD will seek to investigate the impact of different dyadic relationship (strangers, friends, and romantic partners) on pain, while also accounting for sex differences. The following sections will briefly recap the literature on the impact of an observer on pain, specific dyadic relationships, and sex differences, before hypothesising the outcomes of the present study.

3.1.1. The presence of an observer on how pain is reported?

The literature outlined in Chapters 1 and 2 refers to an audience as the presence of at least one other person who is observing the task or activity (Forgas, Brennan, Howe, Kane, & Sweet, 1980; Vigil & Coulombe, 2011). When an audience is present it has been shown that emotions can be expressed differently, depending on who is present; especially when reporting happiness, sadness, anger and fear (Fridlund, Kenworthy, & Jaffey, 1992). Research into audience effects and the presence of other people has looked at this in the context of pain. In an early study, Kleck et al. (1976) found that adults are cautious as to how they express their emotions when in pain, especially when others were present, and are more likely to suppress their expression of pain in the presence of an observer. More recently, it has been shown that just having an awareness, but not necessarily the physical presence of, an observer may be enough to have an impact on how pain is reported (Badali, 2008). Additionally, self-reported pain ratings are, on average, lower when the participant is aware of an observer's presence, when compared to completing a pain induction task alone (Badali, 2000). If someone is aware of someone else being present it can often alter their expression of pain and the participant also suppresses their reporting of pain (Block et al., 1980). Therefore, overall, it can be concluded that the awareness and presence of an observer can result in less pain being reported.

3.1.2. The impact on different dyadic relationships on pain

In Chapter 1 a continuum of relationship closeness was presented, with strangers being at one end, and romantic partners at the other, with friends in the middle of the continuum. This PhD thesis will focus on these three types of relationship, where there is some evidence to suggest that these different dyadic relationships can have different effects on pain (for a full review, refer back to section 1.5. in Chapter 1).

Pain is typically underestimated by stranger observers, than the individuals experiencing the pain induction Sullivan et al. (2006b), and predetermined knowledge about a stranger can also have an impact on how an observer rates someone's pain (Martel et al., 2008). Overall, the presence of strangers can result in a reduction in pain reporting, which is similar to the literature based on observer

effects; knowing someone is observing the pain is enough to increase pain threshold and tolerance. However, the results within friends isn't as clear; the sex of the friends dyad can often have a large role in how pain is expressed; men suppress their pain more in front of another male friend (McClelland & McCubbin, 2008), and women are less likely to express their pain (Fischer et al., 1986). The literature focusing on friends is largely based on social support; for example, same-sex female dyads are more likely to draw upon social support in a painful experience, which coincides with a lower pain tolerance. However, to my knowledge, there is no evidence highlighting the impact opposite-sex friends can have on pain, but the differences in sexes will be explored in more detail in the next section. Despite this, the impact of opposite-sex romantic partners on pain has been investigated; pain severity increases when the adequate support from the partner is not received (Cano et al., 2004). The opposite of this has also been reported; when an individual receives support from their partner, their pain sensitivity decreases (Cano et al., 2004b).

In these three different types of dyadic relationship, sex differences with the dyad are beginning to emerge. In general, sex differences have been well established in pain, but now there is an increasing interest to investigate the sex of both of the individuals in the dyad, as the sex of the observer can also impact on pain.

3.1.3. Sex differences in pain

When considering the sex of the participant, men typically have a higher pain threshold and tolerance than women (Fillingim et al., 2009; Keogh & Birkby, 1999), and women have a greater sensitivity to pain than men (Keogh & Birkby, 1999). These findings are well established in the literature, and are often replicated in experimental paradigms (Chapter 1, section 1.3.1. for a full review). As previously mentioned, this thesis will continue to try and replicate previously found sex differences, but also expand on this by also accounting for the sex of the observer; Vigil and Coloumbe (2011) focused on the sex of the observer in the context of larger audiences, but this PhD thesis will build on that further and focus on the sex of the observer in dyads.

3.1.4. The present research

As this is the first empirical chapter of this PhD thesis, I aimed to address a number of the research questions one, two, and three highlighted at the end of Chapter 1. The aim in this chapter is to build upon previous research into interpersonal influences on pain, and investigate whether sex-related factors impact on pain reports using a dyadic methodology. This study forms the first of three inter-related experimental studies in this PhD thesis, and across the three studies the continuum of relationships outlined in Chapter 1 will be focused upon. The continuum has people who do now know each other at one end (i.e. strangers), and people who have intimate relationships with each other at the other end (i.e. romantic partners). This chapter will focus on the first part of the continuum by focusing on strangers and friends.

During the task, a participant experienced pain when an observer was present, and when they were alone (this is explained in more detail below in the methods section of this chapter). From this, I could determine whether the presence of an observer had an impact on pain (research question 1); whether the nature of the relationship mattered (i.e. were there differences between friends and strangers, research question 2); and whether there were any sex differences present (research question 3).

The following was hypothesised:

a) the presence of an observer will have an analgesic effect on pain; more pain will be tolerated in the presence of someone else;

b) when considering the dyadic relationship, it was predicted that there would be a bigger increase in threshold, tolerance and pressure-pain threshold levels when there was a friend present, when compared to a stranger;

c) it was predicted that men would have a higher pain threshold, tolerance, and pressure-pain threshold than women.

3.2. Method

3.2.1. Design

A mixed-groups design was employed for this study. There were two between-groups factors: sex of the participant (male vs. female) and the relationship of the observer to the participant (friend vs. stranger). The within-groups variable

was the testing phase (observer present vs. no observer present). The dependant variables were pain response indexes from the pain induction tasks.

3.2.2. Participants and observers

Based on a power analysis for medium effect sizes, a total of 96 adults (47 male, 49 female; *M* = 24.69 years, *SD* = 6.51 years) were recruited from the University of Bath via an undergraduate research participation scheme, posters, emails and word-of-mouth. The University of Bath's participation scheme is open to undergraduate psychology students only, thus, posters and email distribution lists were used to target other staff and students primarily based on campus. The inclusion criteria was to be a pain-free healthy adult (i.e. ≥ 18 years). The exclusion criteria were: currently experiencing pain; taking medication; or any skin complaints such as eczema, sensitive skin or asthma. The inclusion and exclusion criteria was clearly stated on the participation scheme, recruitment posters and emails so potential participants could check their eligibility before enquiring about taking part. Potential participants contacted the researcher via email highlighting their interest and confirming that they complied with the inclusion and exclusion criteria. Upon receipt of this email, the researcher then sent the information sheet (which also restated the inclusion and exclusion criteria) and asked the participant to confirm they had read and understood the information provided, and wanted to take part. From this point, the precise method of recruitment depended on which group participants were initially allocated to (see below). Condition order was determined at the very start of each study using the random list function in Microsoft Excel. As participants were recruited they were allocated to the next available condition on this randomised list, and informed which type of dyadic partner they would be required to bring. None of the participants reported taking medication or having eczema, asthma or sensitive skin, and they all reported being pain-free.

Participants were recruited to take part in a pain study, where they were asked to either experience pain or observe someone in pain. A total of 48 participants were allocated into the pain experience condition. A further 24 participants were recruited into the stranger-observer condition, whereby half of the observers were matched to a participant of the same sex, and half the opposite sex. However, due to a human error in recruitment, overall, there were 11 same-sex stranger dyads and 13

opposite-sex stranger dyads. An additional 24 participants were recruited as friend-observers. Given the need for the observers to have a pre-existing relationship with the person in pain, a different method of recruitment was required. Here, the 24 participants who had been allocated to the pain experience condition with a friend, were asked to identify a friend of their choice, who was not a romantic partner. Interestingly, all participants brought a friend of the same-sex with them to the study. Therefore, in total, 11 same-sex strangers, 13 opposite-sex strangers, 24 same-sex friends were recruited in to the study.

This method of recruitment resulted in 48 dyads being created, each of which consisted of 48 participants in the pain experience condition (24 male; *M* = 26.62 years, *SD* = 8.14 years and 24 female; *M* = 22.75 years, *SD* = 3.54 years) and 48 observers (23 male; *M* = 27.04 years *SD* = 3.75 years, and 25 female; *M* = 22.72 years *SD* = 3.57 years). Within the dyads, half consisted of stranger observers and half consisted of friends of the person to experience pain.

Table 3.1. *The distribution of participants within each condition.*

	Friend (*n* = 48)	Stranger (*n* = 48)
Males	12 male participants	12 male participants
	12 male observers	*5 male observers*
		7 female observers
Females	12 female participants	12 female participants
	12 female observers	*6 male observers*
		6 female observers

3.2.3. Pain Induction

3.2.3.1.Cold pressor pain

A cold pressor task was adopted to induce pain, which is considered a safe and valid method of pain induction (von Baeyer et al., 2005). This pain induction task has also been used in previous social dyadic pain studies (Vigil & Coulombe, 2011). Participants submerged their left hand in a water bath at a starting temperature of 19 °C (± 1°C) for 2 minutes to standardise their hand temperature

(Vervoort et al., 2011b). Next, participants submerged the same hand in a cold water bath, which was kept at a constant temperature of 1 °C (± 1°C) (Myers et al., 2001). Water temperature was maintained by a Techne thermoregulator (a temperature controlled thermostat) and a dip cooler (Model: RU-200), and the water circulated using an integrated water pump to prevent local warming around the participant's hand. This ensured consistency in water, and hand, temperature across the study (Mitchell, MacDonald, & Brodie, 2004). In addition to the temperature controlled thermostat, a handheld digital thermometer was also used to ensure the temperature of the water baths was maintained at ± 1°C of the temperature stated above.

During the cold water exposure, participants were timed from immersion to when they first experienced a painful sensation (pain threshold), and to the point at which they could no longer tolerate the pain (pain tolerance). Unknown to the participants, there was an upper limit of two minutes, at which point the experimenter asked the participant to withdraw their hand (Keogh et al., 2000). Once the participant had withdrawn their hand (i.e. after the participant could no longer tolerate the pain, or the upper limit of two minutes had been reached), the participant placed their hand back in the starting temperature water bath to allow their hand to return to the standardised starting temperature. There was no time limit on this, and the participant withdrew their hand when they felt it had returned to a comfortable temperature.

3.2.3.2. Pressure pain

The second method of pain induction used here was pressure-pain, which was induced using a hand-held Somedic Algometer. The algometer measures pressure-pain thresholds, and comprises of 1cm² round rubber surface which comes in contact with soft tissue (Kinser et al., 2009). Pressure was applied to the forearm of the right arm using a 1 cm² probe, at a rate of 30 kPa/sec. Pressure was applied in a similar place to the dorsal forearm, approximately 8cm from the elbow (Hastie et al., 2012). Participants were asked to indicate the first point at which they felt a painful sensation, and this was recorded as their pressure pain threshold. A total of three trials were conducted, with a short interval between trials to increase reliability. An average of the three trials was taken.

3.2.4 Self-report measures

Following each induction task pain participants completed the following subjective, self-report, pain measures:

3.2.4.1. Visual Analogue Scale to measure pain intensity

A Visual Analogue Scale (VAS) was administered to indicate how much pain was experienced during the task. Participants were asked to mark their answer on a 100mm line, with anchors indicating the range; from *no pain at all* to *worst pain imaginable* and scored out of 100. VAS scales are used widely in pain research, and have high levels of validity for both chronic and experimental pain induction tasks (Price, McGrath, Rafii, & Buckingham, 1983).

3.2.4.2. Short form McGill Pain Questionnaire (SF-MPQ-2)

The Short Form McGill Pain Questionnaire Version 2 (SF-MPQ-2) was administered after each pain induction. The questionnaire consists of 22 pain-related symptoms that each participant rated on a Likert-scale based on the intensity of the pain, ranging from 0 *(no pain)* to 10 *(worst possible pain)* (Dworkin et al., 2009). The overall total score was calculated (internal consistency: $\alpha = .91$ (Dworkin et al., 2009)) for the current study, with a higher number indicating more pain. The SF-MPQ-2 has been used in both experimental pain induction studies and with chronic pain patients. This scale is also reported to be both valid and reliable (Gauthier et al., 2014).

In addition, all participants (pain and observer condition) completed various scales after the pain induction tasks. These were administered to ensure that the only group differences were on the scales that measured closeness of relationship, and not mood (which could affect pain reports):

3.2.4.3.Depression, Anxiety and Stress Scale (DASS)

The Depression Anxiety and Stress Scale (DASS) (Lovibond & Lovibond, 1995) is a 42-item self-report questionnaire that assesses the symptoms of depression, anxiety and stress. The DASS is a well-established measure of mood, and has been used in both clinical and non-clinical settings around the world

(Brown, Chorpita, Korotitsch, & Barlow, 1997). All participants were asked to rate on a Likert-scale between 0 (*did not apply to me at all*) and 3 (*applied to me very much*) each question based on the past week. A DASS total score was computed and used for the analysis, as we were interested in general mood differences (internal consistency: α = .87 (Lovibond & Lovibond, 1995)). A higher score indicated a higher negative mood.

3.2.4.4.Unidimensional Relationship Closeness Scale (URCS)

The Unidimensional Relationship Closeness Scale (URCS) (Dibble, Levine, & Park, 2012) is a 12-item self-report questionnaire which assesses the closeness of the relationship between the participant and observer (internal consistency: α = .92 to α = .99 (Dibble et al., 2012)).The questionnaire asked participants to think of the other person from the dyad in the room when responding to the items using a 7-point Likert-scale from 1 *(strongly disagree)* to 7 *(strongly agree)*. Items on the questionnaire were used to assess how close the dyads were to each other: whether the other person is a priority in their life and whether the other person is considered when making important decisions, showing high levels of convergent validity (Dibble et al., 2012). The more distant the dyad the lower the score will be, and a closer dyad would result in a higher score.

3.2.4.5. Relationship Closeness Inventory (RCI)

The Relationship Closeness Inventory (RCI) (Berscheid, Snyder, & Omoto, 1989) was used to assess the closeness of two people with regards to their interdependence and has been since shown to be a very robust measure in young adults (Laursen & Williams, 1997). The items on the questionnaire were combined to give an overall estimation of closeness. The RCI was designed to look closely at the different relationships between people, including romantic couples, friends and family (Berscheid et al., 1989). The RCI has three subscales: the strength, diversity and frequency. The diversity and frequency subscales were considered redundant measures of closeness as they do not include modern ways of communicating. Therefore, only the strength subscale was used in the analysis (internal consistency: α = .90 (Berscheid et al., 1989)). The higher the score the closer the dyad.

3.2.5. Ethical Considerations

Full ethical approval was obtained from the Department of Psychology Ethics Committee (Reference number: 14-003) and the Department for Health Ethics Committee (Reference number: EP 13/14 79) at the University of Bath, UK.

3.2.6. Procedure

Following recruitment, all participants were screened upon arrival to the laboratory to ensure they were not in any form of pain, or had no knowledge of a skin complaint. They provided written consent, completed a demographics form, and were given instructions about the task.

Figure 1 illustrates the set-up of the laboratory during each pain induction task, and also shows the positioning of the dyads and experimenter during the study. The experimenter for this, and all subsequent studies reported in this PhD was female.

Immediately after completing the consent form and demographics questionnaire (approximately 5 minutes), the experimenter explained the procedures for the pain induction tasks, which were the next phase in the study procedure. Participants always completed the algometer first (approximately 3 minutes), then completed the cold pressor task (approximately 8 minutes). Immediately after completing the pain induction tasks, participants completed the VAS and SF-MPQ-2 in order to rate the pain they had just experienced (approx. 7 minutes). Participants completed the VAS and SF-MPQ-2 for the algometer, and then for the cold pressor task.

The two pain induction tasks were conducted twice, using a between-groups counterbalancing procedure (see next paragraph, below): once when there an observer present, and once when they were absent. In the observer present condition, observers were sat directly in front of the person conducting the pain induction task. Similar procedures were followed during the no-observer condition; participants were asked to look in the direction of where the observer would be sat (but of course, were not present). The participants had a short break (3 minutes) between the observer present and absent conditions, as the social context was altered (i.e. the observer either entered or left the laboratory). The participants then went on to complete the other condition, starting with the algometer.

Participants allocated into the pain condition completed the pain induction tasks twice: once with an observer present, and once without. In order to account for practice effects, the order in which participants completed the tasks with and without an observer was counterbalanced. Half of the participants completed the study alone and then with an observer, whereas the other half completed with an observer first and then alone. The observers did not complete either of the pain induction tasks, but simply watched the task being conducted.

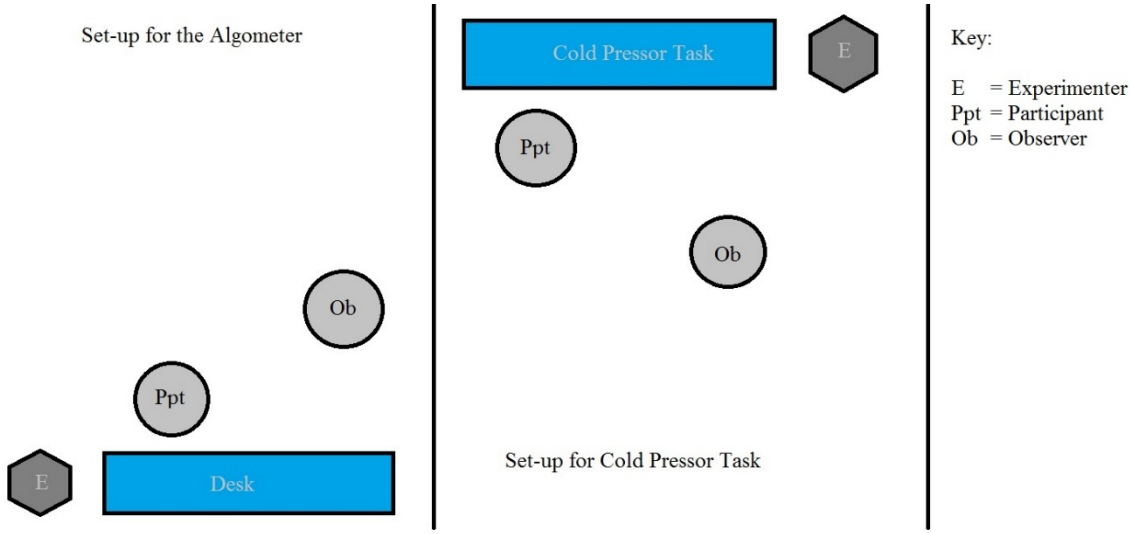

Figure 3.1. A representation of the participant and observer paradigm.

After the pain induction tasks, both participant and observer completed the DASS, URCS, and RCI and were debriefed. The participants were advised to turn each completed measure over, face down, so it could not be read by either the research present or the observer. Course credits or a monetary payment were given to all participants and observers, and the whole process took approximately 45 minutes per dyad.

3.3. Results

3.3.1. Data screening

Data screening of all raw data was conducted following procedures outlined by Tabachnick and Fidell (2006). Outliers were identified by converting the raw scores to z-scores, and considered an outlier if they were ±3.29. This method

revealed four outliers (all in the cold pressor task threshold condition, without an observer present), which were adjusted to a value one unit larger/smaller than the next extreme score in the distribution (Tabachnick & Fidell, 2006). To ensure that the scores were normally distributed, histograms were generated to visually check for abnormalities, and skewness and kurtosis values checked. The data were normally distributed.

The participants were recruited in dyads, with 24 in each condition; friends (M = 24.21 years, SD = 5.97 years) and strangers (M = 25.17 years, SD = 7.11 years). The means and standard deviations for the self-report measures can be found in Table 3.2., and each of the pain induction tasks and the self-report pain questionnaires can be found in Table 3.3.

3.3.2. Analysis of self-report measures

A series of ANOVA's were conducted to investigate whether there were group differences on the self-report measures. This was to ensure that the stranger-friend group dyad allocation resulted in differences in closeness of relationship, but not on the other variables, such as mood. Dyadic relationship condition (friend vs. stranger), sex of participant (male vs. female) and participant role (experiencing pain vs. observer) were the between-group variables throughout. The means and standard deviations for the DASS, URCS, and RCI are in Table 3.2.

Table 3.2. *Means and standard deviations (in parenthesis) for self-report measures by dyadic relationship (friends vs. strangers), sex of participant (male vs. female) and participant role (experiencing pain vs. observer).*

	Friends group				Strangers group			
	Experiencing pain		Observer		Experiencing pain		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
DASS	15.00 (20.84)	9.58 (10.27	18.17 (9.94)	12.00 (10.88)	11.50 (8.19)	16.75 (11.01)	29.91 (29.87)	25.54 (16.16)
URCS	3.78 (1.05)	5.10 (.75)	3.92 (1.19)	5.24 (.58)	1.25 (.55)	1.12 (.20)	1.42 (.40)	1.17 (.25)
RCI Strength subscale	1.86 (.36)	2.22 (.26)	1.68 (.20)	2.26 (.16)	1.79 (.29)	2.07 (.63)	1.72 (.24)	2.30 (.15)

Notes: DASS = The Depression Anxiety and Stress Scale

URCS = The Unidimensional Relationship Closeness Scale

RCI = The Relationship Closeness Inventory

3.3.2.1. DASS

To see whether there were unintended group differences on mood, an ANOVA was conducted on the DASS total scores. The only significant main effect was for participant role, $F(1,88) = 5.69$, $p < .05$, $\eta_p^2 = .06$. Observers had higher negative mood ($M = 13.69$, $SD = 13.70$) than those allocated to the pain induction condition ($M = 21.37$, $SD = 18.94$). There was also a significant interaction between the sex of the participant and whether they were with a friend or a stranger, $F(1,88) = 4.06$, $p < .05$, $\eta_p^2 = .04$. However, post-hoc analysis revealed no significant differences between men and women, or friends and strangers (all p values > .05). This is not considered any further.

3.3.2.2. Friendship manipulation check

3.3.2.2.1. URCS

For the URCS, there was a main effect of dyadic relationship, $F(1,88) = 513.81$, $p < .001$, $\eta_p^2 = .85$ indicating that friends had closer relationships ($M = 4.51$, $SD = 1.12$) than strangers ($M = 1.23$, $SD = .38$). There was also a main effect of the sex of participant, $F(1,88) = 15.11$, $p < .001$, $\eta_p^2 = .14$ in that women ($M = 3.11$, $SD = .22$) reported closer relationship than men ($M = 2.62$, $SD = 1.53$). However, both should be interpreted in light of a significant two-way interaction between dyadic relationship and the sex of the participant, $F(1,88) = 27.44$, $p < .001$, $\eta_p^2 = .24$ (see Figure 3.2.). There were no other significant interactions.

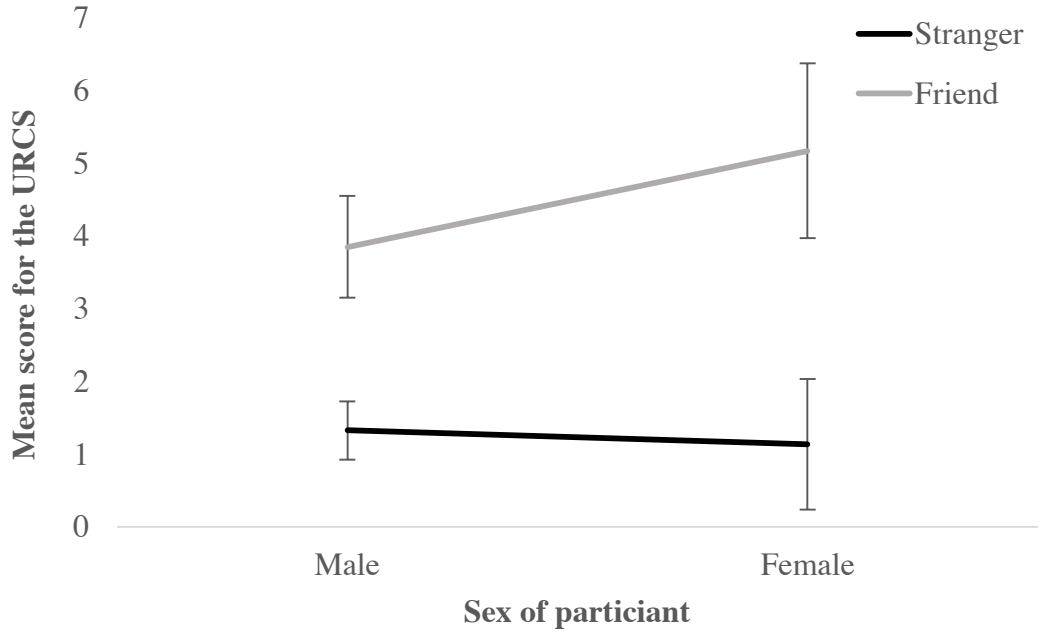

Figure 3.2. The mean scores on the Unidimensional Relationship Closeness Scale for male and female participants in the friends and stranger dyadic relationship condition. Error bars represent ± 1 standard error of the mean.

Post-hoc t-tests were subsequently conducted on the two-way interaction, with a Bonferroni correction applied to control for inflated alpha (p <.0125). Men in the friendship group (M = 3.85, SD = 1.10) reported closer relationships than the men in the stranger group (M = 1.33, SD = .48), $t(45) = 10.07$, $p < .001$, $d = 2.96$. This significant difference was also mirrored in the female participants; women had a higher URCS score in the friends group (M = 5.17, SD = .66), compared to the strangers group (M = 1.14, SD = .22), $t(45) = 28.84$, $p < .001$, $d = 4.33$. However, when asked to rate closeness with friends, a significant sex difference was found: women (M = 5.17, SD = .66) reported being much closer to the friend compared to men (M = 3.85, SD = 1.10), $t(46) = -5.02$, $p < .001$, $d = 2.56$. However, these differences were not observed when men (M = 1.33, SD = .48) and women (M = 1.14, SD = .22) rated their closeness with strangers, $t(46) = 1.79$, $p > .05$, $d = .50$.

3.3.2.2.2. RCI

A similar ANOVA was conducted on the strength subscale for the RCI. The anticipated effect of dyadic relationship was significant, $F(1,88) = 48.98$, $p < .001$,

$\eta_p^2 = .36$. Participants allocated to the friend's condition ($M = 2.81$, $SD = .82$) rated the strength of their relationship as higher than the participants allocated to the stranger condition ($M = 1.47$, $SD = 1.04$). There were no other significant differences (all p values > .05).

3.3.3. Impact of an observer on reporting of cold pressor pain

To examine the effects of an observer on the experience of pain, a mixed group ANOVA was conducted on each of the cold pressor outcomes (threshold, tolerance, SF-MPQ-2, and VAS pain scores). Each analysis included the sex of the participant experiencing pain within each dyad (male vs. female) and the dyadic relationship (friend vs. stranger) as between-group factors. Observer presence (absent vs. present) was also included as a within-group factor in this analysis. The means and standard deviations can be found in Table 3.3.

Table 3.3. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by dyadic relationship (friends vs. strangers), the phase (no observer vs. observer) and sex (male vs. female).*

	Friends group				Strangers group			
	No observer		Observer		No observer		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
Cold Pressor Task								
Threshold (seconds)	15.90 (11.44)	9.43 (9.56)	23.38 (25.86)	14.37 (18.12)	14.90 (10.73)	5.04 (2.94)	18.90 (18.49)	5.65 (3.84)
Tolerance (seconds)	67.95 (45.21)	25.21 (18.99)	78.52 (44.24)	32.95 (32.35)	32.31 (32.11)	22.11 (32.31)	35.16 (30.38)	27.48 (30.48)
SF-MPQ-2	2.33 (1.56)	1.82 (1.21)	2.24 (1.53)	1.74 (.96)	1.98 (1.19)	2.93 (1.84)	1.82 (1.04)	2.77 (1.73)
VAS	53.0 (26.7)	54.2 (16.9)	54.8 (22.9)	56.9 (18.0)	59.3 (14.8)	60.2 (23.1)	65.9 (17.4)	69.1 (11.2)
Algometer								
Threshold (kPa)	967.88 (365.00)	441.55 (147.92)	1094.85 (348.05)	486.47 (231.40)	699.34 (207.31)	428.57 (185.97)	725.13 (196.38)	480.88 (195.69)
SF-MPQ-2	1.68 (1.05)	1.49 (1.04)	1.65 (.86)	1.08 (.66)	1.34 (1.09)	1.97 (1.73)	1.16 (.92)	1.71 (1.61)
Algometer VAS	37.0 (26.7)	42.4 (18.0)	39.3 (21.7)	38.9 (18.8)	40.7 (11.5)	39.7 (18.3)	39.0 (14.6)	44.9 (17.8)

Notes: VAS = Visual Analogue Scale; SF-MPQ-2 = Short Form McGill Pain Questionnaire Version 2

In terms of possible interactions, I predicted that the effects of an observer characteristics should only have an effect when the observer was actually present. For pain thresholds, there was a main effect of participant sex, $F(1,44) = 6.79$, $p < .05$, $\eta_p^2 = .13$. Overall, and as expected, men ($M = 18.27$ secs, $SD = 14.94$ secs) had a higher pain threshold than women ($M = 8.62$ secs, $SD = 10.24$ secs). In addition, there was a main effect of observer presence, $F(1,44) = 4.56$, $p < .05$, $\eta_p^2 = .09$. Pain thresholds were higher when an observer was present ($M = 15.58$ secs, $SD = 18.99$ secs) compared to when they were absent ($M = 11.31$ secs, $SD = 10.03$ secs). However, there was no main effect of dyadic relationship, $F(1,44) = 1.57$, $p > .05$, $\eta_p^2 = .04$, and there were no significant interactions.

A similar analysis was conducted on cold pressor pain tolerance levels. The mean sex difference in pain tolerance was 26.53 seconds, confirming that men ($M = 53.47$ secs, $SD = 41.28$ secs) had a significantly higher tolerance scores than women ($M = 26.94$ secs, $SD = 27.85$ secs), $F(1,44) = 7.82$, $p < .01$, $\eta_p^2 = .15$. A main effect of observer presence was again found $F(1,44) = 6.13$, $p < .05$, $\eta_p^2 = .12$, indicating higher tolerance levels when an observer was present ($M = 43.51$ secs, $SD = 39.53$ secs) compared to when they were absent ($M = 36.89$ secs, $SD = 37.29$ secs). Additionally, there was a main effect of dyadic relationship, $F(1,44) = 5.32$, $p < .05$, $\eta_p^2 = .11$, in that participants allocated to the friends condition ($M = 51.16$ secs, $SD = 40.68$ secs) tolerated more pain compared to those in the stranger condition ($M = 29.26$ secs, $SD = 30.69$ secs). Interestingly, the critical interaction between dyadic relationship and observer presence was not significant ($p > .05$), nor were any of the other interactions.

Analysis of the self-report pain measures found no significant effects for SF-MPQ-2 scores. For the VAS scores, a main effect of observer presence was found, $F(1,44) = 6.38$, $p < .05$, $\eta_p^2 = .13$. Self-reported pain levels were higher when an observer was present ($M = 61.67$, $SD = 18.31$) than absent ($M = 56.65$, $SD = 19.31$). No other significant effects were found (all p's $> .170$).

3.3.4. Impact of an observer on reporting of pressure pain

A similar series of ANOVA's were conducted on outcomes from the pressure pain task, with the means and standard deviations also shown in Table 3.3. For

pressure pain thresholds, a main effect of sex was found $F(1,44) = 36.66$, $p < .001$, $\eta_p^2 = .46$, with men ($M = 874.05$ kPa, $SD = 324.38$ kPa) exhibiting a higher thresholds than women ($M = 459.37$ kPa, $SD = 172.64$ kPa). A main effect of observer presence was also found, $F(1,44) = 10.28$, $p < .01$, $\eta_p^2 = .19$, showing that pressure pain thresholds were higher when an observer was present ($M = 696.83$ kPa, $SD = 350.33$ kPa) than when absent ($M = 636.59$ kPa, $SD = 325.25$ kPa). When considering the dyadic relationship, a main effect was found, $F(1,44) = 5.91$, $p < .05$, $\eta_p^2 = .12$. Those allocated to the friends group exhibited higher pressure pain thresholds ($M = 749.94$ kPa, $SD = 397.45$ kPa) compared to those in the stranger group ($M = 583.48$ kPa, $SD = 228.74$ kPa). As before, the interaction between dyadic relationship and observer was not significant ($p > .05$). However, a significant interaction was found between dyadic relationship and the sex of the participant, $F(1,44) = 5.27$, $p < .05$, $\eta_p^2 = .11$ (see Figure 3.3.). No other interactions were significant.

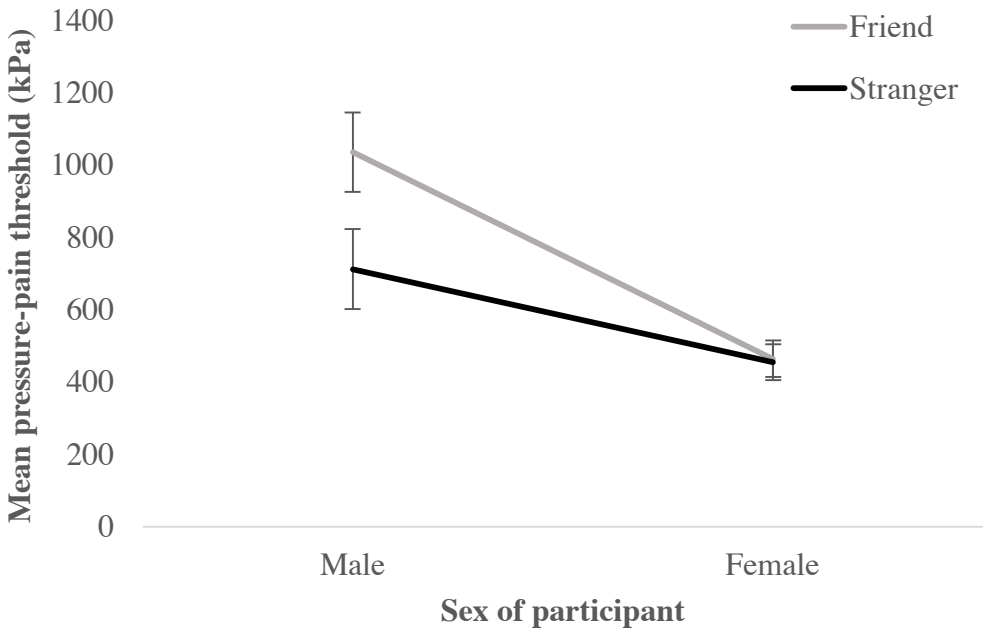

Figure 3.3. Mean pressure threshold (kPa) for male and female participants in the friends and strangers group. Error bars represent ± 1 standard error of the mean (Study 1).

Follow-up analysis was conducted on the significant two-way interaction and the appropriate Bonferroni adjustments were made (p = .0125). This indicated that when in the friends group, men (M = 1035.87 kPa, SD = 351.83 kPa) had a significantly higher pressure pain thresholds than women (M = 464.01 kPa, SD = 167.75 kPa), $t(22) = 5.04$, $p < .001$, $d = 2.06$. A similar difference was found for those in the stranger group: men had higher thresholds (M = 712.24 kPa, SD = 197.74 kPa) than women (M = 454.73 kPa, SD = 184.74 kPa) in the stranger group, $t(22) = 3.05$, $p < .01$, $d = 1.25$. However, when looking within men, those in the friends group (M = 1035.87 kPa, SD = 351.83 kPa) had a significantly higher pressure pain thresholds than those in the strangers group (M = 712.24 kPa, SD = 197.74 kPa), $t(22) = 3.21$, $p < .01$, $d = 1.31$. No such effect was found for women, $t(22) = .06$, $p > .05$, $d = .03$).

For the SF-MPQ-2, a significant main effect of observer presence was found, $F(1,44) = 7.83$, $p < .01$, $\eta_p^2 = .15$. When an observer was present (M = 1.40, SD = 1.08) pain intensity was lower compared to when absent (M = 1.62, SD = 1.24). No other significant effects were found.

For pressure pain VAS scores, no significant effects were found.

3.4. Discussion

Referring back to the predictions in the beginning of this chapter, I was able to replicate previously established sex differences in the context of experimental pain induction paradigms; compared to females, males had a consistently higher pain threshold and tolerance on both the cold pressor task and algometer (Riley Iii, Robinson, Wise, Myers, & Fillingim, 1998). This study also showed that the presence of an observer can impact on how pain is reported (Vigil & Coulombe, 2011), resulting in an increase in threshold and tolerance. There was also a suggestion that the nature of the effect of different types of observers may also be relevant, with participants in the friend's condition having a higher pain tolerance than participants in the stranger condition.

3.4.1. Interpretation of results

Focusing on each of the predictions individually, these results can help facilitate the understanding of the social and contextual influences of the reporting of pain in both men and women. The first prediction was that the presence of an observer would impact on pain reporting's, which was found in both pain tasks, which replicates findings from previous research (for example, Badali, 2008). Previous research has predominantly focused on the observers perceptions of pain, and overall, observers tend to report pain as less intense when compared to the ratings the person experiencing pain gives (Martel et al., 2008; Sullivan, Martel, Tripp, Savard, & Crombez, 2006a). This study adds a slightly different aspect to what is already known about to social influences on pain reporting's as the observer did not rate the pain, but the person experiencing the pain did. Interestingly, when an observer was present, pain threshold and tolerance increased on both the cold pressor task and the algometer, supporting one of the very first studies investigation the social influences on pain (Block et al., 1980). Moreover, for the cold pressor task, participants rated the pain as more intense when there was an observer present; thus, even though more the participants tolerated more pain, they also reported the pain as more intense. This suggests that the willingness to experience more pain may be a conscious decision that the participant makes.

When looking at the composition of the dyads more closely, the nature of the dyadic relationship also seems to have an impact on cold pressor pain threshold and tolerance; the participants allocated to the friend's condition tolerated more pain than the participants allocated to the stranger's condition. There is little research on the impact of friendship on pain, but there is a related literature to suggest that the nature of relationships within dyads can impact on the reporting of pain (Martel et al., 2008). As mentioned in the methodology section, all of the participants in the friends condition brought a friend of the same sex along to participate, which generates two further questions a) is there a reason why people prefer a friend of the same sex in a potentially threatening and/or vulnerable situation, and b) would the results found here be similar if the friend was of the opposite sex.

Finally, in line with the third research question, there were consistent sex differences found within this study; overall, male participants had a higher pain

threshold and tolerance on both the cold pressor task and the algometer. These findings are well established within the literature, so to be able to replicate them, and build upon them, emphasises the need to incorporate sex differences and the contextual influences on pain in to more experimental studies.

3.4.2. Implications of results to pain research

The findings of this study add more depth to what was understood about communicating pain in a social setting (Vigil & Coulombe, 2011; Vigil et al., 2013). Pain can be communicated in a variety of ways including through facial expressions (Craig, 1992) and body posture (Walsh, Eccleston, & Keogh, 2014), but this research adds a new dimension to how researchers can understand how the social context can impact on pain. This research is novel in the way it introduces another observer to the social context, but also accounts for the relationship between the dyads. The physical presence of a friend or stranger in an experimental setting has been established (Krahe et al., 2013) but this study emphasises that there are sex differences in how we communicate and report pain in the presence of others. Therefore, this study more knowledge on how men and women report their pain.

The current finding that the nature of the dyadic relationship can have an impact on pain reports adds to a growing body of work that considers social-contextual influences on pain. For example, within a clinical setting, pain reports differ depending on who is present (Cano et al., 2004b) and within an experimental setting the reporting of pain has been considered with regards to social support from a partner; those who receive adequate support from a partner show a decrease in pain intensity (Brown et al., 2003; Vigil et al., 2013). Additionally, within a group setting whereby there are a number of unknown people present, pain sensitivity decreases (Vigil & Coulombe, 2011). This study supports previous literature on how the physical presence of someone else can impact on pain, but highlights the importance of looking at sex differences within social environments. Prior to this study being conducted, there was no research that specifically focused on the sex of the observer, type of relationship, and the impact it can have on pain reporting. This study has shown that the sex of the participant and observer needs to be accounted

for, and more research is needed that focuses on the social and contextual influences on the reporting of pain, for example, the specific dyadic relationships.

3.4.3. Limitations

There are numerous strengths to this study but the limitations warrant further discussion. Firstly, the experimenter was physically present throughout the study. Even though the experimenter was 'hidden' from view (see Figure 1), it could be argued that there was not a truly alone condition. Whilst the experimenter was consistent across both sessions, what we might be measuring here is the effect of adding a friend or stranger to an existing stranger-based social setting. There is evidence that increasing the number of unknown people present can affect pain (Vigil & Coulombe, 2011), as well as suggestions that the sex of an experimenter can also affect how pain is reported (Kallai et al., 2004) (Gijsbers & Nicholson, 2005).

Secondly, this study aimed to address the impact of friends and strangers on pain reporting, by focusing of men and women, split equally. However, this was not achieved, due to the recruitment process. There were equal numbers of men and women in the strangers condition (there were same-sex and opposite-sex stranger dyads recruited in to the study), but there were only same-sex friends recruited. This is because the participants allocated to the friend's condition were asked to bring a friend of their choice, and as a consequence they all chose a friend of the same-sex. However, due to this limitation, the results cannot be considered in a wider friendship setting, only in a same-sex friend context. Therefore, it would be of great interest to replicate this study with the primary focus of investigating friendship further to understand more about the dyadic components of friendship, and the impact it can have on pain.

3.4.4. Next steps for future studies based on the results

Building on the limitations of this study, the next stage of this research would be to employ the same methodology but explore different social groups, for example, same-sex and opposite-sex friends. Women are more likely to turn to other women for support which could be a reason for the present finding within female

participants (Aries & Johnson, 1983). Men are more likely to suppress their pain in front of a same-sex friend (McClelland & McCubbin, 2008). However, there is a gap in the knowledge regarding opposite-sex friends. By replicating the study but manipulating the sex of the friend, more in-depth knowledge would be sought about the effect of having a friend present, and whether the sex of the friend impacts on the pain experience.

3.4.5. Summary and conclusion

To conclude, this study has shown that the presence of someone else can impact on the reporting of pain on both pain induction tasks; in the presence of an observer, pain thresholds and tolerance levels increase. However, when investigating the dyadic relationships, there was a difference between friends and strangers; when the participants were in the friend's condition, there was an increase in cold pressor tolerance and pressure-pain threshold. This suggested that an observer can alter the reporting of pain, and the dyadic relationship may also impact on the reporting of pain. While noting the limitations and areas for future research, the next stage in this research is to explore different groups of people and monitor the relationships. Specifically, the next chapter will build upon this study by replicating the methods but focusing on recruiting same-sex and opposite-sex friends. This will add more knowledge, and whether there are any differences in the way pain is reported when there is a friend of the same sex or opposite sex present.

Chapter 4: Investigating the differences in the reporting of pain in same-sex and opposite-sex friends

As outlined in Chapter 3, the methods and results from this study have been published in the journal PAIN, with Dr Ed Keogh and Professor Chris Eccleston as co-authors:

Edwards, R. T., Eccleston, C., & Keogh, E. (2017). Observer influences on pain: an experimental series examining same-sex and opposite-sex friends, strangers, and romantic partners. *PAIN, 158*(5), 846-855. doi: 10.1097/j.pain.0000000000000840

The publication is a multi-study manuscript covering the methods and results from this chapter, Chapter 3 and Chapter 5.

4.1. Introduction

Chapter 1 highlighted how pain does not occur in isolation, and there are multiple social components that require further investigation (Keogh, 2014). One of the social aspects of pain to consider is the impact of an observer, and whether the dyadic relationship can have an impact on pain. Chapter 3, the first experimental study in this PhD thesis, highlighted the presence of an observer can have an analgesic effect of pain. Additionally, pain tolerance was higher when being observed by a friend, as opposed to the participants who were observed by a stranger. Finally, there were clear sex differences present, with men having a higher pain threshold and tolerance than women. As the effect of dyadic relationship was identified in the previous chapter, I decided to extend and build upon the experimental paradigm used in Chapter 3 with a specific focus on friendship. In line with the continuum mentioned in Chapters 1 and 3, friendship is the next stage along the continuum from strangers.

One of the unforeseen limitations of study 1 was that all participants allocated to the friend's condition brought a friend of the same sex. While this allowed for direct comparisons between male-male and female-female dyads, it did not allow for any opposite-sex dyads. Given that one of the primary research questions for this PhD is to investigate sex differences and dyadic relationships, and there is evidence suggesting that there are sex differences present, the next study in this series of experimental studies will focus on same-sex and opposite-sex friends.

Friends are important in everyday life, and are considered one of the everyday relationships individuals are familiar with. The literature indicates that same-sex friendships are typically reported as closer friendships than opposite-sex friendships (Aries & Johnson, 1983). Previous research has indicated that friends are linked to social support, and with females seeking more social support than males (Gillespie, Lever, Frederick, & Royce, 2015), they are more likely to express their pain to friends. However, the role of a friend, and more specifically the sex of the friend, in the context of pain is yet to be investigated thoroughly. Thus, by focusing on different dyadic friendships (same-sex and opposite-sex), I can build on the findings from the previous study, and the continuum of the closeness of the relationship that was discussed in Chapter 1.

This study therefore sought to directly investigate the differences between same-sex and opposite-sex friends, by controlling for the sex of the participant and sex of the friend observing. It was hypothesized that:

a) the presence of a friend will increase pain threshold and tolerance,
b) pain will be expressed more by same-sex friends, when compared to opposite-sex friends; and,
c) there will be clear sex differences present; men will have a higher pain tolerance than women.

4.2. Method

4.2.1. Design

A similar design was used here as reported in Chapter 2. The main difference was that no strangers were recruited, but instead observers consisted of either same-sex or opposite-sex friends. Specifically, a mixed-groups design was employed, with two between-groups factors: sex of the participant (male vs. female) and sex of the observer (male vs. female). The within-groups variable was the presence of an observer (observer present vs. observer absent). The dependant variables were various pain response indexes from the two pain induction tasks.

4.2.2. Participants and observers

A total of 96 adults were recruited in a similar way to that described in Study 1, but with a focus on ensuring an equal split of male and female observers. Initially, 48 participants were recruited to take part in a pain study. After initial screening, half of the participants were asked to bring a same-sex friend and the other half were asked to bring an opposite-sex friend with them to the study. The only other stipulation was that there was no romantic involvement with the friend. The friend did not complete any of the pain tasks, but instead observed.

Therefore, the 96 individuals comprised of four groups of 12 dyadic same/different sex pairs i.e., male-male, male-female, female-female, female-male (as shown in Table 1). Within each pair, one person served as an observer (24 male; M = 24.08 years, SD = 7.64 years, 24 female; M = 20.46, years SD = 3.44 years)

and the other took part in the pain induction tasks (24 male; *M* = 24.21 years, *SD* = 7.60 years and 24 female; *M* = 19.67 years, *SD* = 2.35 years).

Table 4.1. *The distribution of participants within each condition.*

	Same-sex friend (*n* = 48)	Opposite-sex friend (*n* = 48)
Males	12 male participants	12 male participants
	12 male observers	*12 female observers*
Females	12 female participants	12 female participants
	12 female observers	*12 male observers*

4.2.3. Pain Induction

4.2.3.1. Cold pressor pain and pressure pain

This chapter mirrors the same methodology as presented in Chapter 2. The same experimental pain induction tasks were employed, following exactly the same procedure; i.e. the cold pressor was kept at 1ºC (± 1ºC), for a maximum of two minutes. The methodology for the algometer was also conducted in the same way; taking three readings to enable an average to be calculated.

4.2.4. Self-report measures

The same self-report measures were used as in Chapter 2. This includes the visual analogue scale to measure pain intensity and the Short Form McGill Pain Questionnaire. Additionally, each participant completed the Depression, Anxiety and Stress Scale, the Unidimensional Relationship Closeness Scale and the Relationship Closeness Inventory. Again, these measure were completed to identify any differences in relationship closeness and mood.

4.2.5. Ethical Considerations

Full ethical approval was obtained from the Department of Psychology Ethics Committee (Reference number: 14-003) and the Department for Health Ethics Committee (Reference number: EP 13/14 79) at the University of Bath, UK.

4.2.6. Procedure

The procedure followed here was the same as described in the previous experimental chapter. Participants completed the cold pressor and pressure pain task alone and with an observer (order was counterbalanced between pairs). This followed the same format as the representation of the paradigm in Figure 3.1 (Chapter 2). The same questionnaires measures were also administered, in the same way. The only differences between studies was the nature of the dyadic pairings. All participants were reimbursed for their participation.

4.3. Results

4.3.1. Data screening

Screening of the raw data was conducted using the techniques described in study 1. Outliers were identified by data with z-scores ±3.29. This revealed one outlier for pain threshold on the cold pressor task when an observer was present, which was adjusted to a value one unit larger than the next score (Tabachnick & Fidell, 2006). There is also some missing data; six participants not complete the VAS for the cold pressor task, four participants did not complete the SF-MPQ-2, and four participants did not complete the VAS for the pressure pain. Histograms, and skewness and kurtosis values were checked, which confirmed normal distributions for all variables.

The means and standard deviations for the self-report measures can be found in Table 4.2., and each of the pain induction tasks and the self-report pain questionnaires can be found in Table 4.3.

4.3.2. Analysis of self-report measures

ANOVA's were conducted on the self-report measures to investigate potential group differences. Sex of the participant (male vs. female), sex of the observer (male vs. female) and participant role (experiencing pain vs. observer) served as between-groups variables. The self-report measures, URCS, DASS and RCI were the dependant variables. The means and standard deviations are shown below in Table 4.2.

Analyses on the URCS, DASS, and the strength subscale for the RCI found no significant main or interaction effects, which highlight no difference in relationship closeness or mood differences between conditions.

Table 4.2. *Means and standard deviations (in parenthesis) for self-report measures by dyadic relationship (same-sex friends vs opposite-sex friends), sex of participant (male vs. female) and participant role (experiencing pain vs. observer).*

	Same-sex friends group				Opposite-sex friends group			
	Experiencing pain		Observer		Experiencing pain		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
DASS	6.22 (6.12)	6.58 (4.20)	6.08 (4.08)	7.06 (8.26)	6.94 (5.90)	9.19 (7.18)	9.15 (9.76)	7.86 (4.48)
URCS	3.99 (1.05)	3.64 (1.60)	4.05 (.94)	4.33 (1.32)	3.24 (1.09)	2.98 (1.62)	3.57 (1.37)	3.60 (1.11)
RCI Strength subscale	4.33 (1.78)	4.58 (2.15)	3.50 (1.88)	2.73 (1.85)	3.12 (1.21)	4.42 (1.62)	3.58 (2.23)	4.55 (2.02)

Notes: DASS = The Depression Anxiety and Stress Scale

URCS = The Unidimensional Relationship Closeness Scale

RCI = The Relationship Closeness Inventory

4.3.3. Impact of an observer on reporting of cold pressor pain

A series of ANOVA's were conducted on the cold pressor pain outcomes, and where relevant, follow-up t-tests with Bonferroni corrections. The between groups variables were sex of participant (male vs. female), sex of the observer (male vs. female) and the within groups factor was observer presence (absent vs. present). The means and standard deviations can be found in Table 4.3.

Table 4.3. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by dyadic (same-sex friends vs. opposite-sex friends), the phase (no observer vs. observer) and sex (male vs. female).*

	Same-sex friends group				Opposite-sex friends group			
	No observer		Observer		No observer		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
Cold Pressor Task								
Threshold (seconds)	13.48 (11.54)	8.80 (8.90)	15.72 (5.24)	7.21 (6.26)	12.82 (10.86)	5.38 (3.55)	15.47 (11.28)	6.15 (3.97)
Tolerance (seconds)	79.31 (44.19)	17.57 (9.74)	96.50 (38.32)	26.79 (22.06)	43.55 (38.44)	17.44 (14.79)	54.16 (46.34)	21.85 (22.69)
SF-MPQ-2	2.04 (0.73)	2.44 (1.26)	2.34 (1.05)	2.38 (1.12)	3.11 (1.98)	3.06 (1.65)	2.89 (2.33)	2.86 (1.45)
VAS	56.83 (15.22)	65.33 (12.89)	57.50 (13.93)	67.08 (11.59)	57.91 (17.54)	55.27 (23.41)	58.27 (27.26)	62.20 (22.95)
Algometer								
Threshold (kPa)	576.75 (192.17)	422.42 (153.50)	659.33 (225.35)	538.75 (281.17)	620.08 (251.18)	400.25 (118.21)	730.08 (269.67)	429.58 (133.84)
SF-MPQ-2	1.21 (0.71)	1.65 (1.20)	1.09 (.57)	1.53 (0.88)	1.06 (0.66)	1.37 (0.92)	.85 (.60)	1.36 (1.03)
Algometer VAS	34.25 (18.52)	41.17 (21.52)	33.58 (17.91)	49.25 (21.42)	23.00 (19.03)	35.18 (19.70)	19.82 (17.25)	35.55 (20.35)

Notes: VAS = Visual Analogue Scale; SF-MPQ-2 = Short Form McGill Pain Questionnaire Version 2

For pain thresholds, a main effect of sex of the participant was found, $F(1,44) = 12.60$, $p < .001$, $\eta_p^2 = .22$. Men ($M = 14.37$ secs, $SD = 8.47$ secs) had higher cold pressor pain thresholds than women ($M = 6.88$ secs, $SD = 5.64$ secs). No other significant effects were found.

For pain tolerance a significant effect of participant sex was found, $F(1,44) = 28.37$, $p < .001$, $\eta_p^2 = .39$. Men ($M = 68.38$ secs, $SD = 44.09$ secs) exhibited a higher pain tolerance than women ($M = 20.91$ secs, $SD = 16.70$ secs). Additionally, there was a main effect of observer presence, $F(1,44) = 13.98$, $p < .001$, $\eta_p^2 = .24$, with pain tolerance levels being higher when the observer was present ($M = 49.82$ secs, $SD = 44.46$ secs) compared to when absent ($M = 39.47$ secs, $SD = 39.14$ secs). Sex of the observer was also significant, $F(1,44) = 5.44$, $p < .05$, $\eta_p^2 = .11$. Pain tolerance was higher amongst participants allocated to the male observer group ($M = 55.04$ secs, $SD = 44.46$ secs) compared to the female observer group ($M = 34.25$ secs, $SD = 34.58$ secs).

There was also a significant two-way interaction between sex of the participant and the sex of the observer, $F(1,44) = 4.19$, $p < .05$, $\eta_p^2 = .09$ (see Figure 4.1.). After Bonferroni adjustments (.05/4 = .0125), analysis revealed that when in the male observer condition, male participants ($M = 87.90$ secs, $SD = 39.33$ secs) exhibited higher pain tolerance levels than women ($M = 22.18$ secs, $SD = 15.21$ secs), $t(22) = 5.46$, $p < .001$, $d = 2.23$. However, when in the female observer condition, male participants ($M = 48.86$ secs, $SD = 41.06$ secs) were not significantly different from women ($M = 19.65$, $SD = 18.66$ secs); $t(22) = 2.17$, $p > .0125$, $d = .89$. Furthermore, male participants placed in the male friend condition exhibited a statistically similar pain tolerance level to when placed in the female observer condition, $t(22) = 2.44$, $p > .0125$, $d = 1.00$. Similarly, within female participants, no significant differences were found between those in the male observer and female observer conditions, $t(22) = .54$, $p > .05$, $d = .22$.

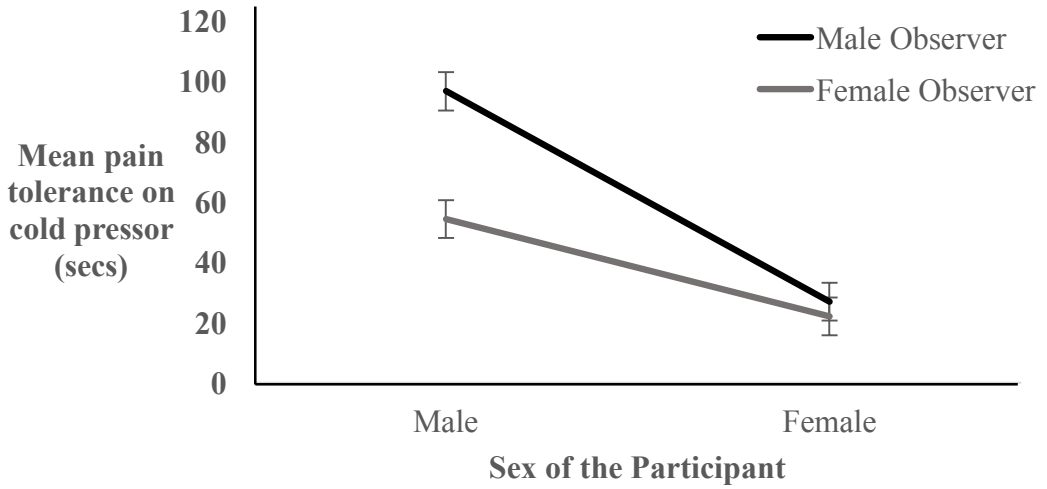

Figure 4.1. Mean tolerance time for the cold pressor (secs) for male and female participants with a male and female observer. Error bars represent ± 1 standard error of the mean.

No significant effects were found for SF-MPQ-2 and VAS.

4.3.4. Impact of an observer on reporting of pressure pain

A similar series of ANOVA's were conducted on outcomes from the pressure pain task, with the means and standard deviations also shown in Table 4.3. For pressure pain, a main effect was found for the sex of the participant, $F(1,44) = 11.47$, $p < .001$, $\eta_p^2 = .21$. Men ($M = 646.56$ kPa, $SD = 227.77$ kPa) had a higher pressure-pain threshold than women ($M = 447.75$ kPa, $SD = 170.89$ kPa). Additionally, there was a main effect of having an observer present $F(1,44) = 25.23$, $p < .001$, $\eta_p^2 = .36$, with higher pressure pain thresholds found when an observer was present (M =589.44 kPa, SD = 255.10 kPa) compared to when they were absent ($M = 504.88$ kPa, $SD = 203.55$ kPa). No other significant effects were found.

For the SF-MPQ-2 no significant differences were found. However, for the VAS, a main effect of participant sex was found, $F(1,42) = 5.06$, $p < .05$, $\eta_p^2 = .11$, in that women ($M = 40.50$, $SD = 20.20$) reported higher intensity pain than men (M = 27.93, $SD = 18.64$). A significant interaction was found between the sex of the participant and presence of an observer, $F(1,42) = 5.00$, $p < .05$, $\eta_p^2 = .11$ (see Figure 4.2.). Follow-up analysis revealed that when the observer was absent, men and women reported similar pain levels, $t(44) = -1.61$, $p > .0125$, $d = -.47$. However,

when an observer was present, women (M = 42.70, SD = 21.60) reported their pain as being more intense than men (M = 27.00, SD = 18.57), $t(44) = -2.64$, $p < .0125$, $d = -.78$. No other significant effects were found.

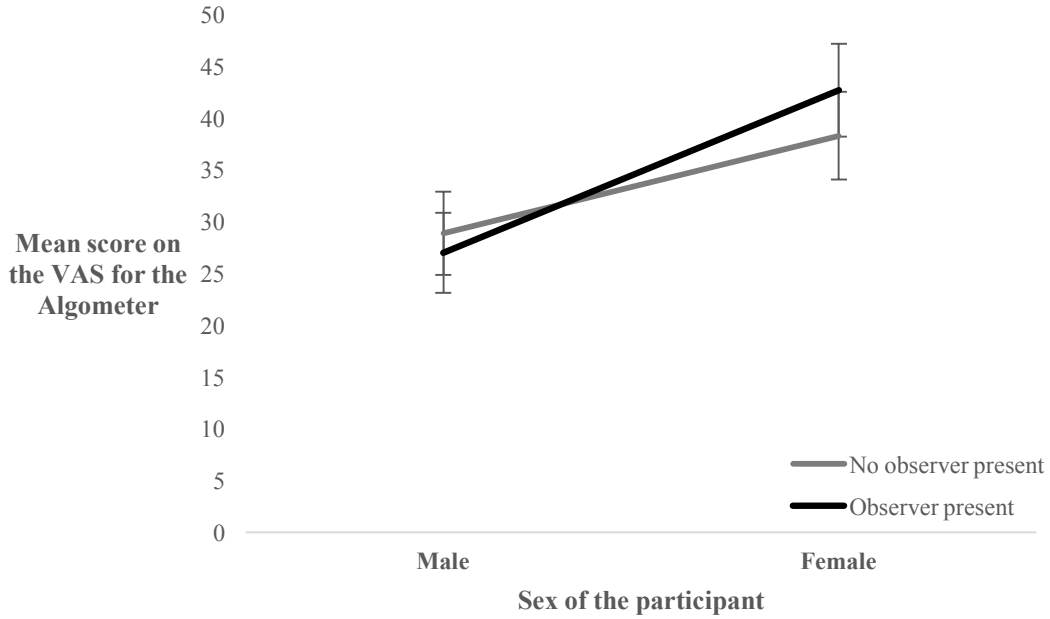

Figure 4.2. Mean VAS score for the algometer (seconds) for male and female participants with and without an observer present. Error bars represent ± 1 standard error of the mean.

4.4. Discussion

The primary aim of this study was to investigate the impact same-sex and opposite-sex friends have on pain. Additionally, I investigated whether there were any sex differences present. Similar to the first experimental study in this thesis, pain threshold and tolerance increased in the presence of an observer, which in this study was always a friend. Interestingly, pain was tolerated more in the same-sex friend's condition, as opposed to the opposite-sex condition. However, when exploring this interaction further, pain was tolerated the most when the dyad comprised of male-male friendships. With regards to sex differences, men had higher pain threshold, tolerance, and pressure-pain threshold, in comparison to women.

4.4.1. Interpretation of results

Several patterns emerged from the above results which build on the previous study in this PhD. As seen in the previous study, and replicated here, the presence of an observer had an effect on the way pain was reported; when an observer was present pain tolerance increased, which is also consistent with previously reported findings (Vigil & Coulombe, 2011; Vigil et al., 2013). For example, previous work by Vigil and colleagues suggests that in the presence of an observer, pain tolerance increases. This study also supports these finding.

The current study findings emphasise the need to consider the sex-context in which pain is reported. This study controlled for the sex of the participant and the sex of the friend, and by investigating the impact of both same-sex and opposite-sex friends have on pain, interesting results emerged. It was apparent that pain was tolerated more when the friend was of the same-sex. However, when this was broken down further by posthoc analysis, it was evident that the significant effect was in the male-male friends.

The third hypothesis stated in the introduction was referring to sex differences; in this study, I was able to support the predicted sex differences as men had a higher pain threshold and tolerance than women. To be able to replicate these results from the previous study, and from the literature, adds strength to the design of the paradigm and also allows for the results of the dyadic interactions to be interpreted in a similar way to the previous study. Interestingly, there was also a sex difference in the effect of having a friend present (of either sex) on self-reported pain. Women rated their pain as more intense than men when in the presence of a friend, which could provide more evidence as to why women had a lower pain threshold and tolerance to men. If women, in the presence of a friend, find pain more sensitive, perhaps friends only have an effect on men (Eagly, 2013).

4.4.2. Implications of results to pain research

These findings build upon what is already known in the literature, but it also builds upon the findings from Chapter 3. Friendship, and the effect it has on pain reporting is largely under researched, but our findings complement the few studies that have been reported (McClelland & McCubbin, 2008). The sex of the friend was

important, in that men report less pain when in the presence of a same-sex friend. This finding contrasts with previous work, which tends to examine the effects of same-sex strangers, rather than friends, yet seems to find similar pain suppression patterns in male-male dyads. Reasons for this vary, but may be linked to stereotypical patterns of gendered behaviours. For example, men are typically considered to be more stoic, less likely to express their emotions in an everyday context, and so maybe less likely to be seen drawing on social support – especially from other men (Eagly, 2013). Competition between men may also plays a role in pain expression (Niederle & Vesterlund, 2007), especially throughout adolescence and early adulthood. Research suggests that men often want male peers to view them favourably (Ricciardelli, McCabe, & Banfield, 2000), and so it is possible that same-sex male friends produces a more competitive environment within which friendship dyads operate (Booth & Nolen, 2012). In comparison, same-sex female friends may be more likely to focus on friendship around social support and intimacy, and be less inhibited to express signals associated with pain (Reis et al., 1985). Generally, women have lower competitive levels on a day-to-day basis (Gneezy, Leonard & List, 2009), and often seek more reassurance and social support during vulnerable environments; this may provide an explanation or the results seen in this study. Male-male friends had the highest tolerance, but there was no difference in women, irrespective of the condition, which highlights that competitiveness may have an impact on how men express their pain. If so, it is possible that men and women interact with same and opposite-sex friends in different ways, and it would be interesting to consider these issues further, especially in terms of interpersonal competition.

One reason why men might exhibit higher tolerance to pain when accompanied by a same-sex friend could be because where pain expression is perceived as a visible marker of vulnerability, men are more likely to supress pain communication in the presence of other men. If this is the case, then for men, presenting vulnerability (i.e., pain) may be most likely to occur when competition is low (Karen & Washington, 2015), such as when in the presence of a very close opposite-sex acquaintance. Research suggests that women have a wider range of social support networks, whereas men tend to rely more on a spouse for support (Keogh, 2014).

From this we might predict that men would be most willing to disclose pain when accompanied by a close romantic partner, as opposed to a friend or stranger.

More generally, the findings add to what is already understood about how we communicate pain in social settings (McClelland & McCubbin, 2008; Vigil & Coulombe, 2011; Vigil et al., 2013). Whilst we know that pain is communicated through nonverbal signs, such as facial expressions (Craig, 1992) and body posture (Walsh et al., 2014), less is known about how the type of people we interact with affects pain experiences, beyond simple familiarity. The nature of the relationship between participants and observer is important (Krahe et al., 2013), although friendship is rarely considered. For example, within a systematic review conducted by Krahe et al. (Krahe et al., 2013), which identified 26 studies, the majority compared strangers and social partners, with only four specifically looking at the effect of friends. Furthermore, of the friend studies that were reported, few took the sex context of dyads into consideration. The results here confirm that this is a potentially important oversight and one that should be corrected within future studies of this type (Keogh, 2014).

The results also support the continuum mentioned in Chapters 1 and 3; friends had closer relationships than strangers (Chapter 3), and in this study, same-sex friends reported having closer relationships than opposite-sex friends. This shows that relationships closeness can be placed on a continuum, and different stages of the continuum may have a different impact on pain.

4.4.3. Limitations

As with most experimental studies, there are limitations that should be considered. The main limitation for this study is the type of dyadic relationship recruited. This study specifically focusing on same-sex and opposite-sex friends, which does not allow for other types of dyadic relationship to be considered. While acknowledging this was an important step in order to build on the results from the previous chapter, this study is very specific to friends, and does not include any other type of dyadic relationship. However, the aim of the first half of this PhD thesis is to explore different dyadic relationships along a continuum of closeness, from not knowing the observer (strangers), to having an intimate relationship with them

(romantic partners). Thus, so far in this PhD thesis I have investigated the role of strangers, and friends (the middle of the continuum), but this PhD has not investigated how romantic partners can have an impact on pain. Therefore, despite this study providing further evidence and interpretation on the impact of friends, another study will need to be conducted which also includes romantic partners, in order to complete the full continuum of relationship closeness.

4.4.4. Directions for next study

Addressing the findings of the current study, it would be beneficial to conduct a third experimental study that mirrors the paradigm used so far in the PhD, but to investigate the differences between romantic partners and opposite-sex friends. This would allow the full continuum of how well the dyad know each other to be investigated. This would continue with the exploration of everyday relationships, and develop a richer understanding of how dyadic relationships can impact on the reporting of pain in men and women.

Chapter 5: Investigating the differences in the reporting of pain in opposite-sex friends and romantic partners

As with the previous two chapters, the methods and results from this study have been published in the journal PAIN, with Dr Ed Keogh and Professor Chris Eccleston as co-authors:

Edwards, R. T., Eccleston, C., & Keogh, E. (2017). Observer influences on pain: an experimental series examining same-sex and opposite-sex friends, strangers, and romantic partners. *PAIN, 158*(5), 846-855. doi: 10.1097/j.pain.0000000000000840

The publication is a multi-study manuscript covering the methods and results from this chapter, Chapter 3 and Chapter 4.

5.1. Introduction

Building on Chapters 2 and 3, and previous literature, it is evident that dyadic relationships can have an impact on how pain is reported. So far in this PhD thesis, I have found that knowing an observer, or not knowing them, can have an impact on how pain is reported; friend observers have a greater effect on increasing participants' pain tolerance than stranger observers do. When this observer effect is investigated further, pain tolerance is highest when the participants are male, and with a male friend. However, there is little variation in the way women report pain when in the presence of different types of observer; e.g. the mean for pain threshold and tolerance are similar, irrespective of the sex of the observer and dyadic relationship. As outlined in the previous chapters, there are numerous explanations for this, ranging from men wanting to appear less vulnerable and more stoic, to women seeking more social support than men, and thus, more likely to communicate their pain. Even though an increase in pain tolerance has been identified in observers who are strangers and friends, romantic partners have not yet been considered.

Building upon the continuum of relationship closeness outlined in the first chapter, around how well a couple within a dyad know each other, it is important to now consider the impact a romantic partner can have on pain, as this is the only relationship not yet addressed in this PhD thesis. Romantic partners are amongst the most intimate relationships that can be formed between individuals, and often are a primary source of support to their partner. Thus, given the level of support received by a partner, this is an important relationship to consider in the context of pain. Romantic partners in the context of chronic pain have been extensively researched, with the primary outcomes being that living with a spouse who has chronic pain can often have detrimental effects of a marriage, and often means the chronic pain patient often doesn't feel that they receive adequate support from their partner (Cano, 2004). There is related research, in the context of social support, where research indicates that feelings of an unsupportive spouse can lead to increased pain sensitivity, and poor psychological wellbeing (Flor et al., 1989). A lot of the research has focused on the social support of a spouse, and the impact chronic pain can have on marital satisfaction (Kerns et al., 1990). Additionally, spouses are often able to identify pain in their partner and often rate the pain as more severe than the patient

with chronic pain (Cano et al., 2004b). However, even though the impact of a chronic pain on a relationship is relatively understood (Cano et al., 2008; Cano et al., 2004a; Cano et al., 2004b; Cano et al., 2000; Leonard & Cano, 2006; Leonard et al., 2006), there is very limited research on how the partner can have an impact on pain reporting's healthy adults experiencing acute pain; this study will aim to address this.

Therefore, given there is limited available research that understands the impact of a spouse on acute or temporary pain, this next study aims to investigate the impact of having a romantic partner present on pain threshold and tolerance. By focusing on romantic partners, it will also complete a series of studies that has focused upon how the closeness of relationships can have an impact on pain. As with previous studies in this PhD thesis, this study will have two dyadic relationships recruited; romantic partners and opposite-sex friends. In the previous study, the friends in the opposite-sex condition had a lower pain threshold and tolerance than the friends in the same-sex condition; thus, it is of interest to test whether the level of intimacy can have an impact on how pain is reported. For this reason, heterosexual romantic partners will be recruited alongside opposite-sex friends.

In order to investigate whether closeness of the relationship can have an impact on how pain is reported in men and women, this study will investigate whether there is a difference in the pain reporting between opposite-sex friends and romantic partners, and men and women. It was hypothesised that:

a) In line with the previous two studies, overall, the presence of an observer will increase pain threshold and tolerance,
b) When considering the nature of the dyadic relationship, opposite-sex friends will have a higher pain tolerance than romantic partners; and,
c) overall, men would report a higher pain tolerance than women

5.2. Method

5.2.1. Design

As in previous studies, a mixed-groups design was employed. There were two between-groups factors: sex of the participant (male vs. female) and the dyadic relationship (romantic partner vs. opposite-sex friend). The within-groups variable

was the observer (observer present vs. observer absent). The dependant variables were pain response indexes from the two pain induction tasks.

5.2.2. Participants and observers

A total of 96 participants were recruited into Study 3, which comprised of 48 dyads. Of these 24 dyads were opposite-sex romantic partners (*M* length of relationship = 35.62 months, *SD* = 23.56 months) and 24 dyads were opposite-sex friends. Within each dyad, one person completed the pain induction tasks (24 male; *M* = 25.42 years *SD 5.11* years, 24 female; *M* = 23.92 years *SD* = 4.23 years) and one observed (24 male; *M* = 25.38 years *SD* = 6.01 years, 24 female; *M* = 24.25 years *SD* = 4.20 years).

Participants were recruited using a similar approach at Chapter 3. Initially, 48 participants were recruited to take part in the pain induction tasks, and were made aware that they would have to bring an either a friend or a romantic partner of the opposite-sex to observe.

Table 5.1. *The distribution of participants within each condition.*

	Romantic partners (*n* = 48)	Opposite-sex friend (*n* = 48)
Males	12 male participants	12 male participants
	12 female observers	*12 female observers*
Females	12 female participants	12 female participants
	12 male observers	*12 male observers*

5.2.3. Pain Induction

5.2.3.1. Cold pressor pain and pressure pain

This chapter mirrors the same methodology as presented in Chapter 2. The same experimental pain induction tasks were employed, following exactly the same procedure. I.e. the cold pressor was kept at 1ºC (± 1ºC), for a maximum of two minutes. The methodology for the algometer was also conducted in the same way; taking three readings to enable an average to be calculated.

5.2.4. Self-report measures

The same self-report measures were used as in Chapter 2. This includes the visual analogue scale to measure pain intensity and the Short Form McGill Pain Questionnaire. Additionally, each participant completed the Depression, Anxiety and Stress Scale (DASS), the Unidimensional Relationship Closeness Scale (URCS) and the Relationship Closeness Inventory (RCI). Again, these measures were completed to identify any differences in relationship closeness and mood.

5.2.4.1. Experiences of Close Relationships – Revised (ECR-R)

As well as including the same self-report measures described in previous studies, the Experiences in Close Relationships-Revised (ECR-R) (Fraley, Waller, & Brennan, 2000) was included. This scale assesses individual differences in attachment-related anxiety (how secure someone feels with regards to availability and responsiveness of their partner/others) and attachment-related avoidance (the extent to which people are uncomfortable being close to their partner/others), which may be relevant to how close the romantic relationship is. The ECR-R comprises of 36 items, which are rated on a Likert-scale between 1 (*strongly disagree*) to 7 (*strongly agree*). The measure produces two subscales; attachment-related anxiety and attachment-related avoidance. Questionnaires were scored in line with the guidance from Fraley, Heffernan, Vicary, and Brumbaugh (2011), whereby scoring high on both scales would indicate the person is fearful-avoidant, and lower scores on both scales indicates feeling secure with the relationship.

5.2.5. Ethical Considerations

Full ethical approval was obtained from the Department of Psychology Ethics Committee (Reference number: 14-003) and the Department for Health Ethics Committee (Reference number: EP 13/14 79) at the University of Bath, UK.

5.2.6. Procedure

The procedure mirrored what has been presented in Chapter 2 and 3. Participants completed the cold pressor and pressure pain task alone and with an observer (order was counterbalanced between pairs). This followed the same format

as the representation of the paradigm in Figure 1 (Chapter 2). The same questionnaires measures were also administered (and the additional ECR-R), in the same way. The only difference between studies was the nature of the dyadic pairings. All participants were reimbursed for their participation with either monetary rewards or course credits.

5.3. Results

5.3.1. Data screening

Data were checked for potential outliers using z-scores (±3.29), but none were found. Histograms and the skewness/kurtosis values confirmed that normality was met. For the cold pressor task, six participants did not complete the VAS and two participants did not complete the SF-MPQ-2. For the pressure pain, eight participants did not complete the VAS and 2 participants did not complete the SF-MPQ-2.

The means and standard deviations for the self-report measures can be found in Table 5.2., and each of the pain induction tasks and the self-report pain questionnaires can be found in Table 5.3.

5.3.2. Analysis of self-report measures

Analyses were conducted on the various self-report measures to ensure there were no unexpected group differences. Dyadic relationship (opposite-sex friend vs. romantic partner), sex of participant (male vs. female) and participant role (experiencing pain vs. observer) were the between-group variables. The means and standard deviations for the DASS, URCS, and RCI are in Table 5.2.

Table 5.2. *Means and standard deviations (in parenthesis) for self-report measures by dyadic relationship (opposite-sex friends vs. romantic partners), sex of participant (male vs. female) and participant role (experiencing pain vs. observer).*

	Opposite-sex friends group				Romantic partners group			
	Experiencing pain		Observer		Experiencing pain		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
DASS	28.30 (12.40)	18.42 (16.25)	20.21 (12.68)	18.27 (16.81)	14.40 (8.40)	14.01 (13.72)	15.20 (9.25)	13.60 (13.57)
URCS	3.98 (1.23)	4.58 (.97)	4.49 (1.76)	3.74 (1.31)	6.19 (.81)	6.53 (.38)	6.63 (.26)	6.16 (1.34)
RCI Strength subscale	5.53 (.62)	3.73 (1.00)	5.32 (.72)	3.60 (1.05)	5.74 (.82)	3.91 (.82)	5.69 (.73)	3.98 (.80)
ECR-R Anxiety subscale	2.72 (.81)	2.46 (.64)	2.90 (1.01)	2.56 (.77)	2.31 (.79)	2.68 (.91)	2.34 (.75)	2.86 (1.12)
ECR-R Avoidance subscale	3.16 (1.02)	3.39 (1.11)	2.87 (.87)	3.06 (1.04)	2.22 (.94)	1.80 (.76)	2.60 (1.16	2.27 (.97)

Notes: DASS = The Depression Anxiety and Stress Scale

URCS = The Unidimensional Relationship Closeness Scale

RCI = The Relationship Closeness Inventory

ECR-R = The Experiences in Close Relationships-Revised

5.3.2.1. URCS

The analysis on the URCS revealed a significant main effect of dyadic relationship, $F(1,88) = 111.21$, $p < .001$, $\eta_p^2 = .56$. Participants in the romantic partner condition ($M = 6.38$, $SD = .81$) perceived their relationship with each other to be closer than those in the opposite-sex friends condition ($M = 4.20$, $SD = 1.20$). A significant interaction was also found between sex of participant and participant role, $F(1,88) = 6.86$, $p < .05$, $\eta_p^2 = .07$. Post-hoc tests failed to reveal any significant differences, and so are not reported any further. No other significant effects were found.

5.3.2.2. RCI

The second analysis was on the RCI, which also revealed a single significant effect of sex of the participant. Unusually, men ($M = 5.53$, $SD = .72$) reported having a closer relationship with the person present, when compared to female participants ($M = 3.80$, $SD = .90$), $F(1,80) = 99.13$, $p < .001$, $\eta_p^2 = .55$. The expected effect of dyadic relationship was not significant, nor were there any differences between whether the participant completed to pain tasks or not ($p > .05$).

5.3.2.3. DASS

Analysis on the DASS revealed that participants in the romantic partner condition ($M = 14.23$, $SD = 10.95$) had a significantly lower mood than participants in the friend condition ($M = 19.44$, $SD = 14.62$), $F(1,88) = 4.30$, $p < .05$, $\eta_p^2 = .05$. There is also a significant interaction present between the participants' role and dyadic relationship, $F(1,88) = 4.37$, $p < .05$, $\eta_p^2 = .05$. Post-hoc analysis indicated that amongst participants who completed the pain induction tasks, DASS scores were lower if allocated to the romantic partner condition ($M = 12.75$, $SD = 9.94$) compared to the friend condition ($M = 23.21$, $SD = 15.66$), $t(46) = 2.76$, $p < .01$, $d = .80$. There were no other significant differences in the post-hoc analysis.

Finally, a 3-way interaction was found, $F(1,88) = 7.86$, $p < .01$, $\eta_p^2 = .08$. Separate ANOVA were conducted on male and female participants. This revealed that the two-way interaction reported above was for women, $F(1,44) = 8.83$, $p<.01$, $\eta_p^2 = .17$, but not men $F(1,44) = .40$, $p>.05$, $\eta_p^2 = .01$.

5.3.2.4. ECR-R

The analysis for the ECR-R attachment-related anxiety subscale highlighted no differences between men and women, friends and romantic partners or whether or not the participant completed the pain induction tasks (all p values > .05). However, on the attachment-related avoidance subscale, there was a significant main effect of dyadic relationship, $F(1,81) = 19.81$, $p < .001$, $\eta_p^2 = .20$. Participants in the opposite-sex friends condition ($M = 3.16$, $SD = 1.02$) had higher avoidance scores than those in the romantic partners condition ($M = 2.22$, $SD = .94$). There was also a significant interaction present between participant role and sex of the participant, $F(1,81) = 4.25$, $p < .05$, $\eta_p^2 = .05$. However, post-hoc analyses showed no differences between these groups (all p values >.0125).

5.3.3. Impact of an observer on reporting of cold pressor pain

A series of ANOVA's were conducted on the cold pressor outcomes, with the sex of the person experiencing pain (male vs. female), the dyadic relationship (opposite-sex romantic partners vs. opposite-sex friends) as between-group factors, and the observer presence (observer absent vs. observer present) as a within-group factor. The means and standard deviations can be found in Table 5.3.

Table 5.3. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by dyadic (romantic partners vs. opposite-sex friends), the phase (no observer vs. observer) and sex (male vs. female).*

	Opposite-sex friends group				Romantic partners group			
	No observer		Observer		No observer		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
Cold Pressor Task								
Threshold (seconds)	10.51 (6.58)	5.85 (4.27)	11.09 (7.75)	8.43 (6.05)	8.39 (7.44)	5.21 (3.74)	9.54 (6.65)	8.03 (7.33)
Tolerance (seconds)	58.98 (48.46)	16.76 (14.03)	58.58 (47.57)	25.13 (21.74)	60.13 (45.13)	16.48 (11.77)	68.14 (45.28)	17.63 (12.85)
SF-MPQ-2	2.46 (1.58)	2.50 (1.46)	2.35 (1.82)	2.63 (1.61)	2.71 (1.06)	2.65 (1.18)	2.91 (1.73)	2.45 (1.22)
VAS	59.91 (19.25)	59.50 (11.17)	60.10 (22.75)	61.91 (14.27)	64.08 (11.64)	65.00 (13.44)	64.67 (20.01)	68.64 (15.13)
Algometer								
Threshold (kPa)	448.36 (123.93)	329.58 (138.66)	468.08 (149.33)	312.53 (143.03)	414.92 (101.42)	321.17 (129.38)	417.08 (99.94)	341.17 (132.67)
SF-MPQ-2	1.35 (1.12)	1.55 (1.08)	1.33 (1.11)	1.61 (1.29)	.81 (1.04)	1.34 (.84)	.94 (1.15)	1.16 (.86)
Algometer VAS	35.00 (18.30)	34.80 (23.00)	32.40 (18.10)	33.50 (24.30)	19.90 (14.50)	34.59 (14.30)	26.80 (19.60)	41.20 (14.40)

Notes: VAS = Visual Analogue Scale; SF-MPQ-2 = Short Form McGill Pain Questionnaire Version 2

For pain threshold, there was a main effect of observer presence, $F(1,44) = 4.34$, $p < .05$, $\eta_p^2 = .09$. Pain thresholds were lower when the observer was absent ($M = 7.49$ secs, $SD = 5.93$ secs) compared to when present ($M = 9.28$ secs, $SD = 6.86$ secs). There were no other significant effects.

For pain tolerance, a significant effect of participant sex was found, $F(1,44) = 18.68$, $p < .001$, $\eta_p^2 = .30$. Men ($M = 61.46$ secs, $SD = 44.74$ secs) had a higher pain tolerance than women ($M = 19.00$ secs, $SD = 15.03$ secs). Additionally, there was a main effect of observer presence, $F(1,44) = 4.36$, $p < .05$, $\eta_p^2 = .09$. Pain tolerance was higher when participants were accompanied by an observer ($M = 42.37$ secs, $SD = 40.34$ secs) than when tested alone ($M = 38.09$ secs, $SD = 39.69$ secs). No other significant effects were found.

For the SF-MPQ-2 and VAS, no significant differences were found.

5.3.4. Impact of an observer on reporting of pressure pain

A similar series of ANOVA's were conducted on outcomes from the pressure pain task, with the means and standard deviations also shown in Table 5.3. For the pressure pain task, a significant effect of sex was found, $F(1,44) = 10.49$, $p < .01$, $\eta_p^2 = .19$. Men ($M = 437.11$ kPa, $SD = 115.14$ kPa) had a higher pressure pain threshold than women ($M = 326.11$ kPa, $SD = 119.18$ kPa). No other significant effects were found.

For the SF-MPQ-2 no significant effects were found. There was no main VAS effect, however, there was a significant interaction between observer presence and dyadic relationship, $F(1,40) = 5.39$, $p < .05$, $\eta_p^2 = .12$. Post-hoc analysis with a Bonferroni adjustment indicated that there were no significant differences between the groups (all p's $> .0125$). Inspection of means were examined, which suggested that those pain ratings were slightly lower when the romantic partner was absent, compared to when present.

5.4. Discussion

Firstly, as expected, participants in the romantic partner's condition reported closer relationships with their observer than those in the opposite-sex friends group. These results supported the hypothesis that men would have a higher pain tolerance than women. In addition, pain reports were also affected by the presence of an

observer, with more pain being tolerated when an observer was present. However, although I predicted pain tolerance to be higher when men were in the presence of an opposite-sex friend, compared to a romantic partner, the nature of the dyadic relationship did not affect pain reporting.

5.4.1. Interpretation of results

This study was able to replicate results from the previous two studies whereby the presence of an observer increased both threshold and tolerance on the cold pressor task, which emphasises that the contextual influences on the reporting of pain need to be considered further. This finding is a replication on previous literature that has focused on the social influences on pain (Brown et al., 2003; Martin et al., 2015; Vigil & Coulombe, 2011; Vigil et al., 2013), suggesting that the presence of an observer definitely increases pain tolerance. However, this next stage is where this research builds on previous literature; the dyadic relationship has not been widely considered in an experimental context.

In this study between romantic partners and opposite-sex friends, the nature of the dyadic relationship did not have an effect on the reporting of pain. Thus, there was no differences between the observer being a friend or a romantic partner, which was not what was predicted. The romantic partners reported having closer relationships than the friends, but this increase in closeness did not have an impact on the reporting of pain, which suggests that level of intimacy does not play a role in the reporting of pain.

As with the previous studies presented as part of this PhD, and previous experimental pain research, men had a higher pressure-pain threshold and tolerance when compared to women. Over the three experimental studies reported in this PhD thesis, men have had a higher pain tolerance than women. This shows that this consistent replication across the three experimental studies so far in this thesis can support previous experimental research, but also that the paradigms employed in this thesis are both valid and reliable.

5.4.2. Implications of results to pain research

The findings from this study are interesting in light of research that has considered the role of social support from partners/spouses, even though research

suggests that support from a partner can decrease pain intensity (Brown et al., 2003; Vigil et al., 2013), especially when the partner perceives himself or herself as receiving social support from their partner. I did not find that the presence of a romantic partner reduced pain (when compared to opposite-sex friends) which suggests perceived social support can have a bigger role on pain. Whilst we did find that romantic partners were rated as having closer relationships than friends, it might be dubious to assume this is a proxy for perceived support, and so it would be useful to explore the potential role of support and attachment between dyads in future sex-based studies on observer effects.

When considering this findings in light of the continuum of closeness first referred to in Chapter 1, the results from this study show that once the dyad are known to each other, the level of intimacy does not impact on pain. One of the reasons why there were no difference between these two dyadic relationships may be because of social support; both types of dyadic relationship perceived to receive social support from their partner, thus, there were lower levels of competition present in the environment, resulting in no differences in the pain outcomes.

5.4.3. Limitations

The main limitation with this study is regarding the types of dyadic relationships recruited. In the romantic partner's condition, the romantic partners were all heterosexual relationships. Opposite-sex friends and heterosexual couples were recruited in order to keep all dyadic relationships of the opposite-sex, in this study. However, Chapter 3 found the biggest pain tolerance was in same-sex friends, thus, it would be of interest to recruit homosexual romantic partners. By having a series of studies that focus on same-sex and opposite-sex friends and romantic partners, a greater understanding could be gained from whether it is the components of friendship which have an impact on the reporting of pain, or whether it is the level of closeness and intimacy that can have an impact. By investigating both heterosexual and homosexual relationships, the continuum of closeness of relationships can be investigated further, and greater knowledge can be gained from investigating all types of dyadic relationship.

5.4.4. Directions for future research

The above limitations warrant further exploration, but unfortunately sits outside of the remit of this PhD thesis. When considering the continuum of how well a dyad know each other, over the first three studies in this PhD, it has been noted that the highest pain tolerance is within friendships. As I have investigated same-sex and opposite-sex friends so far in this thesis, the next plausible pathway for investigation is to closely look at the components of friendship and consider what specific contextual influences may have a role in pain reporting. For example, it will be interesting to consider the stability of the same-sex observer effect in men. As previously mentioned, the presence of competitiveness between friends may influence the way pain is communicated. It would also be interesting to consider whether competitiveness between friends occurs more within same-sex dyads, and in particular male-male interactions. Additionally, it would be of interest to investigate whether the knowledge of having others present is enough to elicit an observer effect, or whether the observer needs to be physically present before these effects are observed. Finally, it would be interesting to not only consider same and opposite-sex dyads, but perhaps same and opposite gender dyads – something that has not yet been considered in a context such as pain.

5.4.5. Summary and conclusion of first three studies

To conclude, the first three studies in this thesis demonstrate that the presence of having someone else observing a person in pain impacts on how much pain is reported; pain thresholds and tolerance increase in the presence of an observer. These three experiments also suggest that the nature of the relationships between participants and observers, as well as the sex of the dyads moderate how pain is reported. When dissecting the dyadic relationships further, the presence of friends appeared to have the largest effect on participants' pain tolerance. All-male dyads of friends resulted in less pain being reported. Reason for this are unclear, but it was suggested that competitive interactions might play a role and this will be the focus of the next part of this thesis.

The next phase of this PhD thesis will consider this possibility further, by focusing on why pain tolerance might be higher when in the presence of friends, as opposed to strangers and romantic partners. It will do this by considering different

components of friendship, specifically competition and cooperation. Competition is higher in men than women, but the following part of this thesis will focus upon what the impact of a specific competitiveness manipulation task can have on pain. The following chapter will begin by reviewing the literature on cooperativeness and competitiveness, and how it can be linked to pain.

Chapter 6: The difference between cooperation and competition and the impact it has on the reporting of pain in same and opposite-sex friends

6.1. Introduction

The first three experimental studies in this PhD confirmed that social-contextual influences have an impact on the reporting of pain. The main research questions for the first three studies revolved around establishing whether an observer can have an impact on pain reporting, and whether the specific dyadic relationship can provide an explanation as to why the differences may occur. The presence of an observer had an impact on pain; irrespective of the dyadic relationship, more pain was tolerated when someone else was present. Building on this further, if relationships are considered to be on a continuum, with strangers being at one end and romantic partners at the other (Aron, Aron, & Smollan, 1992), the results from these first three experiments suggest that pain is tolerated most when the dyads' relationship is placed in the middle of the continuum, i.e., between friends. Therefore, there is something about friendship which results in more pain being tolerated, when compared to the other types dyadic relationship investigated in this PhD thesis.

One way to understand more about the role friendship has on pain was to consider the different sexes within the dyad, which was also a core research questions throughout this PhD thesis. The results from Chapter 4 suggest the sex of the dyad was important within friendship. Specifically, male-male friend dyads seemed to have the largest impact on pain, in that male participants had the highest tolerance to pain when a male friend was present. However, the increase in pain tolerance in male participants with a male observer was unique to Chapter 4; the increase in pain tolerance was not found when the observer was either a stranger (Chapter 3) or a romantic partner (Chapter 5). It was suggested that one possible explanations for this increase in pain tolerance may be due to a unique form of competition that occurs between male friends. Building on the concept of competitiveness having a role in pain suppression, the next part of this PhD thesis will directly investigate this, and consider the role competitiveness has in increasing or decreasing pain. In this introduction, I will first define competitiveness and cooperativeness within dyads, before reviewing how competition may result in the suppression of pain, and will then apply this theory to sex differences in pain. This will help to set up the rationale for the approach adopted in studies 4 and 5.

6.1.1. Definition of competitiveness and cooperativeness within dyads

Within friendships, like other relationships, there are dynamic interplays between individuals ,which can be conceptualised as forms of competition and cooperation (Moyer, 2016). Deutsch, Coleman, and Marcus (2011) explained that a key element in understanding competition and cooperation in the context of friendship, is to consider the notion of goal interdependence. Competition can be defined as two or more individuals/teams/companies conflicting, and trying to win against each other (Deutsch, 2011). However, the opposite of competition is cooperation, and is defined as two individuals/teams/companies working together, and using each other's strengths, in order to achieve the same goal (Deutsch, 2011).

In the context of this PhD thesis, a dyad can be negatively interdependent, whereby one person's success is highly correlated with the other's failure (i.e. competition). A dyad can also be positively interdependent, which means success correlates with success, and failure correlates with failures (i.e. cooperation). The more cooperative friends are, the stronger the relationship between the two people tends to be. When friends are required to be cooperative, they reframe their goals so each person within the dyad can facilitate the activity with the aim of creating a win-win outcome. However, when a friendship possesses many competitive characteristics, there is an increase in distrust and a decrease in empathy. An additional measure has been added from this point in this PhD thesis which measures the goal interdependence of each of the dyads, but this measure is explained in more detail in the methodology section of this chapter. The goal interdependence of dyads often stems from societal norms and gender stereotypes, and the following subsections will address this directly.

6.1.2. Competitive and cooperative stereotypes

Competitiveness, and the behaviours associated with competitiveness, are closely linked to gendered stereotypes, as outlined in Chapter 1. In Chapter 1, I highlighted how gender differences should be considered, potentially alongside sex differences. However, this is the first experimental chapter in this thesis to directly focus upon the role of sex and gender in the social context of pain. When considering gender stereotypes, feminine women are expected to express more pain than men, and masculine men are less likely to express their pain due to stoic pain

behaviours. However, when considering stereotypes in the context of competition, some of these expectations and stereotypes are altered. Pain is considered a threat, and is closely linked to competition due to the vulnerability it puts the individual in; both painful situations and highly competitive situations result in a shift in behaviour due to the vulnerability experienced. When experiencing vulnerability within competitiveness, the change in behaviour typically results in more masculine traits adopted, in both men and women (Berke et al., 2016). Therefore, gender stereotypes play a role in expectation linked to pain, and when pain and competitiveness are combined, it is unsurprising that pain is expressed less frequently, and is often suppressed more.

Broadly, competition may result in the suppression of pain, but this has not yet been investigated within specific dyadic relationships. However, previous literature has shown that although individuals promote friends over strangers, friendship (and overall closer relationships) can amplify competitiveness via social comparisons (Tesser, 1988; Tesser & Campbell, 1982). Combining friendship with the presence of audience members can often result in individuals pushing themselves through barriers, especially when there is a desired outcome, such as winning (Kurzban, DeScioli, & O'Brien, 2007). This links closely to the results from Chapter 4, and the aims of this present study; if friendship elicits more competition within the dyad, and competition elicits more pain suppression, this could be a possible explanation for the results in the previous Chapters of this thesis. By focusing more specifically on both dyadic relationships and competition, the results of Chapter 4 can be explored in greater detail.

As mentioned in the beginning of this Chapter, the opposite of competition is cooperation. While there is limited information available on pain in a competitive context, there is even less research available on pain in a cooperative environment. However, it is still important to consider cooperativeness as it is considered the extreme of competitiveness, and is considered to elicit more feminine traits. Therefore, when cooperativeness levels are high, it can be hypothesised that pain will not be expressed as much as when friends are competitive. It's important to consider the impact of both competitiveness and cooperativeness to enable a richer, more meaningful interpretation of how the context can have an impact on pain. Given that competitiveness and cooperativeness are associated with gender

stereotypes, sex differences are an important factor to consider. There are already definite sex differences present in pain, so it's of interest to understand more about the impact gender stereotypes can have on the sex differences previously observed.

6.1.3. Competition and sex differences; are the two connected?

One explanation for competition within men stems from evolutionary-based theories such as social modelling and the social construction of sex roles; the competitiveness apparent between males is established during adolescence, as males want other male peers to look sociably favourable upon them (Ricciardelli et al., 2000). Physical physique plays a role during this phase, whereby males strive to be masculine, which was defined by adolescents as having broad shoulders, having large muscles, and fewer pain behaviours (Ricciardelli, McCabe, & Ridge, 2006). The competitiveness present between males continues from adolescence into adulthood, with males having more competitive traits, than females, in everyday environments (Cheng & Chan, 1999). In addition, men behave more competitively towards other men than towards women, whereas women do not operate different levels of competitiveness depending on the sex of the other person (Buunk & Massar, 2012), which is more evidence to suggest the findings from Chapter 4 were based on male-male competition.

There is less research available regarding women and competition, but competitiveness is present in women when there is a goal, i.e. to win. However, there is a sex difference in the way competition is expressed; men operate on a higher competitiveness level on a day-to-day basis, and women are less likely to express their competitiveness in an overt way (Cashdan, 2003). This offers an explanation as to why there is less research focused on competitiveness in women; perhaps the competitiveness expressed is subtler than in men. However, women are considered to be just as competitive as men, when required (Gneezy, Niederle, Rustuchini, 2003), and engage in competing against others in the same way as men (Tergerson & King, 2002). This coincides neatly with the stoic stereotypes seen in men, and it is plausible that these stereotypes overlap women's behaviours in competitive environments; women are more intrinsically motivated in competitive environments than men (Beaudoin, 2006), which suggests that both men and women adopt more masculine traits such as pain suppression in competitive environments.

When combining the research on men and women together, in the context of pain and competitiveness, there is evidence to suggest competition triggers pain suppression, and both men and women adopt stoic traits. Men strive to be competitive with other men in particular, and women are only competitive when there is a goal present such as winning. While men are more competitive with other men, women are competitive with both sexes. However, what is now if interest, is whether there is still a sex difference in pain threshold and tolerance when both men and women complete a competitive manipulation task.

6.1.4. Competition manipulation tasks within experimental settings

The manipulation of competition and cooperation has been extensively researched within social psychology experimental paradigms over the decades. The rationale being that competition and cooperation are extreme opposites, but provide a good indication of how people are motivated to achieve outcomes, e.g. winning. Additionally, within this research, the differences in dyadic relationships have been considered, specifically between friends and strangers; when friends cooperate to achieve a goal, there is a stronger commitment level than with strangers, as friends are obviously known to each other prior to the cooperative task. However, when focusing on a more competitive environment, there were no differences in dyadic relationships; the outcomes are the same with friends and strangers (Peng & Hsieh, 2012).

An example of competition manipulation is video gaming (Mason & Clauset, 2013) and cognitive tasks in an organisational setting (Parise & Rollag, 2010), which have both been linked to real-life virtual environments where by individuals compete or cooperate with others in order to achieve goals. However, these findings can be translated in to more real-world environments; other people can help individuals through specific circumstances in order to achieve outcomes. For example, individuals perform help seeking behaviours in order to alleviate the pain (Miller & Timson, 2004), but what is not known is whether a competitive component of a friendship can have an impact on how pain would be reported.

6.1.5. The next phase of this thesis

Building upon the first three experimental chapters in this PhD thesis, the next part of this thesis will focus on the fourth research question presented in Chapter 1: can we begin to understand why pain is tolerated more in friends? Previously, participants who were observed by a friend had the highest pain tolerance, specifically when the dyad was male-male. This may be due to gendered stereotypes such as competition that is experienced more between men than women. Thus, the next part of this thesis will explicitly investigate the role of two different gendered contexts: competitiveness and cooperativeness. Manipulation methodologies have been explained in Chapter 2, and the exact manipulation task used in this study is explained in the following methods section. This specific chapter will focus on friendships, and the following was hypothesised:

1) Given that competitiveness elicits more masculine traits, such as stoicism and a decrease in pain expression, it was hypothesised that both men and women would suppress their pain more in the competitive game condition, as opposed to the cooperative game condition.
2) Men will have a higher pain tolerance than women.

6.2. Method

6.2.1. Design

A similar deign was used to that described in the previous studies in this PhD thesis. The main difference was the introduction of the competitiveness and cooperativeness manipulation; a mixed-group design was employed in this study. There were two between-groups factors: the sex of the participant (male vs. female), and the sex of the observer (male vs. female). The within-groups variable was the game condition the participants were in (competitive vs. cooperative). The primary dependent variables were the various indices from the pain induction tasks, including the pain threshold, tolerance, pressure-pain threshold, VAS scores for pain intensity, and the McGill Short-Form Pain Questionnaire scores.

6.2.2. Participants and observers

A total of 96 adults (48 male, 48 female; *M* = 22.77 years, *SD* = 3.82 years) were recruited using similar methods as previous studies, including the undergraduate research participation scheme, posters, emails, and word-of-mouth. None of the participants reported taking medication, and they all reported being pain-free. To reduce the likelihood of participants experiencing adverse effects from the pain induction task, participants were excluded if they had eczema, asthma and/or sensitive skin.

Forty-eight participants were recruited to take part in a pain study which also involved playing with a games console. After initial screening, half of the participants were asked to bring a same-sex friend to the study and half of the participants were asked to bring an opposite-sex friend to the study (see Table 6.1.). There was another stipulation that there was no romantic involvement with the friend. The accompanying friend did not complete any of the pain induction tasks, but instead observed (24 male; *M* = 23.42 years, *SD* = 4.27 years and 24 female; *M* = 23.13 years, *SD* = 4.01 years). The participant initially recruited for the study completed the pain induction tasks (24 male; *M* = 23.42 years, *SD* = 4.05 years and 24 female; *M* = 22.13 years, *SD* = 3.54 years). All participants recruited in to the study played the games console. Therefore, the 96 individuals comprised of four groups of 12 dyads; male-male friends, male-female friends, female-female friends, female-male friends.

Table 6.1. *The distribution of participants within each condition.*

	Same-sex friends (*n* = 48)	Opposite-sex friends (*n* = 48)
Males	12 male participants	12 male participants
	12 male observers	*12 female observers*
Females	12 female participants	12 female participants
	12 female observers	*12 male observers*

6.2.3. Games console

The primary research question for this study is to investigate the impact cooperativeness and competitiveness have on pain, thus, a manipulation task was needed to increase participants' competitive and cooperative levels before completing the pain induction tasks. Manipulating the social context is still a relatively new field within pain, with a limited amount of studies providing evidence that social context can be manipulated, and does have impact on pain. However, outside of the pain literature, and leaning towards social psychology, cooperation-competition manipulation tasks are regularly used in experimental paradigms.

Games console based manipulation tasks are a popular methodology, and often these tasks include a sporting game, especially when manipulating competitiveness. There multiple ways to induce competitiveness via a sporting game on a console, for example, wrestling, football, golf, and tennis. One of the important research questions for this study was to focus on both competition and cooperation, and based on the literature, tennis-based games console games suited this criterion best. Competition can be manipulated via a singles tennis game, and cooperation can be induced via a doubles tennis game against the console. For these reasons, Virtua Tennis 4 for a PlayStation 3 was selected as the game appropriate for the manipulation task.

For the manipulation, participants played both game conditions: competitive and cooperative. As outlined above, the competitive condition required the friends to play against each other for two full games (which was scored and controlled by the games console). The cooperative condition was induced by the participants 'teaming up' to play together, to try and beat the games console. Again, the participants played two complete games in this game condition. Each game condition lasted between 10 and 15 minutes, depending on the players' ability, and this is considered to be enough time to induce higher levels of competitiveness or cooperativeness in players.

With regards to selecting the players, all male participants played as either Roger Federer or Novak Djokovic, and the female participants were either Martina Navratilova or Serena Williams. These four players were selected due to them being highly ranked tennis players, and also for consistency across the study, i.e. the participants could not select the player they wished to be. The order in which

participants played was counterbalanced to control for practice effects; half of the participants played a singles match (competitive game condition) then a doubles (cooperative game condition) match, whereas the other half played a doubles match, followed by a singles match.

6.2.4. Pain induction tasks

The pain induction tasks were the same as those reported in the previous studies (1-3) i.e., the cold pressor task and algometer. Specific details of both pain task can be found in Chapter 3 of this thesis.

6.2.5. Self-report measures

As in the previous studies reported here in Chapters 3, 4, and 5, the same self-report measures were administered to participants: Unidimensional Relationship Closeness Scale (URCS) to assess the closeness of the friendship; and for the participants completing the pain induction tasks, the Visual Analogue Scale (VAS) for pain intensity, and Short Form McGill Pain Questionnaire (SF-MPQ- 2). The details for each of these measures can be found in the methods section of Chapter 3. Additionally, three other measures were included; the Goal Interdependence Scale to measure interdependence within the dyad; the Interpersonal Reactivity Index to measure empathy; and Visual Analogue Scales assessing the participants' levels of competitiveness and cooperativeness.

6.2.6. Goal Interdependence Scale (GIS)

The GIS (Alper, Tjosvold, & Law, 1998) is a self-report measure that focuses on the interdependence the friends have on each other, with regards to their goals (Alper, Tjosvold, & Law, 1998). The GIS is an established measure that assesses the goal a dyad have, and given the measure specifically focuses on competitive and cooperative goals, it is eminently relevant to the research question outlined at the end of the previous section. The GIS has 14 items and each participant answers the questionnaire with their present friend in mind; responses are recorded on a Likert-scale from 1 *(strongly disagree)* to 5 *(strongly agree)*. There are three subscales that are calculated from this measure: independent goals (includes items such as *'my friend and I "sink or swim" together'* and *'my friend and I want each other to*

succeed'), competitive goals (referred to above as negatively interdependent, and include items such as *'my friend and I have a "win-lose" relationship'* and *my friend structures things in ways that favour their goals rather than our goals'*) and cooperative goals (referred to as positively interdependent, and include items such as *'my friend and I each "do our own thing"'* and *'our success is unrelated to our relationship'*). The higher the subscale score, the more interdependent the friends are (internal consistency: α = .74, Alper, Tjosvold, & Law, 1998).

6.2.7. Interpersonal Reactivity Index (IRI)

The IRI comprises of 28 self-report items which assesses empathy as a set of constructs in addition to a unitary concept (Davis, 1980) between the participant and their friend. The IRI has been included as a measure of empathy, as friends generally have high levels of empathy towards each other; thus, by accounting for empathic differences between sexes, a richer understanding of the dyadic relationship can be established. The items on the questionnaire form four different subscales: perspective taking (adopting the views of others), fantasy (the tendency to transpose themselves imaginatively into the feelings and actions of fictitious characters in books etc.), empathic concern (the concern for unfortunate others), and personal distress (feelings of person anxiety and unease in interpersonal settings). Each participant rates their answer on a Likert-scale from A *(does not describe we well)* to E *(describes me very well)*. The more empathic the individual, the higher their score on the IRI subscales will be (internal consistency: α = .74, Davis, 1994).

6.2.8. Visual Analogue Scale (VAS) for competitiveness and cooperativeness manipulation check

After each game condition, the participant who was going on to complete the pain induction task was asked to rate how competitive and cooperative they felt at that present moment on two independent scales; each participant rated both competitiveness and cooperativeness for both game conditions to allow further analysis to be conducted on the change in levels. The VAS was a 100mm line, and the participant was asked to mark each line in accordance to how they felt, ranging from *not at all competitive/cooperative* to *very competitive/cooperative*. The mark on the line was then measured, and a score out of one hundred was given.

6.2.9. Ethics

Ethical approval for the study was obtained from the Department of Psychology Ethics Committee (15-204) and the Department for Health Ethics Committee (15/16 45), University of Bath, UK.

6.2.10. Procedure

Following recruitment, participants recruited and their friend provided written consent, completed a demographics form, and were given further instructions about the study. Participants allocated to the pain induction tasks completed the Cold Pressor Task and the Algometer twice: once after playing the cooperative game condition on the games console, and once after playing the competitiveness game condition on the games console. In order to account for practice effects, the order in which participants played each condition on the games console was counterbalanced.

After each of the game conditions, the participant completed VAS's indicating how competitive and cooperative they felt. The friends accompanying the participants did not complete the VAS, or either of the pain induction tasks. However, the observing friends did play on the game console with (in the cooperative game condition) or against (competitive game condition) their friend, but only silently observed the pain induction tasks being completed. During the pain induction tasks, the participant completing the tasks was asked to look at their friend, but not to communicate with them; their friend reciprocated this silent observation. A diagram of the set during the pain induction tasks can be seen in Chapter 3.

After both games and both pain induction tasks, all participants completed the URCS, IRI and GIS, and were debriefed. Course credits of a monetary payments was given to all participants and observers.

6.3. Results

6.3.1. Data screening

Data screening of all raw data was conducted following procedures outlined by Tabachnick and Fidell (2006). Outliers were identified by converting the raw scores to z-scores, and considered an outlier if they were ±3.29. This method revealed two outliers, both of which were in the threshold readings for the cold

pressor task, one in the competitive condition and one in the cooperative condition. The outliers were adjusted to a value one unit larger/smaller than the next extreme score in the distribution (Tabachnick & Fidell, 2006). To ensure that the scores were normally distributed, histograms were generated to visually check for abnormalities, and skewness and kurtosis values checked. These checks confirmed that the data were normally distributed.

Means and standard deviations for the URCS, IRI, and GIS can be found in Table 1, and pain outcomes and self-report questionnaires can be found in Table 2.

6.3.2. Dyad manipulation check

A series of ANOVA's were conducted to investigate whether there were any group differences on the URCS, IRI, and GIS self-report measures. These measures are focusing on relationship closeness, empathy, and relationship interdependence, respectively. Sex of the participant (male vs. female), dyadic relationship condition (same-sex friends vs. opposite-sex friends) and participant role (participant experiencing pain vs. observer) were included as between group variables in the analysis. The means and standard deviations can be found below in Table 6.2.

Table 6.2. *Means and standard deviations (in parenthesis) for the URCS, IRI and GIS by sex of the participant (male vs. female), dyadic relationship (same-sex friends vs. opposite-sex friends) and participant role (participant experiencing pain vs. observer).*

	Same-sex friends				Opposite-sex friends			
	Participant experiencing pain		Observer		Participant experiencing pain		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
URCS	3.85 (.95)	5.20 (1.27)	4.23 (1.18)	5.12 (1.17)	3.08 (1.04)	3.20 (1.03)	3.27 (1.16)	3.21 (1.09)
IRI fantasy subscale	20.75 (4.92)	26.17 (4.76)	22.42 (6.69)	25.83 (6.44)	22.08 (7.62)	21.67 (5.40)	23.83 (4.15)	20.83 (5.56)
IRI perspective taking subscale	25.67 (3.47)	27.25 (2.90)	25.75 (4.31)	26.58 (4.06)	25.83 (3.64)	26.17 (4.34)	26.58 (4.70)	24.25 (5.33)
IRI empathic concern subscale	22.58 (3.78)	30.67 (3.03)	25.42 (3.48)	28.42 (4.46)	27.58 (4.66)	26.09 (4.32)	25.33 (4.94)	27.25 (3.47)
IRI personal distress subscale	16.50 (3.94)	21.50 (4.17)	18.08 (4.80)	22.83 (4.59)	21.33 (4.05)	16.58 (5.21)	18.33 (5.71)	19.83 (4.24)
GIS independent goals subscale	19.17 (3.41)	18.17 (3.66)	19.55 (2.30)	18.50 (5.28)	18.00 (3.32)	19.17 (3.69)	18.92 (3.92)	19.00 (6.15)
GIS competitive goals subscale	10.50 (3.06)	8.25 (2.56)	11.00 (4.63)	7.92 (3.45)	11.28 (3.85)	11.75 (4.29)	10.33 (4.13)	10.91 (4.50)
GIS cooperative goals subscale	14.25 (2.14)	16.08 (2.31)	13.64 (2.62)	15.83 (2.48)	14.09 (2.26)	13.67 (1.77)	14.17 (2.29)	12.64 (4.37)

Notes: URCS = Unidimensional Relationship Closeness Scale; IRI = Interpersonal Reactivity Index; GIS = Goal Interdependence Scale

For the Unidimensional Relationship Closeness Scale (URCS), female participants rated their friendship as closer (M = 4.18, SD = 1.48) than the male participants (M = 3.61, SD = 1.15), $F(1,96) = 6.42$, $p < .05$, $\eta_p^2 = .07$. Additionally, there was a significant main effect of the dyadic relationship, indicating that same-sex friends (M = 4.60, SD = 1.25) reported closer friendships than opposite-sex friends (M = 3.19, SD = 1.05), $F(1,96) = 38.42$, $p < .001$, $\eta_p^2 = .30$. Interestingly, there was also an interaction present between the sex of the participants and the dyadic relationship, $F(1,96) = 5.75$, $p < .05$, $\eta_p^2 = .06$ (see Figure 6.1.).

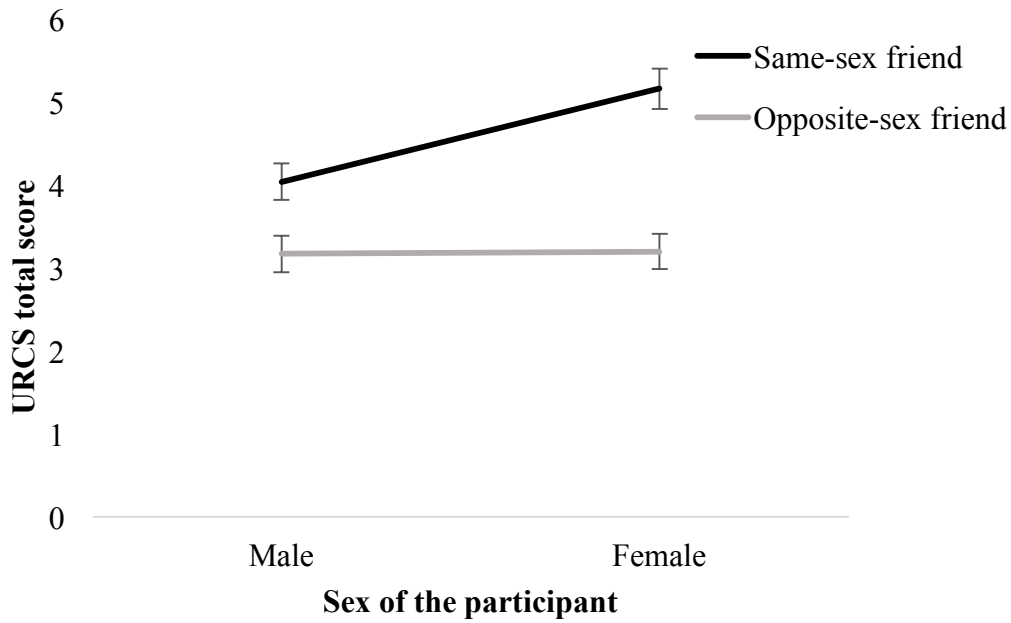

Figure 6.1. The significant interaction present between the sex of the participant and dyadic relationship on the URCS. Error bars represent ±1 standard error of the mean.

After a Bonferonni adjustment, further post-hoc analysis revealed that men reported having closer friendships with same-sex friends (M = 4.04, SD = 1.06), than with opposite sex friends (M = 3.17, SD = 1.08), $t(46) = 2.80$, $p < .0125$, $d = .81$. Mirroring this finding, women also reported having closer friendships with their same sex friends (M = 5.16, SD = 1.20) compared to when accompanied with opposite sex friends (M = 3.20, SD = 1.04), $t(46) = 6.05$, $p < .001$, $d = 1.74$. Within the same-sex friends condition, women (M = 5.16, SD = 1.20) reported having closer

relationships than men (M = 4.04, SD = 1.06), $t(46) = 3.44$, $p < .0125$, $d = .99$, but there were no differences in the opposite-sex friends condition.

For the (Interpersonal Reactivity Index) IRI analysis, each of the four subscales (fantasy, perspective taking empathic concern, and personal distress) were used. A separate ANOVA was conducted on each subscale, and when focusing on the fantasy subscale (the tendency to transpose themselves imaginatively into the feelings of fictitious characters), there were no significant main effects (all p-values > .05), but there was a significant interaction present between the sex of the participant and the dyadic relationship, $F(1,96) = 6.71$, $p < .05$, $\eta_p^2 = .07$ (see Figure 6.2.).

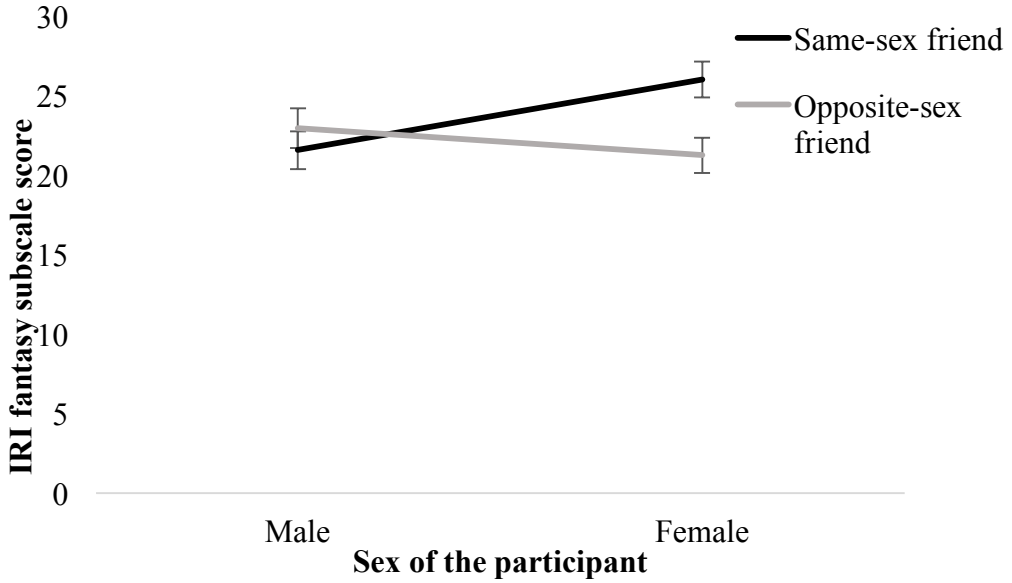

Figure 6.2. The significant interaction present between the sex of the participant and dyadic relationship on the IRI fantasy subscale. Error bars represent ±1 standard error of the mean.

The post-hoc analysis, with a Bonferroni adjustment, indicated that women in the same-sex friends condition had a higher score on the fantasy subscale (M = 26.00, SD = 5.54) than the women in the opposite-sex friends condition (M = 21.25, SD = 5.37), $t(46) = 3.02$, $p < .0125$, $d = .87$. However, this result was not mirrored in the men. When specifically focusing the dyadic relationship, within same-sex friends, men and women scored differently on the fantasy scale; overall, women (M

= 26.00, *SD* = 5.54) had a higher score than men (*M* = 21.58, *SD* = 5.81), *t*(46) = 2.70, *p* < .0125, *d* = .78. For the other subscales on the IRI, there were no significant main effects or interactions present for the perspective taking subscale. For empathic concern (the concern for unfortunate others), there was a significant main effect of sex of the participant, which suggests that women (*M* = 28.15, *SD* = 4.10) had a higher score on the subscale than men (*M* = 25.23, *SD* = 4.49), *F*(1,95) = 11.90, *p* <.01, η_p^2 = .12. In addition, there was also a significant interaction between the sex of the participant and the dyadic relationship, *F*(1,95) = 10.21, *p* <.01, η_p^2 = .11 (see Figure 6.3.).

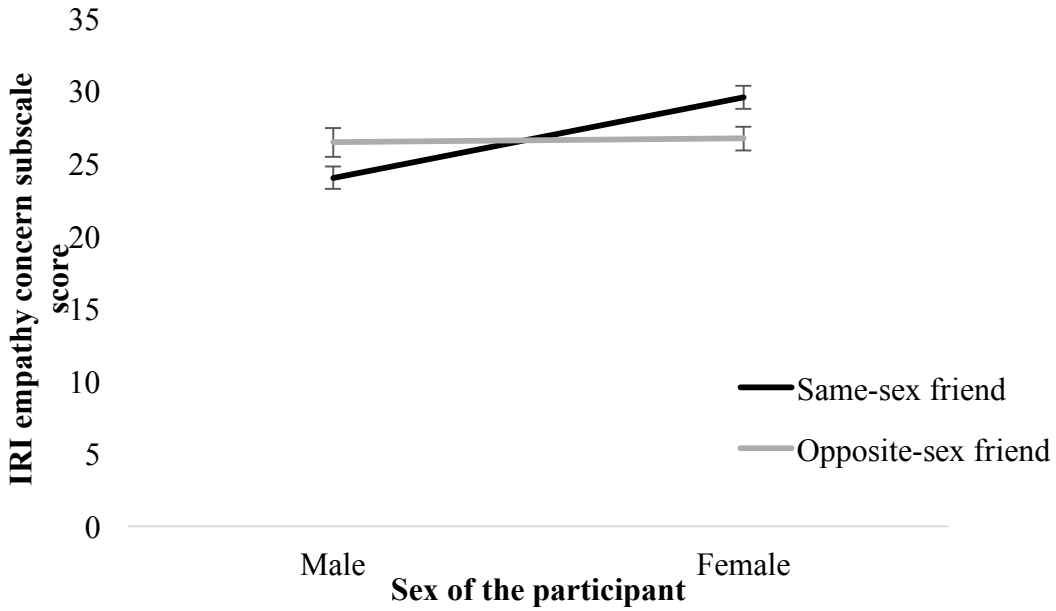

Figure 6.3. The significant interaction present between the sex of the participant and dyadic relationship on the IRI empathic concern subscale. Error bars represent ±1 standard error of the mean.

After a Bonferroni adjustment, the post-hoc analysis revealed on significant result; within same-sex friends, women (*M* = 29.54, *SD* = 3.90) had a significantly higher score on the empathic concern subscale, when compared to men (*M* = 24.00, *SD* = 3.93), *t*(46) = 4.96, *p* < .0125, *d* = 1.41. There were no other significant results, suggesting that there were no differences in the men and women in the opposite-sex friend's condition, and there were no differences in men or women across the two conditions (all *p*-values > .0125).

Finally, for the personal distress subscale (anxiety in interpersonal settings), there were no significant main effects present, but there was a significant interaction between the dyadic relationship and the sex of the participant, $F(1,95) = 10.21$, $p < .01$, $\eta_p^2 = .11$ (see Figure 6.4.).

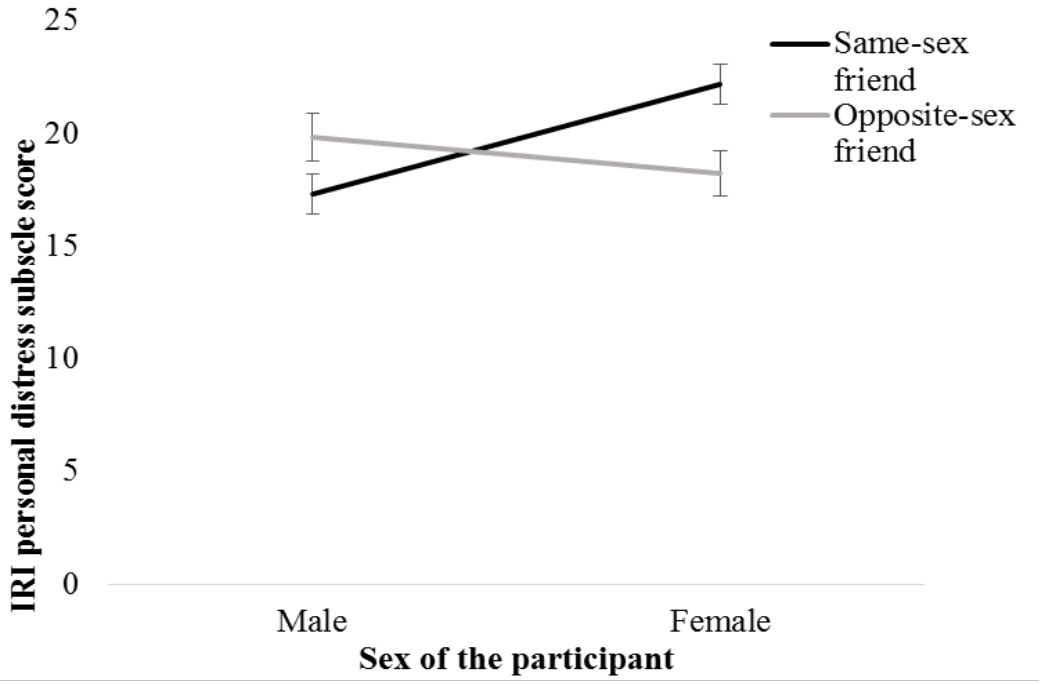

Figure 6.4. The significant interaction present between the sex of the participant and dyadic relationship on the IRI personal distress subscale. Error bars represent ±1 standard error of the mean.

Similar to the other subscales on the IRI, the post-hoc analysis was completed with a Bonferroni adjustment. In women, those participants in the same-sex friends condition ($M = 22.17$, $SD = 4.34$) had a significantly higher score on the subscale than men ($M = 17.29$, $SD = 4.37$), $t(46) = 2.95$, $p < .0125$, $d = .85$. Similarly, when the post-hoc analysis was split by dyadic relationship, in the same-sex friends condition, women ($M = 22.17$, $SD = 4.34$) scored higher than men ($M = 17.29$, $SD = 4.37$) on the subscale, $t(46) = 2.95$, $p < .0125$, $d = .85$. Therefore, overall, women had higher levels of empathy, especially when they are with a same-sex friend.

For the Goal Interdependence Scale (GIS), the analysis was split by each subscale, independent goals, competitive goals and cooperative goals. As mentioned in the methods section, the higher the score, the more independent the dyad is. For the independent goals subscale, there were no main effects or significant interactions present, suggesting that the sex of the participant, their role, or the dyadic relationship had an impact on the individuals goals. When focusing on the competitive goals subscale, there was a significant main effect of dyadic relationship, $F(1,93) = 42.00$, $p < .05$, $\eta_p^2 = .05$, which suggests that the opposite-sex friends condition ($M = 11.07$, $SD = 4.14$) were more independent than the same-sex friends condition ($M = 9.38$, $SD = 3.63$). For the final subscale, the cooperative goals subscale, there was also a significant main effect for dyadic relationship, $F(1,93) = 5.85$, $p < .05$, $\eta_p^2 = .06$. The subscale score was higher for the participants in the same-sex friend's condition ($M = 14.98$, $SD = 2.53$), than the opposite-sex friend's condition ($M = 13.65$, $SD = 2.79$). In addition to this, there was a significant interaction between the sex of the participant and the dyadic relationship, $F(1,93) = 7.63$, $p < .01$, $\eta_p^2 = .08$ (see Figure 6.5.).

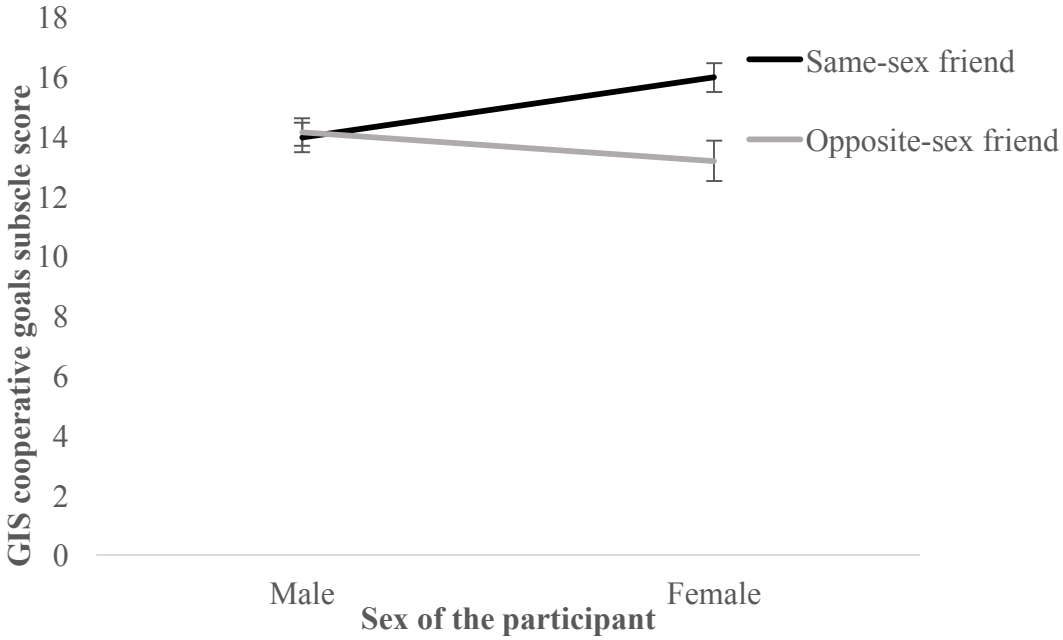

Figure 6.5. The significant interaction present between the sex of the participant and dyadic relationship on the GIS cooperative goals subscale. Error bars represent ±1 standard error of the mean.

To remain consistent with the rest of this chapter, the post-hoc analysis used a Bonferroni adjustment. When focusing on the same-sex friend's condition, women (M = 15.96, SD = 2.35) had a higher score on the cooperative goals subscale than men (M = 13.96, SD = 2.35), $t(45) = 2.92$, $p < .0125$, $d = .85$. When the file was split by the sex of the participant, for women, the cooperative goal subscale scores were higher in the same-sex friends group (M = 15.96, SD = 2.35), as opposed to the opposite-sex friend's group (M = 13.96, SD = 2.35), $t(45) = 3.38$, $p < .0125$, $d = .85$. Overall, this suggests in cooperative goal scores, women are more independent than men, specifically when they are will another female friend.

Overall, the manipulation check for the dyads has shown that same-sex friends are closer than opposite-sex friends, specifically in females. The analysis for the empathy measure highlighted that women are more empathic than men, but there were no differences in the dyadic relationship. Finally, there were differences in the interdependence scale; same-sex friends are more cooperative, especially women, and opposite-sex friends are more competitive. Thus, women have stronger relationships with other women, which may make them more cooperative.

6.3.3. Competitive and cooperative manipulation check

A series of ANOVA's were conducted to investigate whether the singles and doubles tennis-based games successfully manipulated competitiveness and cooperativeness. For the analysis the sex of the participant (male vs. female), sex of the observer (male vs. female), were included as between group variables, and game condition (competitive vs. cooperative) were included in the analysis as a within-group variable. The dependent variables in the analysis are the self-reported levels of cooperativeness and competitiveness reported after participants played the tennis game. Irrespective of the game condition, participants were asked to rate both their competitiveness and cooperativeness on visual analogue scales (VAS), and it is these scores that are used in this analysis. The participant VAS are used in the analysis, not the observer VAS, as the manipulation task is to investigate whether competitiveness and cooperativeness can be manipulated, before investigating the impact it can have in pain threshold and tolerance levels. The means and standard deviations for the VAS are included in Table 6.3., below.

Table 6.3. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by sex of the participant (male vs. female), the condition (cooperative vs. competitive) and sex of the observer (male vs. female).*

	Male observer group				Female observer group			
	Competitive condition		Cooperative condition		Competitive condition		Cooperative condition	
	Male	Female	Male	Female	Male	Female	Male	Female
Competitive VAS	82.83 (17.99)	91.33 (6.51)	77.25 (13.98)	75.58 (21.71)	74.58 (27.18)	80.42 (22.74)	66.50 (29.37)	77.92 (20.87)
Cooperative VAS	40.91 (28.34)	60.50 (25.82)	77.55 (22.78)	81.33 (11.52)	59.75 (32.57)	72.67 (28.21)	90.82 (9.46)	85.58 (18.38)

6.3.3.1. Competitive manipulation check

For the analysis in this subsection, the competitive VAS was used as the dependent variable. The sex of the participant (male vs. female), sex of the observer (male vs. female), were included as between group variables, and game condition (competitive vs. cooperative) was included in the analysis as a within-group variable.

The results indicate that the competitiveness of participants was successfully manipulated; there was a main effect of game condition, $F(1,44) = 5.72$, $p < .05$, $\eta_p^2 = .12$.. Participants reported feeling more competitive in the competitive game condition ($M = 82.29$, $SD = 20.41$), as opposed to the cooperative game condition ($M = 74.31$, $SD = 20.86$). There were no other main effects or significant interactions present (all p-values > .05).

6.3.3.2. Cooperative manipulation check

Similar to above, the analysis in this subsection used the cooperative VAS scores as the dependent variable. The sex of the participant (male vs. female), sex of the observer (male vs. female), were included as between group variables, and game condition (competitive vs. cooperative) was included in the analysis as a within-group variable.

As above, there was a main effect of game condition, $F(1,42) = 34.33$, $p < .001$, $\eta_p^2 = .45$ with the participants showing higher cooperative VAS scores in the cooperative condition ($M = 83.80$, $SD = 16.56$), rather than the competitive condition ($M = 57.87$, $SD = 30.67$). Additionally, there was also a main effect of the sex of the observer, $F(1,42) = 55.87$, $p < .05$, $\eta_p^2 = .12$, which suggests that the cooperative VAS score was higher when the observer was female ($M = 77.15$, $SD = 22.62$), as opposed to male ($M = 65.12$, $SD = 22.91$). There were no other main effects present, but there was also a significant interaction the game condition and sex of the participant, $F(1,42) = 4.44$, $p < .05$, $\eta_p^2 = .10$ (see Figure 6.6.).

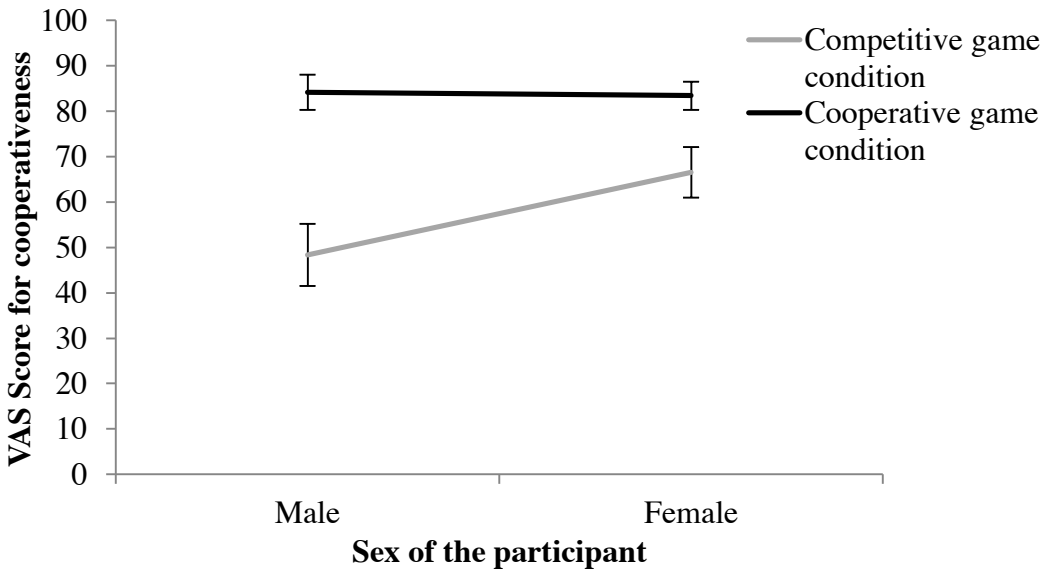

Figure 6.6. The significant interaction present between the sex of the participant and the VAS for cooperativeness in both game conditions. Error bars represent ±1 standard error of the mean.

After a Bonferonni adjustment, the post-hoc analysis revealed that there were no significant sex differences within each game condition (p-values >.0125). However, there were significant differences between the game conditions for both men and women. For men, the VAS scores in the cooperative game condition (M = 84.18, SD = 18.33) were significantly higher than the VAS scores in the competitive condition (M = 48.36, SD = 32.04), $t(45) = 2.92$, $p < .0125$, $d = .85$. This result was also mirrored in women [VAS score in cooperative condition (M = 75.02, SD = 20.98); VAS score in the competitive condition (M = 67.26, SD = 23.29)], $t(45) = 2.92$, $p < .0125$, $d = .85$. Therefore, in the cooperative game condition, both men and women felt more cooperative than competitive. Interestingly, the scores between men and women for cooperativeness in the competitive game condition was not significant, but Figure 6.6. shows that the VAS score for men was a lot lower than for women.

Overall, the manipulation task was successful; participants felt more competitive in the competitive game condition, and more cooperative in the cooperative game condition. Interestingly the sex of the participant was not a significant main effect in either of the analyses. However, the cooperative VAS

scores for both men and women were higher in the cooperative game condition, as opposed to the competitive game condition.

6.3.4. Impact of game condition on the reporting of cold pressor pain

A series of ANOVA's were conducted on the cold pressor pain outcomes, and where relevant, follow-up t-tests with Bonferroni corrections. The between group variables were sex of participant (male vs. female) and sex of observer (male vs. female), and the within groups factor was game condition (cooperative vs. competitive). The dependent variables are the pain outcomes (threshold and tolerance) and self-report pain questionnaires: the Visual Analogue Scale (VAS) and the Short Form McGill Pain Questionnaire (SF-MGPQ-2). The means and standard deviations can be found below, in Table 6.4..

Table 6.4. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by sex of the participant (male vs. female), the condition (cooperative vs. competitive) and sex of the observer (male vs. female).*

	Male observer group				Female observer group			
	Competitive condition		Cooperative condition		Competitive condition		Cooperative condition	
	Male	Female	Male	Female	Male	Female	Male	Female
Cold Pressor Task								
Threshold (seconds)	7.68 (4.75)	7.44 (4.23)	8.22 (4.81)	8.56 (8.91)	12.92 (7.13)	8.98 (7.83)	10.94 (7.79)	9.69 (9.12)
Tolerance (seconds)	71.72 (43.30)	30.32 (30.08)	51.51 (43.07)	34.50 (41.07)	59.83 (45.25)	61.85 (46.04)	49.53 (43.85)	51.76 (45.59)
SF-MPQ-2	2.81 (1.80)	3.36 (1.77)	2.49 (1.30)	3.45 (1.81)	2.20 (.96)	2.61 (.97)	2.49 (1.34)	2.58 (1.32)
VAS	59.17 (19.03)	60.50 (17.95)	60.33 (15.98)	58.45 (15.36)	61.55 (9.39)	64.50 (11.14)	56.58 (14.70)	56.92 (19.02)
Algometer								
Threshold (kPa)	358.39 (193.04)	400.80 (153.87)	383.83 (199.42)	355.50 (132.70)	506.64 (161.01)	386.69 (199.56)	466.97 (119.62)	422.91 (157.23)
SF-MPQ-2	1.35 (1.36)	1.67 (1.71)	1.34 (1.23)	1.70 (1.40)	.94 (.59)	1.05 (.55)	.97 (.72)	1.36 (.84)
Algometer VAS	34.67 (23.27)	35.70 (18.35)	30.58 (18.94)	36.30 (18.50)	32.55 (12.44)	40.42 (18.91)	29.58 (13.78)	34.45 (20.05)

Notes: VAS = Visual Analogue Scale; SF-MPQ-2 = Short Form McGill Pain Questionnaire Version 2

With regards to pain threshold, the ANOVA highlighted no main effects or interactions present. Thus, there were no differences in pain threshold across game condition, sex of the participant or sex of the observer.

When focusing on pain tolerance, the only main effect found for game condition, $F(1,44) = 7.98$, $p < .01$, $\eta_p^2 = .15$. Participants had a higher pain tolerance level in the competitive condition ($M = 55.93$, $SD = 43.24$), when compared to the cooperative condition ($M = 46.83$, $SD = 42.64$). There were no significant interactions present (p-values > .05).

The analysis of the VAS and the MG-MGPQ-2 did not identify any differences in the way the pain was reported by participants or condition (p-values > .05).

6.3.5. Impact of condition on the reporting of pressure pain

A similar analysis was conducted on the pressure pain threshold results from the algometer, and related self-report pain questionnaires.

The analysis revealed no significant differences in pressure pain threshold. There also no main effects or interactions present in the analysis on both the VAS and SF-MGPQ-2.

6.4. Discussion

The results from this study indicated that cooperativeness and competitiveness can be manipulated in an experimental setting. In addition to this, cooperativeness and competitiveness can have an impact on how pain is reported; participants had a higher pain tolerance in the competitive condition when compared to the cooperative condition. However, no other differences were present in the analysis for the cold pressor task or the algometer. More specifically, there were no sex differences present in the way participants rated their cooperativeness or competitiveness, and there were no sex differences present for any of the pain induction tasks. This is an interesting finding which will be explored further in the next section.

6.4.1. Interpretation and implication of the results

The first thing to note is the successful manipulation of competitiveness and cooperativeness through the tennis-based game. Overall, participants were more competitive in the competitive game condition, and more cooperative in the cooperative game condition, which was the primary aim of the manipulation task. Interestingly, there were no sex of the participant differences present in how competitive or cooperative participants felt. However, the cooperative VAS scores for both men and women were higher in the cooperative game condition, as opposed to the competitive game condition. These results are in line with previous literature; when necessary, men and women can be equally as competitive, especially when there is a goal motivation, i.e. to win. As previously highlighted in the introduction of this chapter, competition elicits more stoic and masculine stereotypes in both sexes; thus, this could be an explanation as to why there are no sex differences in the VAS scores for competitiveness and cooperativeness. However, there was a main effect present for the sex of the observer, which suggested that when the observer was female, the cooperative VAS was higher than when the observer was male. Given the success of the manipulation task, the impact of the competitiveness and cooperativeness can be explored in context of pain.

At the end of the introduction, there were two hypotheses made: 1) both men and women would suppress pain more in the competitive game condition than in the cooperative game condition, and 2) males would have a higher pain tolerance than females. The remainder of this section will address both of these points individually and focus on what the implications are for pain research.

When focusing on the differences between the two game conditions, pain tolerance was higher in the competitive condition, which supports the hypothesis made at the beginning of the chapter. This is relevant to the research focusing on pain suppression in order not to appear vulnerable, and to have the ability to tolerate more pain in order to win. This research typically focusing on pain and competitiveness simultaneously, and this study looked at competitiveness and then the impact it had on pain, but this allows the current study to be investigated further; is it definitely competitiveness that is increasing pain tolerance? This question is investigated further in the context of sex differences below, and later on in this chapter as an avenue for future work.

In previous pain research, the presence of another person has been found to have an impact on the reporting of pain (Vigil, Rowell, Alcock, & Maestes, 2014). However, the nature of the dyadic relationship, and the sex of the observer have not been considered in great detail. There is evidence to suggest that the nature of the relationship should be considered (Krahe et al., 2013), as well as the contextual influences. With these clear differences in the way pain is reported from an early age, it is unsurprising that there are differences present in adulthood (Brown et al., 2003). Additionally, the nature of the relationship needs to be considered, and this is what this study has achieved. While still focusing on every day relationships, this study has added a new dimension to what is already known; when the cooperativeness and competitiveness of the friendship is manipulated, participants' pain tolerance increases, and there are no sex differences present on pain tolerance.

In Chapter 4, same-sex and opposite-sex friends were recruited, and the pain suppression occurred in the same-sex friends, particularly male-male dyads. However, this study did not find any significant effects for the sex of the participant or the sex of the observer; i.e. there were no differences between same-sex and opposite-sex friends. There are two possibilities that can explain this main limitation, and they include the previously mentioned theory that men and women are equally as competitive as each other in competitive environments, and the sex of the participant or observer does not matter. The second explanation is closely linked to previous research in the field (Martin, et al., 2015) which specifically focuses on social and emotional contagion such as empathy; emotional contagion of pain can be observed in friends, but not so much in strangers. However, when Martin et al's study was replicated with strangers the results observed were different; those participants who were made to feel less emotionally contingent had a higher pain intensity score than the strangers who did not receive the drug to elicit contagion. There was no difference in pain intensity ratings for same-sex friends or opposite-sex friends. Therefore, Martin and colleagues suggest that levels of empathy and trust need to be increased in strangers, in order for the differences in pain perception to be altered. These findings and suggestions are highly applicable to this research question addressed in this study (and the following chapter).

This PhD thesis and other previous research has shown consistent and clear sex differences up until now. This study showed that men and women are more

competitive than cooperative, in the respective game conditions, but there were no sex differences present on the pain induction tasks or the self-report pain questionnaires, which does not support the predicted hypothesis. With the elimination of sex differences in the pain induction tasks, and in the large increase in pain tolerance in female participants, there is now a new research question appearing which focuses around women being as competitive as men, when necessary. There are many possible reasons for why there were no sex differences found in this study; firstly, when competitiveness is manipulated, men and women can be as competitive as each other (Bateup, Booth, Shirtcliff, & Granger, 2002); and secondly, when competitiveness is considered to be a factor in the outcome, there has been shown to be little differences between the sexes. This suggests that women may have lower competitive levels on average, but when there is a need for competitiveness, they are just as competitive as men (Houston, Carter, & Smither, 1997).

Competitiveness and gender stereotypes are considered as a key part of friendship, and have been considered to be closely linked with regards to social psychology. Pain is a threatening experience and by incorporating evolutionary theory, there are multiple explanations to how and why pain is tolerated more in the presence of other people. When considering competitiveness between two people, this argument is strengthened. Competitiveness is correlated with social threat and team allegiance, and often results in an increase of pressure applied to an individual regarding their performance (Sanderson, Weathers, Snedaker, & Gramlich, 2016). Specifically, within a sporting environment, competitiveness plays a huge role (Gee, 2013). Competitiveness is considered to be a more masculine trait, then feminine, and is closely linked to aggression, and pushing through 'pain barriers' (Messner, 1990, 2002). This form of masculine stereotypes, is embedded within competitive environments, and highlights the desire to push the body through more pain to avoid having their identity threatened (Steinfeldt & Steinfeldt, 2012). It can be argued that this concept is closely linked to the paradigm developed in this study; participants completed a tennis-based PlayStation game where the desired outcome was to win, and competitiveness was successfully induced.

Pain tolerance increased in the competitive condition, which can be linked back to the desire to want to compete more when feeling threatened. Although there were no sex differences present, the field of literature based on competitiveness is

able to provide some explanations, for example, masculine stereotypes and competitiveness can silence pain reporting's in men (Sanderson et al., 2016). The environment created in this study was gendered, and was likely to be perceived as more masculine due to masculinity being closely linked to competitiveness. However, masculinity is present in both men and women, therefore, these more stoic pain behaviours can be observed in both men and women, in competitive environments, which provides an explanation as to why there were no sex differences in the pain outcomes for this study.

In Western cultures and in modern society, women have a desire to prove their toughness, which can explain why sex differences in competitive based tasks do not exist (Niederle & Vesterlund, 2007). This concept has developed over the years and incorporates cultural norms and beliefs (Sabo, 2004). For example, the need for both sexes to suppress their pain in order to achieve the goal, which in this study is winning (Sabo, 2004). In the context of friendships, the communication of pain has been investigated, as well as sex differences; many reasons why competing friends do not convey that they are in pain is due to the cultural norm of accepting injuries and tolerating more pain in order to win. Although the manipulation task was followed by pain induction tasks in this study, the concept of both sexes wanting to appear stoic may still be a plausible explanation for why there were no sex differences in pain threshold, tolerance or pressure-pain threshold. Therefore, even though there are well-established sex differences in pain tolerance (especially in the earlier chapters of this PhD), it would appear that the element of competitiveness added in to this paradigm is enough to eliminate the sex differences. This element of winning and losing may be carried over to the pain induction tasks which would provide an example of why pain tolerance increased, and there were no sex differences present.

6.4.2. Limitations

As with all studies, any limitations need to be discussed. In this study, the main limitation centre around the manipulation task. While the analysis suggests that the manipulation task was successful, the pre-test levels of competitiveness or cooperativeness were not established. Thus, despite the manipulation task appearing to be successful, without pre-test VAS scores, I have to be wary when commenting

on the complete success of the manipulation task. In addition to this, competitiveness and cooperativeness were not measured after the pain induction tasks; it would be beneficial to take post-pain VAS readings for competitiveness and cooperativeness for two reasons; firstly, it would give a richer dataset and a greater understanding of whether the manipulation task is successful, and secondly, if competitiveness and cooperativeness remain higher post-pain tasks then more detailed interpretation can occur from the pain tasks. Therefore, for the next study, this small methodological change will occur; VAS scores for competitiveness and cooperativeness will be taken before any of the tasks, after the game manipulation tasks, and after the pain tasks.

6.4.3. Next steps for future chapters in this PhD thesis

In line with the rest of this PhD thesis, dyadic relationship needs to be considered further; competitiveness and cooperativeness has a specific role within friendships, but it would be of interest to replicate this methodology in strangers to see if the same results are observed. In Chapter 1, I focused upon a continuum of closeness that ranged from strangers to romantic partners, with friends being somewhere in the middle of the continuum. As there were no differences between romantic partners and opposite-sex friends (Chapter 5), the next study for this PhD thesis will focus upon strangers. The key difference between strangers and friends, is that strangers are not known to each other. With this in mind, strangers will naturally show less empathy towards each other, have fewer common goals, and no shared identity. Thus, a very different dyadic relationship to friends. Previous empirical work in this PhD thesis has suggested that the presence of a friend has a greater effect on pain than the presence of a stranger, however, when introducing competition into the environment, it is of interest to see if the same results are found in those who will have less empathy towards each other.

6.4.4. Summary and conclusion

To conclude, this chapter has successfully identified an explanation for the results observed in Chapter 4; pain tolerance is higher in a competitive environment, in comparison to a cooperative environment. There were no sex differences in competitiveness scores, or pain threshold and tolerance, which indicates that when

there is a goal motivation such a winning, men and women perform the same on the pain induction tasks. Therefore, to be certain that the results from Chapter 4 are potentially due to competition, this study will be replicated in strangers, and will also include some adaptations to the methodology as outlined above.

Chapter 7: Investigating the differences between cooperation and competition manipulation tasks on the reporting of pain in same-sex and opposite-sex strangers

7.1. Introduction

The previous experimental chapter indicated that cooperation and competition can be manipulated in an experimental environment, specifically by playing Virtua Tennis 4 on a PlayStation 3. After the manipulation task, pain tolerance increased after playing tennis in the competitive condition. Interestingly, in the pain induction tasks, there were no sex differences present, and in particular there was no effect of the sex of the observer on any pain outcomes.

Towards the end of the last chapter there was some detailed explanation as to why pain tolerance increased in the competitive condition, and one of the reasons proposed is that competition elicits more masculine traits which are found in both men and women, which may explain why there are no differences in the pain tasks (Sabo, 2004). For example, women have their levels of competitiveness heightened because of the desire to appear tougher, and more competitive (Sabo, 2004). This results in competitive levels in men and women to be fairly equal, especially when competition has been successfully manipulated. However, what is not known is whether the same findings can be observed in different dyadic relationships.

The first empirical chapter in this PhD thesis focused on friends and strangers, and the participants in the friend's condition had a higher pain tolerance than the strangers. Given that this PhD focuses on different dyadic relationships, and how pain is communicated differently, depending on the relationship, it is of interest to now apply the manipulation task to a different dyadic relationship. This will allow me to investigate whether competitiveness and cooperativeness can still be manipulated, and also to see if the sex differences are eliminated like in the previous study. Considering the findings from the first empirical study in this PhD, and applying it to the manipulation task, it would be expected that the pain tolerance would increase after the competitive manipulation task.

This study will specifically focus on same-sex and opposite-sex strangers. Even though strangers do not know each other and have no connections with each other, previous literature suggests that individuals are still susceptible to feelings of competitiveness with others they do not know. Furthermore, Waddell and Peng (2014) found that when manipulating competitiveness and cooperativeness in friends and strangers, there are no sex differences and no differences between the behaviours of those in the friends group when compared to the strangers group. Therefore, both

friends and strangers are susceptible to manipulation tasks, and the successful manipulation of competition may be enough to eliminate any differences previously observed in this PhD thesis (Waddell & Peng, 2014; Peng & Hsieh, 2012).

Therefore, it was hypothesised:

a) The manipulation task would still be successful, and the participants would report feeling more competitive in the competitive condition, and more cooperative in the cooperative condition.

b) Based on the literature, and previous findings in this thesis, pain tolerance will be higher in the competitive condition, when compared to the cooperative condition.

c) Men will have a higher pain tolerance than women.

7.2.Method

7.2.1. Design

Similar to the previous study, a mixed-group design was employed throughout this study. There were two between-groups factors: the sex of the participant (male vs. female), and the sex of the observer (male vs. female). The within-groups variable was the game condition the participants were in (competitive vs. cooperative). The dependent variables were the various indices from the pain induction tasks and self-report measures.

7.2.2. Participants and observers

A total of 96 adults (48 male, 48 female; *M* = 24.03 years, *SD* = 6.05 years) were recruited using similar methods as previous studies. None of the participants reported taking medication, and they all reported being pain-free. To reduce the likelihood of participants experiencing adverse effects from the pain induction task, participants were excluded if they had eczema, asthma and/or sensitive skin.

Ninety-six participants were recruited to take part in a pain study which also involved playing with a games console, and to either experience pain or observe a stranger in pain. After initial screening, half of the participants were allocated into the pain experience condition (24 male; *M* = 26.92 years, *SD* = 9.53 years and 24 female; *M* = 21.12 years, *SD* = 3.23 years), and the other 48 participants were allocated to the stranger-observer condition (24 male; *M* = 23.50 years, *SD* = 3.87

years and 24 female; *M* = 24.58 *y*ears, *SD* = 4.13 years) (see Table 7.1.). There were equal numbers of males and females recruited into the study, with the sex of the observers counterbalanced with the sex of the participants. Therefore, there were four groups of 12 dyads; 12 male-male, 12 male-female, 12 female-female, and 12 female-male stranger dyads.

All participants recruited in to the study played Virtua Tennis 4 on the games console, but only the participants initially recruited in to the study completed the pain induction tasks.

Table 7.1. *The distribution of participants within each condition.*

	Same-sex strangers (*n* = 48)	Opposite-sex strangers (*n* = 48)
Males	12 male participants	12 male participants
	12 male observers	*12 female observers*
Females	12 female participants	12 female participants
	12 female observers	*12 male observers*

7.2.3.Pain induction tasks

The pain induction tasks were the same as the other previous studies; the cold pressor task and the algometer. More detail of these can be found in the first empirical chapter of this thesis, Chapter 3.

7.2.4. Games console

The same Virtua Tennis 4 PlayStation 3 game was used as the manipulation task for cooperativeness and competitiveness, as reported in Chapter 6.

7.2.5. Self-report measures

Mirroring the previous empirical study, the Visual Analogue Scale (VAS) and Short Form McGill Pain Questionnaire (SF-MPQ-2) were administered to the participants who completed the pain induction tasks. More information on these scales can be found in Chapter 3. Additionally, all participants completed various measures focusing on their relationship with the stranger present (i.e. as a check that they did not know each other prior to the study). These included the Unidimensional

Relationship Closeness Scale (URCS), the Interpersonal Reactivity Index (IRI), and the Goal Interdependence Scale (GIS). More details on the URCS can be found in Chapter 3, and information regarding the IRI and GIS can be found in Chapter 6.

7.2.5.1. VAS Competitiveness and cooperativeness manipulation

Finally, VAS's were used to check if the manipulation for competitiveness and cooperativeness worked, but this was done in a slightly different way to the previous study. Participants completed the VAS for both competitiveness and cooperativeness at three time points in each game condition; before playing the PS3 game, after paying the PS3 game but before the pain induction tasks, and after the pain induction tasks. Participants were asked to mark their answer on the 100mm line with anchors ranging from *not at all competitive/cooperative* to *very competitive/cooperative*, with reference to how they felt at that moment. The participants were asked at these three independent time points so analysis can be completed to investigate whether the manipulation task transferred to the pain induction tasks.

7.2.5. Ethical Approval

Ethical approval for the study was obtained from the Department of Psychology Ethics Committee (15-204) and the Department for Health Ethics Committee (15/16 45), University of Bath, UK.

7.2.6. Procedure

Following recruitment, everyone provided written consent, completed a demographics form, and was given further instructions about the task. Similar to the previous study, participants allocated to the to the pain induction tasks completed the Cold Pressor task and the algometer twice: once after playing the cooperative condition on the games console, and once after playing the competitiveness condition on the games console. In order to account for practice effects, the order in which participants played each condition on the games console was counterbalanced.

Before and after each of the game conditions on the games console, the participants completing the pain induction completed two visual analogue scales indicating how competitive and cooperative they felt. The participants then went on

to complete the pain induction tasks. The strangers accompanying the participants did not complete either of the pain induction tasks, but they were asked to observe silently. After the pain induction task, the participant was asked to complete two more VAS on how competitive and cooperative they felt. This whole procedure was completed once for the competitive game condition, and once for the cooperative game condition. The order in which the dyads completed the study was counter-balanced to account for practice effects.

After both games and both pain induction tasks, all participants completed the URCS, IRI and GIS, and were debriefed. Course credits or monetary payments were given to all participants and observers.

7.3.Results

7.3.1. Data screening

Data screening of all raw data was conducted following procedures outlined by Tabachnick and Fidell (2006), and previous chapters in this thesis. Outliers were identified by converting the raw scores to z-scores, and considered an outlier if they were ±3.29. This method revealed two outliers, both of which were in the threshold readings for the cold pressor task, one in the competitive condition and one in the cooperative condition. The outliers were adjusted to a value one unit larger/smaller than the next extreme score in the distribution (Tabachnick & Fidell, 2006). To ensure that the scores were normally distributed, histograms were generated to visually check for abnormalities, and skewness and kurtosis values checked. These checks confirmed that the data were normally distributed.

Means and standard deviations for the URCS, IRI, and GIS can be found in Table 7.2, the VAS scores for competitiveness and cooperativeness can be found in Tables 7.3 and 7.4, and pain outcomes and self-report questionnaires can be found in Table 7.6.

7.3.2. Dyad manipulation check

A series of ANOVA's were conducted to investigate whether there were any differences between the same-sex and opposite-sex strangers on the self-report measures. Sex of the participant (male vs. female), dyadic relationship condition (same-sex strangers vs. opposite-sex strangers) and participant role (participant

experiencing pain vs. observer) were included as between-groups variables in the analysis. The means and standard deviations can be found below, in Table 7.2.

Table 7.2. *Means and standard deviations (in parenthesis) for the URCS, IRI and GIS by sex of the participant (male vs. female), dyadic relationship (same-sex friends vs. opposite-sex friends) and participant role (participant experiencing pain vs. observer).*

	Same-sex friends				Opposite-sex friends			
	Participant experiencing pain		Observer		Participant experiencing pain		Observer	
	Male	Female	Male	Female	Male	Female	Male	Female
URCS	1.22 (.32)	1.26 (.48)	1.10 (.18)	1.15 (.27)	1.18 (.26)	1.12 (.20)	1.14 (.21)	1.11 (.30)
IRI fantasy subscale	23.75 (4.63)	24.67 (6.92)	22.08 (6.13)	22.92 (6.26)	22.75 (5.79)	22.42 (6.35)	22.92 (6.50)	25.83 (5.61)
IRI perspective taking subscale	25.58 (4.48)	26.92 (3.80)	24.50 (5.63)	26.00 (4.81)	24.92 (4.87)	24.58 (3.65)	25.58 (4.42)	26.33 (6.47)
IRI empathic concern subscale	27.83 (2.52)	28.33 (3.26)	25.17 (5.08)	25.92 (5.98)	25.00 (3.44)	25.75 (6.22)	24.67 (3.44)	25.75 (6.22)
IRI personal distress subscale	18.25 (5.43)	22.67 (4.48)	18.92 (5.55)	20.00 (5.61)	17.17 (4.09)	17.83 (4.59)	18.83 (5.52)	19.17 (6.04)
GIS independent goals subscale	16.25 (3.02)	15.67 (4.42)	18.25 (2.38)	17.33 (7.05)	18.75 (6.48)	15.58 (5.20)	18.75 (4.49)	18.17 (5.42)
GIS competitive goals subscale	9.75 (5.07)	10.00 (3.81)	10.92 (4.81)	9.25 (4.22)	9.92 (4.01)	8.17 (3.24)	11.33 (5.10)	9.08 (4.42)
GIS cooperative goals subscale	9.42 (3.20)	8.83 (4.53)	8.92 (3.87)	7.92 (3.42)	7.17 (3.66)	9.42 (4.10)	8.42 (4.70)	9.50 (3.92)

Notes: URCS = Unidimensional Relationship Closeness Scale; IRI = Interpersonal Reactivity Index; GIS = Goal Interdependence Scale

For the URCS, there were no main or interactions effects.

For the IRI, there were no significant main effects. However, there was a significant interaction between the dyadic relationship condition and participant role on the empathic concern scale, $F(1,88) = 5.09$, $p < .05$, $\eta_p^2 = .06$, see Figure 7.1. After a Bonferonni adjustment, the post-hoc analysis revealed no significant differences in the four variables (all p-values > .0125).

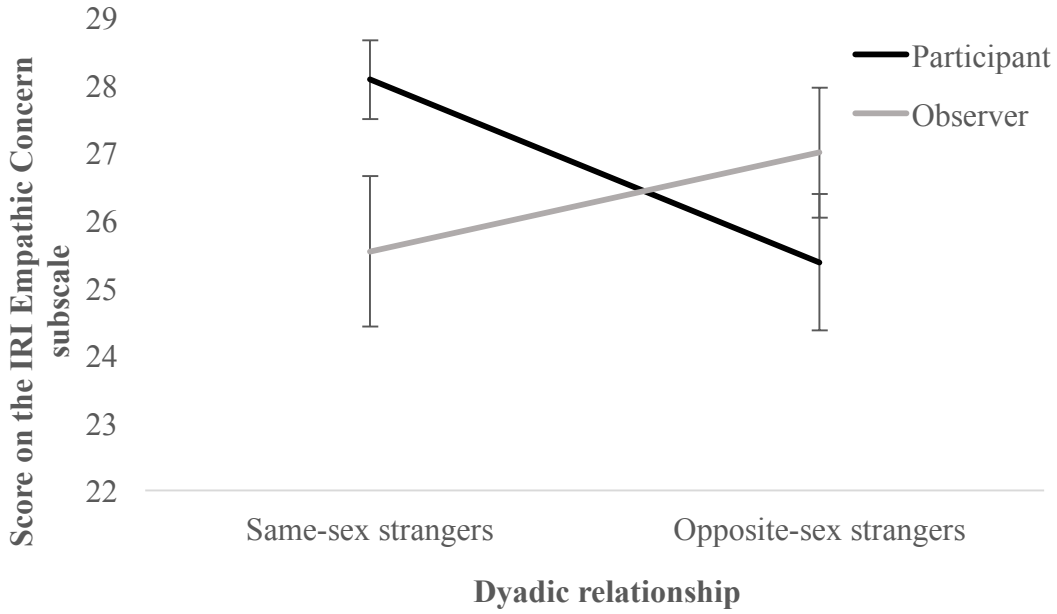

Figure 7.1. The significant interaction present between the dyadic relationship and participant role for the IRI empathic concern subscale. Error bars represent ±1 standard error of the mean.

For the GIS, there were no significant main effects or interactions present (all p-values > .05).

7.3.3. Competitive and cooperative manipulation check

A series of ANOVA's were conducted to determine whether the competitive-cooperation task produced the desired effect. The between groups variables were sex of participant (males vs. females) and sex of observer (male vs. female), and the within group variables were game condition (cooperative vs. competitive) and time (time point 1 [VAS score before the game and pain tasks], 2 [after the game but before the pain tasks], and 3 [after the game and pain tasks]). The dependent

variables were the competitive and cooperative scores on the VAS. The means and standard deviations are presented below in Tables 7.3. and 7.4.

Table 7.3. *Means and standard deviations (in parenthesis) for pain measures and questionnaires when the observer is male by the condition (cooperative vs. competitive), and sex of the participant (male vs. female).*

	Competitive condition T1		Cooperative condition T1		Competitive condition T2		Cooperative condition T2		Competitive condition T3		Cooperative condition T3	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Competitive VAS	56.25 (31.87)	64.50 (25.55)	39.83 (31.96)	63.33 (24.71)	71.83 (20.45)	85.42 (18.59)	71.42 (29.80)	73.67 (26.67)	55.25 (21.98)	69.92 (26.52)	64.75 (27.80)	59.42 (25.99)
Cooperative VAS	83.58 (22.72)	80.00 (16.95)	80.83 (28.21)	85.83 (11.92)	72.50 (23.62)	78.83 (23.26)	81.50 (21.66)	87.92 (9.87)	70.33 (22.47)	74.75 (23.83)	77.42 (20.86)	80.17 (11.57)

Notes: T1 = Time point 1, which is the VAS score before the participant played the Virtua-Tennis 4 game, and before any pain induction tasks

T2 = Time point 2, which is after the participants have played the Virtua-Tennis 4 game, but before the pain induction tasks

T3 = Time point 3, which is after the Virtua-Tennis 4 game and the pain induction tasks have been completed

Table 7.4. *Means and standard deviations (in parenthesis) for pain measures and questionnaires when the observer is female by the condition (cooperative vs. competitive), and sex of the participant (male vs. female).*

	Competitive condition T1		Cooperative condition T1		Competitive condition T2		Cooperative condition T2		Competitive condition T3		Cooperative condition T3	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Competitive	58.36	64.42	51.17	50.67	69.58	75.33	64.50	72.25	59.00	64.75	59.83	61.08
VAS	(32.51)	(21.90)	(29.94)	(21.27)	(28.87)	(18.24)	(31.80)	(18.36)	(27.47)	(23.13)	(28.84)	(22.15)
Cooperative	80.36	79.58	84.08	80.58	76.08	68.33	86.83	83.83	68.17	75.33	76.58	77.67
VAS	(16.11)	(15.63)	(18.16)	(16.65)	(18.63)	(25.55)	(12.42)	(10.70)	(19.23)	(14.45)	(15.37)	(17.25)

Notes: T1 = Time point 1, which is the VAS score before the participant played the Virtua-Tennis 4 game, and before any pain induction tasks

T2 = Time point 2, which is after the participants have played the Virtua-Tennis 4 game, but before the pain induction tasks

T3 = Time point 3, which is after the Virtua-Tennis 4 game and the pain induction tasks have been completed

7.3.3.1. Cooperation manipulation check

When considering the cooperation VAS scores in the cooperation and competitive game condition, there was a significant main effect of game condition, $F(1,43) = 11.88$, $p < .001$, $\eta_p^2 = .22$, suggesting that the VAS scores for cooperativeness were higher in the cooperative game condition ($M = 81.85$, $SD = 16.58$) than the competitive game condition ($M = 75.80$, $SD = 20.12$). The was also a main effect of time present, $F(1,43) = 17.32$, $p < .001$, $\eta_p^2 = .29$, suggesting that overall, cooperative VAS scores decreased over time (time point 1: $M = 81.68$, $SD = 17.57$, time point 2: $M = 79.69$, $SD = 18.50$, time point 3: $M = 75.09$, $SD = 18.16$). There were no other main effects or significant interactions present (p-values > .05).

7.3.3.2. Competition manipulation check

Similar to above, there was a significant main effect of game condition, $F(1,43) = 8.43$, $p < .01$, $\eta_p^2 = .16$, indicating that the competitive VAS scores were higher in the competitive game condition ($M = 66.53$, $SD = 24.83$) than the cooperative game condition ($M = 60.45$, $SD = 26.61$). In addition, there was also a main effect of time, $F(1,43) = 4.16$, $p < .05$, $\eta_p^2 = .09$, suggesting that participants felt the most competitive immediately after completely the game task (time point 1: $M = 55.86$, $SD = 27.68$, time point 2: $M = 72.90$, $SD = 24.30$, time point 3: $M = 61.71$, $SD = 25.18$). There were also two significant interactions present, and these will be explored in more detail below.

There was a significant interaction present between game condition and time, $F(1,43) = 4.19$, $p < .05$, $\eta_p^2 = .09$, see Figure 7.2. below.

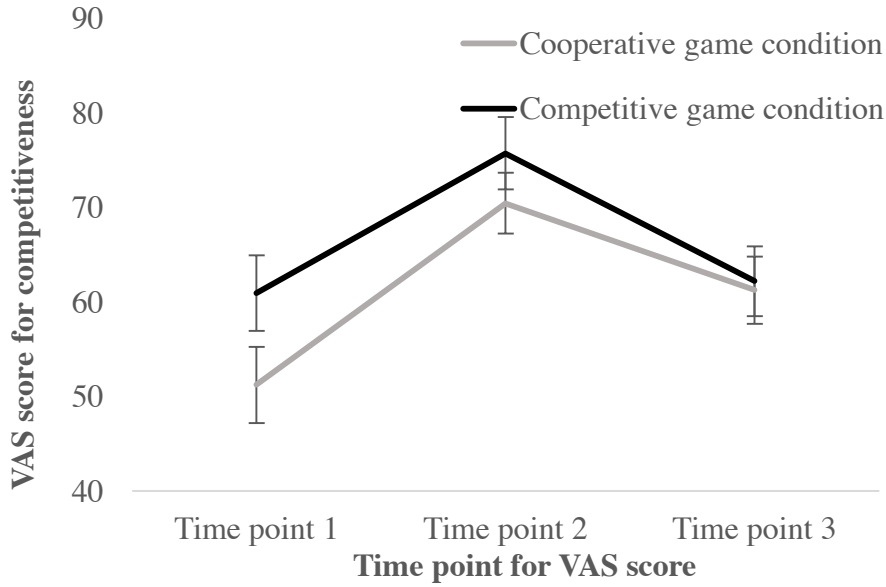

Figure 7.2. The significant interaction present between game condition and time for VAS competitiveness scores. Error bars represent ±1 standard error of the mean.

Post hoc analysis, including a Bonferroni adjustment giving an adjusted *p*-value of .008, revealed a significant difference at time point 1, $t(46) = 3.41$, $p < .001$, $d = .37$; the VAS score for competitiveness was higher in the competitive game condition ($M = 60.94$, $SD = 27.52$) when compared to the cooperative game condition ($M = 50.79$, $SD = 27.83$). When specifically focusing on the differences present between each of the time points in the cooperative game condition, there was a significant difference between times points 1 and 2, 2 and 3, and 3 and 1. When specifically focusing on the competitive game condition, there were significant differences present between time points 1 and 2, and 2 and 3, but there was not a difference between time points 3 and 1. The *t*-statements from the post-hoc analysis have been placed in Table 7.5, which allows you to see the 5 significant *t*-tests. The means and standard deviations for this analysis haven't been repeated in this section as they are presented in Tables 7.3. and 7.4., where it is tabulated in the same way as the analysis in this subsection has been analysed.

Table 7.5. *Table representing the post-hoc analysis completed on the significant interaction between time and game condition for the VAS scores on competitiveness.*

***t*-test analysis when split by time point (dependent variable is VAS score for competitiveness)**	***t*-statement**
TP 1 vs TP 2 in cooperative game condition	$t(47) = 5.78$, $p < .001$, $d = .71$
TP 2 vs TP 3 in cooperative game condition	$t(47) = 3.17$, $p < .008$, $d = .35$
TP 3 vs TP 1 in cooperative game condition	$t(47) = 2.96$, $p < .008$, $d = .38$
TP 1 vs TP 2 in competitive game condition	$t(46) = 4.38$, $p < .001$, $d = .60$
TP 2 vs TP 3 in competitive game condition	$t(47) = 4.91$, $p < .001$, $d = .57$

Notes: TP = time point

There was a significant four-way interaction present between the sex of the participant, sex of the observer, game condition, and time, $F(1,43) = 6.08$, $p < .05$, $\eta_p^2 = .12$. To make easier to interpret, I have visualised the interaction (Figures 7.3, 7.4, 7.5, and 7.6), split by sex of the participant and sex of the observer; thus, producing four graphs to coincide with the four different dyadic relationship present in this study (male-male, male-female, female-male, female-female).

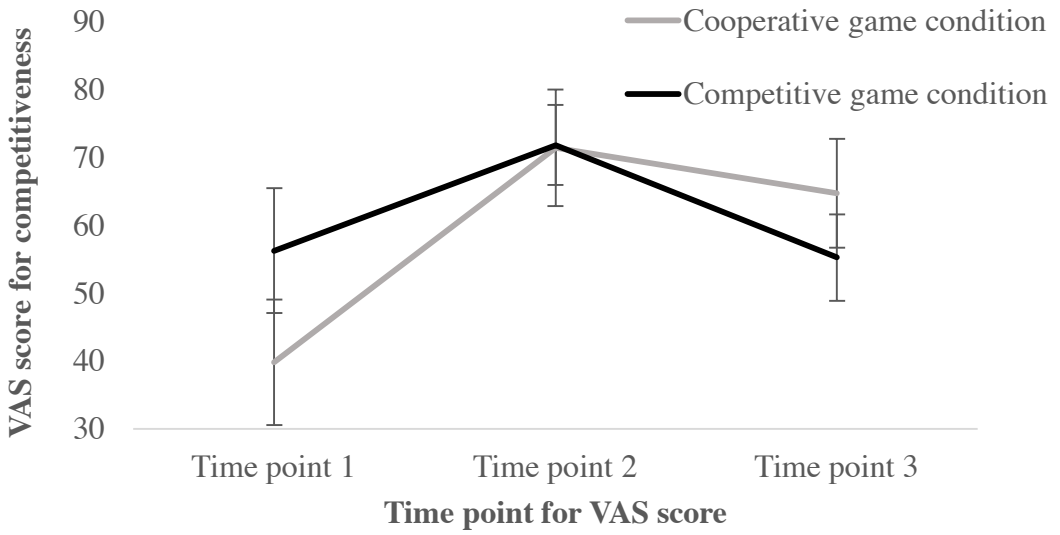

Figure 7.3. A visual representation of the interaction present between time and game condition for the male-male stranger dyads. Error bars represent ±1 standard error of the mean.

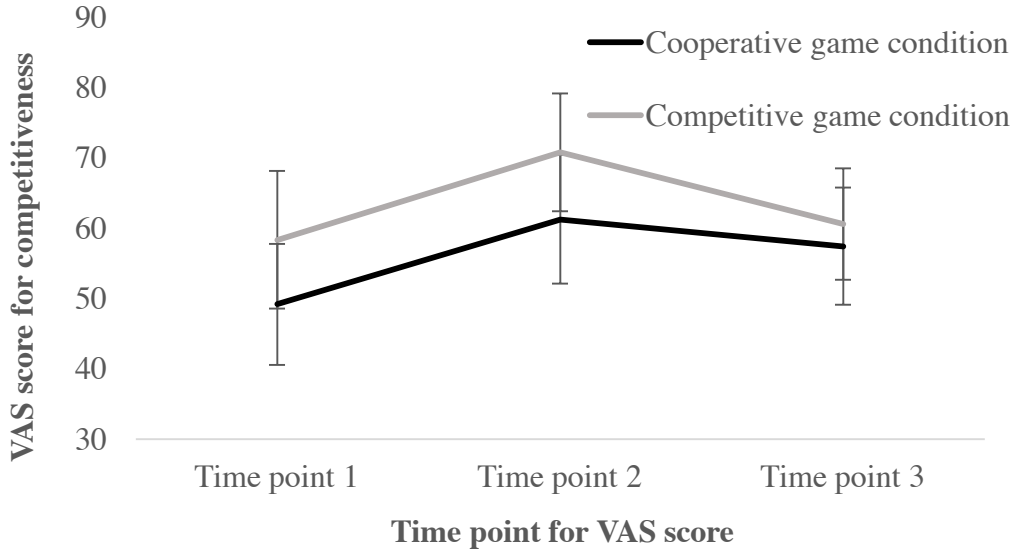

Figure 7.4. A visual representation of the interaction present between time and game condition for the male-female stranger dyads. Error bars represent ±1 standard error of the mean.

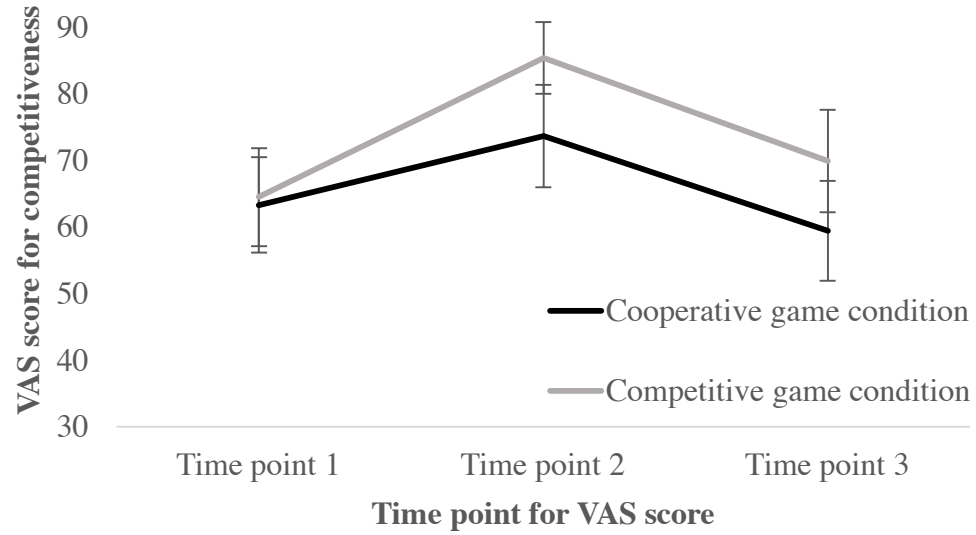

Figure 7.5. A visual representation of the interaction present between time and game condition for the female-male stranger dyads. Error bars represent ±1 standard error of the mean.

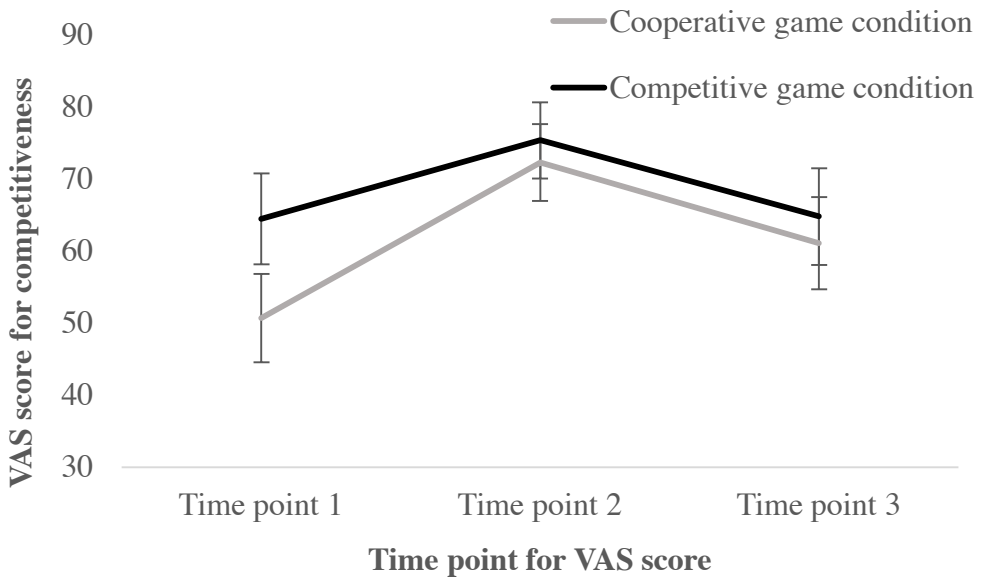

Figure 7.6. A visual representation of the interaction present between time and game condition for the female-female stranger dyads. Error bars represent ±1 standard error of the mean.

Further post-hoc analysis revealed that when splitting the data by both the sex of the participant and the sex of the observer, the interaction between game condition and time was only significant for the same-sex dyads (Figures 7.3 and 7.6).

The interaction between game condition and time for male-male dyads was significant, $F(1,11) = 12.38$, $p < .01$, $\eta_p^2 = .53$, and as was this interaction between female-female dyads was significant, $F(1,11) = 5.65$, $p < .05$, $\eta_p^2 = .34$. From this point, the further post-hoc analysis, with the Bonferroni adjustment, will be completed on these two significant 2-way interactions.

The post-hoc analysis for the male-male stranger dyads showed a significant difference between the competitive VAS scores for time point 1 ($M = 39.83$, $SD = 31.96$) and 2 ($M = 71.42$, $SD = 29.80$) in the cooperative game condition $t(11) = 3.95$, $p < .008$, $d = 1.02$, and an additional difference between time points 3 ($M = 64.75$, $SD = 27.80$) and 1 ($M = 39.83$, $SD = 31.96$), $t(11) = 3.98$, $p < .008$, $d = .83$. However, there were no other significant differences present (p-values > .008). The post-hoc analysis for the female-female stranger dyads showed a significant difference in the VAS scores for competitiveness at time point 1 ($M = 50.67$, $SD = 21.27$) and 2 ($M = 72.25$, $SD = 18.36$) in the cooperative game condition, $t(11) = 4.56$, $p < .008$, $d = 1.09$, but there were no other significant differences present.

Overall, this means that the manipulation check was successful; participants felt more competitive in the competitive condition, and more cooperative in the cooperative condition. Furthermore, in same-sex strangers, the cooperation was successful. Both same-sex female stranger dyads, and male stranger dyads had a significant increase in cooperativeness immediately after playing the game. Interestingly, and importantly, the cooperative VAS score was still higher at time point 3, than at time point 1, which shows the level of cooperation can be carried over to the pain induction tasks.

7.3.4. Impact of game condition on the reporting of cold pressor pain

A series of ANOVA's were conducted on the cold pressor pain outcomes, and where relevant, follow-up t-tests with Bonferroni adjustments. The between groups variables were sex of participant (males vs. females) and sex of observer (male vs. female), and the within groups factor was game condition (cooperative vs. competitive). The dependent variables are the pain outcomes (threshold and tolerance), and self-report pain questionnaires: the Visual Analogue Scale (VAS) and the Short Form McGill Pain Questionnaire (SF-MGPQ-2). The means and standard deviations are presented below in Table 7.6.

Table 7.6. *Means and standard deviations (in parenthesis) for pain measures and questionnaires by sex of the observers (male vs. female), the phase (no observer vs. observer) and participant sex (male vs. female).*

	Male observer group				Female observer group			
	Competitive condition		Cooperative condition		Competitive condition		Cooperative condition	
	Male	Female	Male	Female	Male	Female	Male	Female
Cold Pressor Task								
Threshold (seconds)	11.73 (238.12)	12.41 (11.01)	9.34 (7.50)	9.49 (7.23)	9.85 (4.33)	5.53 (3.48)	9.80 (5.46)	6.60 (7.34)
Tolerance (seconds)	45.27 (37.29)	51.49 (34.30)	47.58 (45.35)	37.60 (30.53)	47.63 (28.85)	27.53 (31.82)	35.69 (18.79)	25.14 (31.23)
SF-MPQ-2	2.14 (2.07)	2.46 (1.84)	2.05 (1.85)	2.57 (1.50)	2.97 (1.97)	2.29 (1.32)	2.79 (1.56)	2.56 (1.35)
VAS	17.09 (22.28)	63.50 (9.82)	46.60 (20.64)	61.42 (14.78)	64.89 (19.08)	65.27 (15.75)	59.36 (16.06)	60.67 (18.64)
Algometer								
Threshold (kPa)	474.30 (238.12)	395.72 (170.87)	419.94 (213.64)	370.26 (153.64)	539.72 (166.72)	284.36 (131.79)	475.01 (138.76)	293.61 (117.24)
SF-MPQ-2	1.28 (1.39)	1.40 (1.06)	1.32 (1.32)	1.47 (.96)	1.19 (.94)	1.39 (2.29)	1.20 (.87)	1.38 (.98)
Algometer VAS	31.64 (17.19)	44.75 (14.42)	26.72 (14.18)	36.64 (18.81)	34.44 (17.68)	35.91 (18.89)	31.81 (16.52)	37.45 (17.83)

Notes: VAS = Visual Analogue Scale; SF-MPQ-2 = Short Form McGill Pain Questionnaire Version 2

For pain threshold on the CPT, there were no significant main effects (all *p*-values > 05). However, there was a significant interaction present between the game condition and the sex of the observer, $F(1,44) = 4.73$, $p < .05$, $\eta_p^2 = .01$, see Figure 7. Interestingly, after the Bonferroni adjustment the post-hoc analysis revealed no further significant differences between the four variables (all *p*-values > .0125). Despite there not being any significant results in the posthoc analysis, Figure 7.7. suggests that when the observer is male, pain thresholds are higher in the competitive game condition.

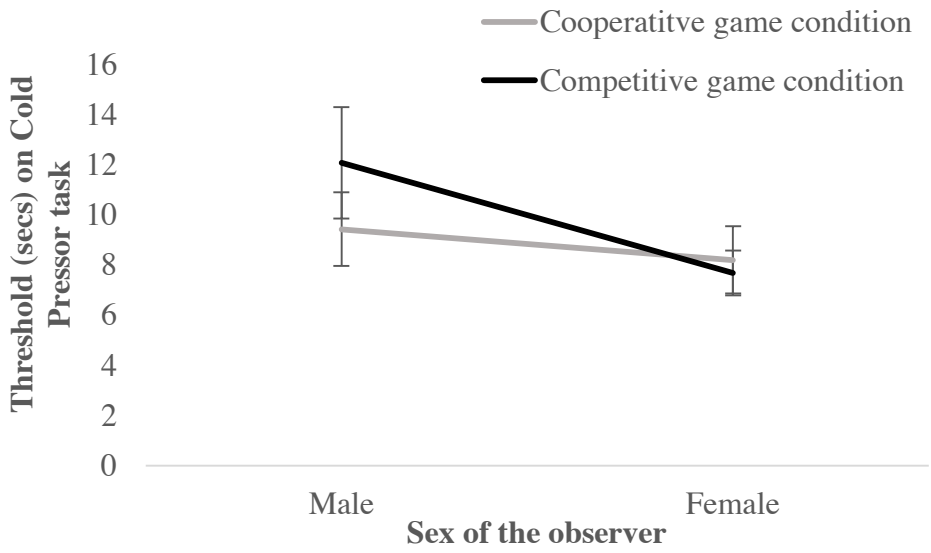

Figure 7.7. The interaction present between the sex of the observer and game condition for pain threshold on the Cold Pressor task. Error bars represent ±1 standard error of the mean.

Focusing on pain tolerance for the CPT revealed a significant main effect for the game condition, $F(1,44) = 9.00$, $p < .05$, $\eta_p^2 = .17$, indicating that pain tolerance was higher in the competitive condition ($M = 42.98$, $SD = 33.45$) as opposed to the cooperative condition ($M = 36.50$, $SD = 32.79$). There were no other significant main effects present (p-values >.05). However, there was a significant three-way interaction present between the game condition, sex of the participant and sex of the stranger observer, $F(1,44) = 8.90$, $p < .01$, $\eta_p^2 = .17$, see Figures 7.8 and 7.9. To visually represent the interaction, the data has been split by the sex of the participant,

which aligns with the research question focusing on sex differences, and mirrors the multi-way interaction procedure in other parts of this chapter.

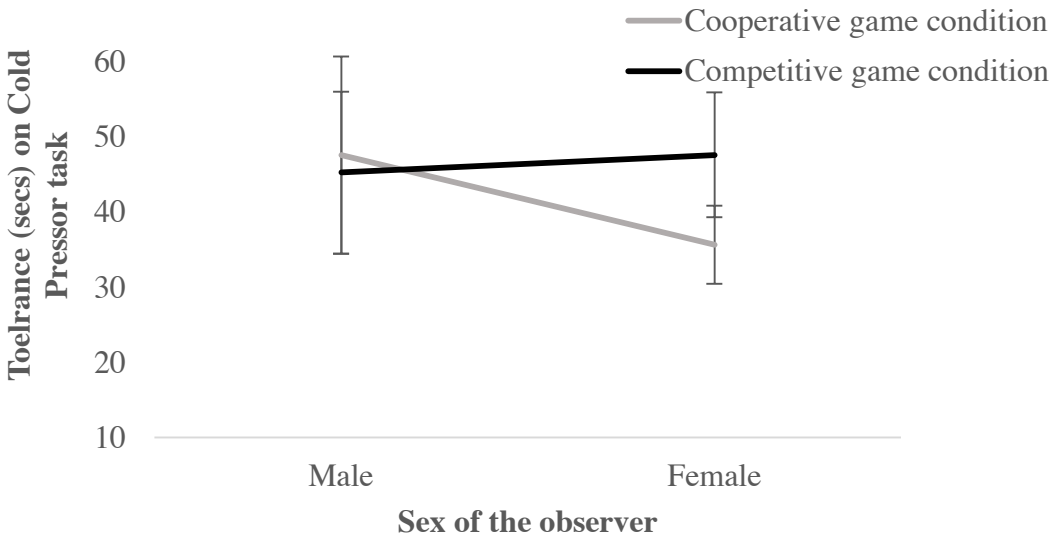

Figure 7.8. The interaction present for male participants between the sex of the observer and game condition for pain tolerance on the Cold Pressor task. Error bars represent ±1 standard error of the mean.

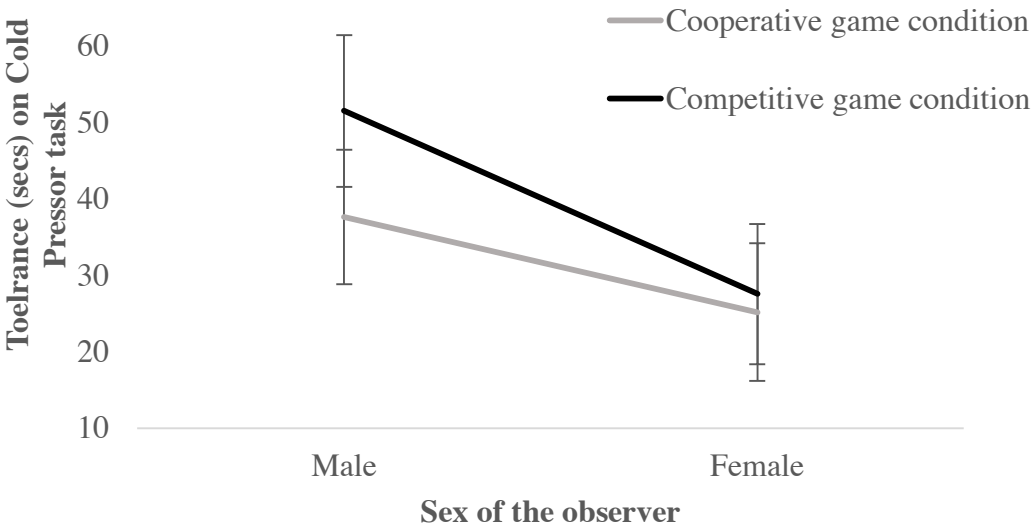

Figure 7.9. The interaction present for female participants between the sex of the observer and game condition for pain tolerance on the Cold Pressor task. Error bars represent ±1 standard error of the mean.

When considering the three-way interaction when the data is split by the sex of the participant, there were no further interactions present in men; thus, there was no change in pain tolerance for men, irrespective of the game condition and the sex of the observer. However, for female participants there was an effect of game condition, $F(1,22) = 6.40$, $p < .05$, $\eta_p^2 = .23$, suggesting that pain tolerance was higher in the competitive game condition ($M = 39.51$ seconds, $SD = 34.59$ seconds) as opposed to the cooperative game condition ($M = 31.37$ seconds, $SD = 30.87$ seconds), as graphed in Figure 9. Given that this is the only significant two-way interaction present, this will be explored further in a post-hoc analysis with a Bonferroni adjustment. The only significant difference was when the observer was male, there was a significant difference in the female pain tolerance between the cooperative game condition ($M = 37.60$ seconds, $SD = 30.53$ seconds) and the competitive game condition ($M = 51.49$ seconds, $SD = 34.30$ seconds), $t(11) = 3.27$, $p < .0125$, $d = .43$. There were no other significant differences present ($p > .0125$).

The analysis on the VAS for the CPT showed a significant main effect of game condition. Participants rated their pain as more intense in the competitive condition ($M = 60.76$, $SD = 17.80$), when compared to the cooperative condition ($M = 58.21$, $SD = 18.03$), $F(1,38) = 4.24$, $p < .05$, $\eta_p^2 = .10$. There were no other significant main effects or interactions for the VAS.

Analysis of the MG-MGPQ-2 revealed no significant effects (all p-values > .05).

7.3.5. Impact of condition on the reporting of pressure pain

Similar to the cold pressor task, a series of ANOVA's were conducted on the pressure-pain outcomes, and where relevant, follow-up t-tests with Bonferroni adjustments. The between groups variables were sex of participant (males vs. females) and sex of observer (male vs. female) and the within groups factor was game condition (cooperative vs. competitive). The dependent variables are the pain outcomes (threshold and tolerance) and self-report pain questionnaires: the Visual Analogue Scale (VAS) and the Short Form McGill Pain Questionnaire (SF-MGPQ-2).

For the pressure-pain threshold, there was a main effect of the sex of the participant, indicating that men (*M* =276.70 kPa, *SD* = 195.18 kPa) had a higher pressure-pain threshold than women (*M* =398.17 kPa, *SD* = 176.30 kPa), $F(1,44) = 8.78$, $p < .01$, $\eta_p^2 = .17$. Additionally, there was a significant main effect of game condition, suggesting that pressure-pain thresholds were higher in the competitive condition (*M* = 423.52 kPa, *SD* = 199.81 kPa) than in the cooperative condition (*M* =389.70 kPa, *SD* = 168.75 kPa), $F(1,44) = 7.20$, $p < .01$, $\eta_p^2 = .14$. There was no significant main effect of the sex of the observer (*p*-value > .05).

There was also a significant interaction present between the sex of the participant and the game condition, $F(1,44) = 4.17$, $p < .05$, $\eta_p^2 = .09$ (see Figure 7.10.).

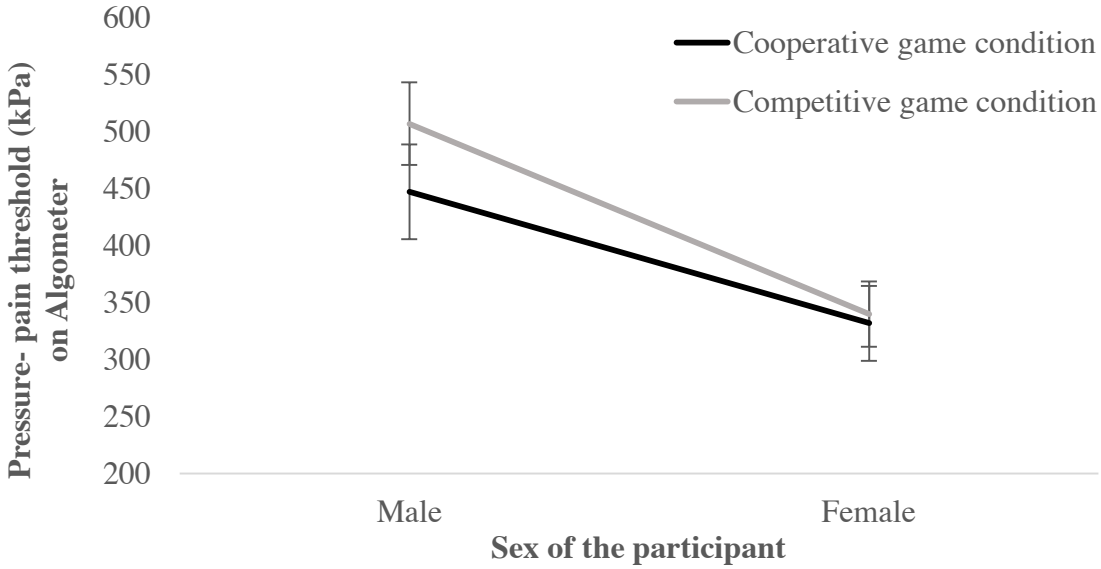

Figure 7.10. The significant interaction present for the sex of the participant and the game condition on the algometer. Error bars represent ±1 standard error of the mean.

Further post hoc analysis with a Bonferonni adjustment was conducted. This revealed a significant difference between the cooperative condition (*M* =447.48 kPa, *SD* = 178.40 kPa) and competitive condition (*M* =507.01 kPa, *SD* = 203.79 kPa) in men, $t(23) = 3.05$, $p < .0125$, $d = .30$. This difference was not significant in women. Additionally, there a sex difference present between men and women in the competitive game condition, with men (*M* =507.01 kPa, *SD* = 203.79 kPa) having a

higher pressure-pain threshold than women (M =340.04 kPa, SD = 159.71 kPa), $t(46) = 3.16$, $p < .0125$, d =.91. However, this difference was not observed in the cooperative game condition.

The analysis for the VAS revealed no significant main effects. However, there was a signficant interaction present between the game condition and the sex of the observer, $F(1,38) = 6.39$, $p < .05$, $\eta_p^2 = .14$ (see Figure 7.11.). Post hoc analysis showed a signficant difference for male observers in how they rated their pain in the cooperative condition (M =31.68, SD = 17.03) compared to when in the competitive condition (M =38.09, SD = 17.12), $t(21) = 301$, $p < .01$, d =.38. Pain was tolerated more when in the presence of male observers during the competition condition. There were no other significant differences found.

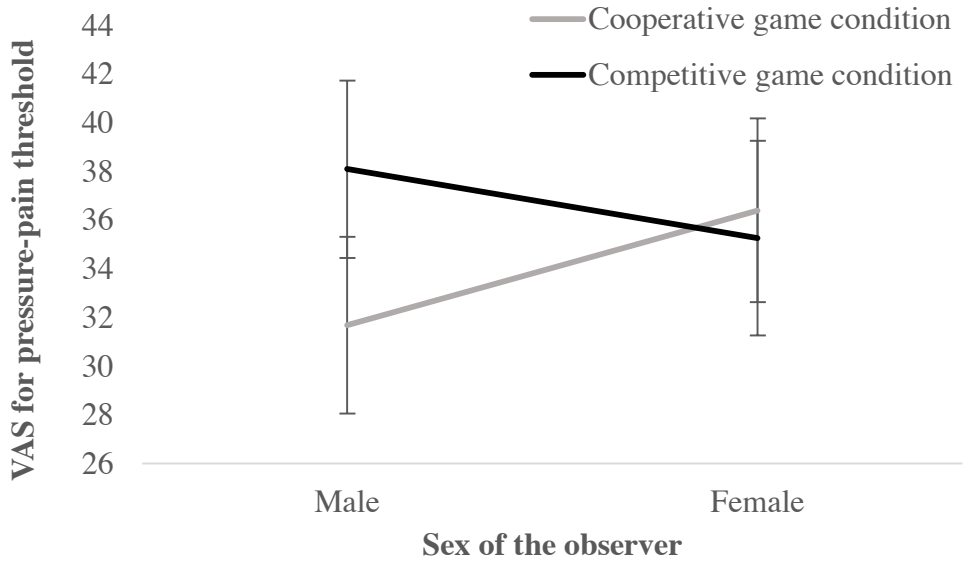

Figure 7.11. The significant interaction present the sex of the observer and game condition on the VAS score for the algometer. Error bars represent ±1 standard error of the mean.

There were no significant main effects or interactions present in the analysis for the SF-MPQ-2 (all p-values > .05).

7.4. Discussion

The results of this study provide an interest insight and potential interpretations as to how the social context can have an impact on pain. To begin, the manipulation task was again successful in this study; participants felt more competitive in the competitive condition, and more cooperative in the cooperative condition. Furthermore, in same-sex strangers, the cooperation manipulation game condition was successful, and both same-sex female stranger dyads, and male stranger dyads had a significant increase in cooperativeness immediately after playing the game. Interestingly, and importantly, the cooperative VAS score was still higher at time point 3, than before the manipulation task took place, which shows the level of cooperation can be heightened, and then carried over to the pain induction tasks.

When considering the impact competitiveness and cooperativeness have on the pain tasks, again, more interesting results emerged. For the cold pressor task, the pain tolerance was higher in the competitive game condition, as opposed to the cooperative game condition. Specifically, when the observer was male, female participants had a higher pain tolerance in the competitive game condition, as opposed to the cooperative game condition. For the pressure-pain condition, threshold was higher in the competitive condition, specifically by men; men had a higher pressure-pain threshold than women.

7.4.1. Interpretation of results

The results from this study are of great interest, and some are also a little different to what was originally hypothesised in the introduction of this chapter. At the beginning of the chapter, I hypothesised that the game manipulation would be successful, and participants would feel more competitive in the competitive game condition, and more cooperative in the cooperative game condition. From the analysis of the manipulation task, it can be suggested that the cooperativeness of the participants was successfully manipulated, with participants reporting being more cooperative after the task in the cooperative game condition, and more competitive in the competitive game condition. This study built on the previous study's

manipulation task by asking participants to rate their competitiveness and cooperativeness before the task and pain induction, after the manipulation task, and then after the task and pain induction tasks. The highest score for cooperativeness was immediately after the manipulation task, but the high cooperativeness score did not continue after the pain induction task, suggesting that the manipulation task was only immediately effective. In addition, it is plausible to have high scores for competitiveness and cooperativeness in the cooperative game condition, but only to have high scores on competitiveness in the competitive game condition. This suggests that it is mainly the cooperativeness of participants that was manipulated throughout the tasks as competitiveness was high in both tasks.

The second hypothesis presented in the introduction section of this thesis was that pain threshold and tolerance would be higher in the competitive game condition, as opposed to the cooperative game condition. To a certain extent, I was able to support this hypothesis; on the cold pressor task, more pain was tolerated in the competitive game condition. Additionally, this effect was also seen in pressure-pain thresholds; there was a higher pressure-pain threshold when in the competitive game condition, when compared to the cooperative game condition. These findings build upon the previous study slightly; in both studies, pain tolerance was higher in the competitive game condition, as opposed to the cooperative game condition. This shows that the manipulation task was successful for both studies, and that there is something unique about competitiveness that results in more pain being tolerated in front of strangers and friends.

The final hypothesis for this study was that men would have a higher pain threshold and tolerance than women. However, this hypothesis was not fully supported in this study. Interestingly, for cold pressor pain threshold, there was an interaction between game condition and sex of the observer. Despite the posthoc results not being significant, the visualisation of the findings showed that when the observer was male, pain thresholds were higher in the competitive game condition. When considering cold pressor pain tolerance, there was no change in pain tolerance for men, irrespective of the game condition and the sex of the observer. However, for women, pain tolerance was higher in the competitive game condition. When focusing on this interaction further, it was apparent that the significant difference

was when the participant was female, but the observer was male, there was a difference in pain tolerance; pain tolerance was higher in the competitive game condition. Interestingly, there were also sex differences present for pressure-pain thresholds; men had a higher pressure-pain threshold than women. An interaction emerged between the sex of the participant and the game condition, which is slightly different to the results of the cold pressor task. When investigated further in posthoc analysis, men had a significantly higher pressure-pain threshold in the competitive game condition, and men also had a higher pressure-pain threshold than women. These results indicate that after successful manipulation of competitiveness and cooperativeness, women can appear to have similar pain tolerance levels as men. This coincides with previous research based in social psychology, which suggests that women, when necessary, can be equally as competitive as men. The additional finding here is that this was specifically when the observer was a man; this highlights an area of future research to explore whether opposite-sex strangers can have more of an effect on pain, when being made to feel more/less competitive or cooperative. At present, it is difficult to infer why these differences may have occurred as there is limited research in this area, but what is important to note is the differences in the results between this study and the previous study, which focused specifically on friendships. Thus, there is something unique about the type of dyadic relationship and closeness of the two people that may have had an impact on pain thresholds and tolerance.

7.4.2. Implications of results for pain research

Some of the findings from the current study mirror those found in the previous chapter; that overall sex differences are either eliminated in the cold pressor task (men do not have a higher pain tolerance than women, overall), but are present in pressure-pain thresholds. Reflecting the cold pressor findings on the literature, the link between competitiveness and masculinity is still highlighted. In the present study, women had the biggest increase in pain tolerance, especially when the observer was male, which suggests that the masculine gendered context resulted in women suppressing their pain. However, to my knowledge there is no literature available that has looked at the effectiveness of a competitive and cooperative

manipulation task in the context of pain before. Therefore, the results should be interpreted with caution until more is understood about why competitiveness can have an impact on pain reporting. However, it is important to consider the differences between this study where sex differences were identified, and the prior study where there were no sex differences; and the key difference between the empirical chapters is the type of relationship recruited. When the participants are friends, i.e. known to each other, there are no sex differences. However, when the element of shared identity, common goals, and empathy are removed in strangers, the sex differences are observed again, and in particular women have a larger increase in pain tolerance.

One possible explanation for this, is that when women do not know the observer, they adopt more masculine traits to comply with the social context, which results in an increase in pain tolerance. It was previously hypothesised that competitiveness and pain would be highly correlated due to the competitiveness characteristic is friendship; however, there have been noted differences in this chapter which has focused on strangers, so perhaps the concept that competitiveness is a characteristic of friendship can also translate into strangers too, particularly in an virtual gaming context (Kou & Gui, 2014). Therefore, a possible explanation is that competitiveness and cooperativeness may not be limited to friendships only; when in an environment that is considered competitive, women adopt more masculine gendered traits to prove their stoicism and toughness, especially in front of men.

7.4.3. Directions for future research

The obvious next step for future research is to develop the competitiveness manipulation further by exploring competition in a naturally occurring environment, for example, a sporting environment. It would be of great interest to see if the same results are found in naturally occurring pain within a sports team, especially in teams that are familiar with each other, and new teams of strangers. This would add to what we already know with regards to competitiveness between different people, and it would address the wider implications of this research. The communication of pain to other team players is still a fairly under researched area, but one that may be crucial to both the short term and long-term performance of a team.

7.4.4. Summary and conclusion

To conclude, this study has shown that competitiveness and cooperativeness can be manipulated in an experimental paradigm, and that it can have an impact on pain. Pain tolerance is higher in competitive conditions, with females having a higher pain tolerance in front of a male observer. Future research needs to continue to incorporate the sex of participant and also the observer, and the dyadic relationship and its characteristics such as competitiveness. Additionally, this research can now be applied to a more naturally occurring environment, in order for this section of this PhD thesis to have even more real-world implications.

Chapter 8: General Discussion

8.1. Summary of findings in relation to research questions

The aim of the current research was to investigate the social context of pain, using an experimental pain methodology. A series of 5 experiments were conducted, which manipulated the type of observer present, and then context, during a painful event, in order to consider the following research questions (as outlined in Chapter 1):

1. *Research question 1: Does the presence of an observer impact on the reporting of pain?*

Based on previous research, it was predicted that the presence of an observer would increase pain threshold and tolerance. Throughout studies 1 – 3, I found that the presence of an observer produced inconsistent results for pain threshold, but consistent results for pain tolerance; when an observer was present, pain tolerance increased.

2. *Research question 2: Does the dyadic relationship between the observer and the individual experiencing pain impact on the reporting of pain?*

Out of all of the dyadic relationships examined, it was predicted that the presence of friends would have the greatest effect on (increasing) pain threshold and tolerance, compared to strangers (study 1); and that a similar effect would be found when accompanied by romantic partners (study 3). Throughout this PhD I recruited various dyadic relationships (strangers, opposite-sex friends, same-sex friends, romantic partners) and found that pain was tolerated the most by participants who were allocated to the friend's condition. When investigating this further, it was found that pain was tolerated most when the friends were within a same-sex dyad.

When considering the dyadic relationships recruited in studies 4 and 5, there were interesting results regarding the dyadic relationship; once the context had been manipulated, differences in the friend's condition were eliminated. However, for the stranger's condition, pain was tolerated more when the dyad were of the opposite-sex.

3. *Research question 3: Does the sex of the dyad impact pain reporting by an individual?*

Based on previous research conducted on sex differences in pain, it was predicted that men would have a higher pain tolerance than women. There were clear sex differences reported throughout the first three experimental studies in this PhD; men consistently had a higher pain tolerance than women. This was particularly observed when the dyad were male-male friends. However, when the context was manipulated in the final two experimental studies, women had the highest pain tolerance, especially when their observer was a male stranger.

4. *Research question 4: If pain is tolerated more in friends, can we begin to understand why?*

This research question specifically focused on the second part of this PhD thesis, i.e. on studies 4 and 5. The previous studies in this PhD thesis found that pain was tolerated when the friends were same-sex, and it was suggested that this could be explained by different aspects of friendship, such as competitiveness and cooperativeness. Competitiveness and cooperativeness may offer an explanation as why pain may be tolerated more in friends, and in the final two studies of this PhD thesis, competitiveness and cooperativeness were explored through a manipulation task. It was predicted that in study 4, same-sex friends would have a higher pain tolerance in a competitive environment than opposite-sex friends. Building on this further, study 5 went on to expand on the manipulation task, and specifically focus on same-sex and opposite-sex strangers. While more pain was tolerated in the competitive condition, as opposed to the cooperative condition, interestingly, there were no differences in same-sex or opposite-sex friends. However, for study 5 which focused on strangers, opposite-sex strangers had a higher tolerance than same-sex strangers, and this was observed when the person completing the pain tasks was female and the observer was male.

The results of the individual empirical studies conducted in this PhD have already been discussed in the previous experimental chapters, a summary of which can be found in Figure 8.1. This figure is similar to that presented in the introduction

(Figure 1.2.), but with key findings from the experiments included. This general discussion chapter will now consider the experiments as a whole, and reflect on what they collectively tell us about the nature of social context of pain, and in reference to my core research questions. I will conclude this chapter by focusing on the real-world implications of my work, as a whole, and consider future avenues of research to investigate. .

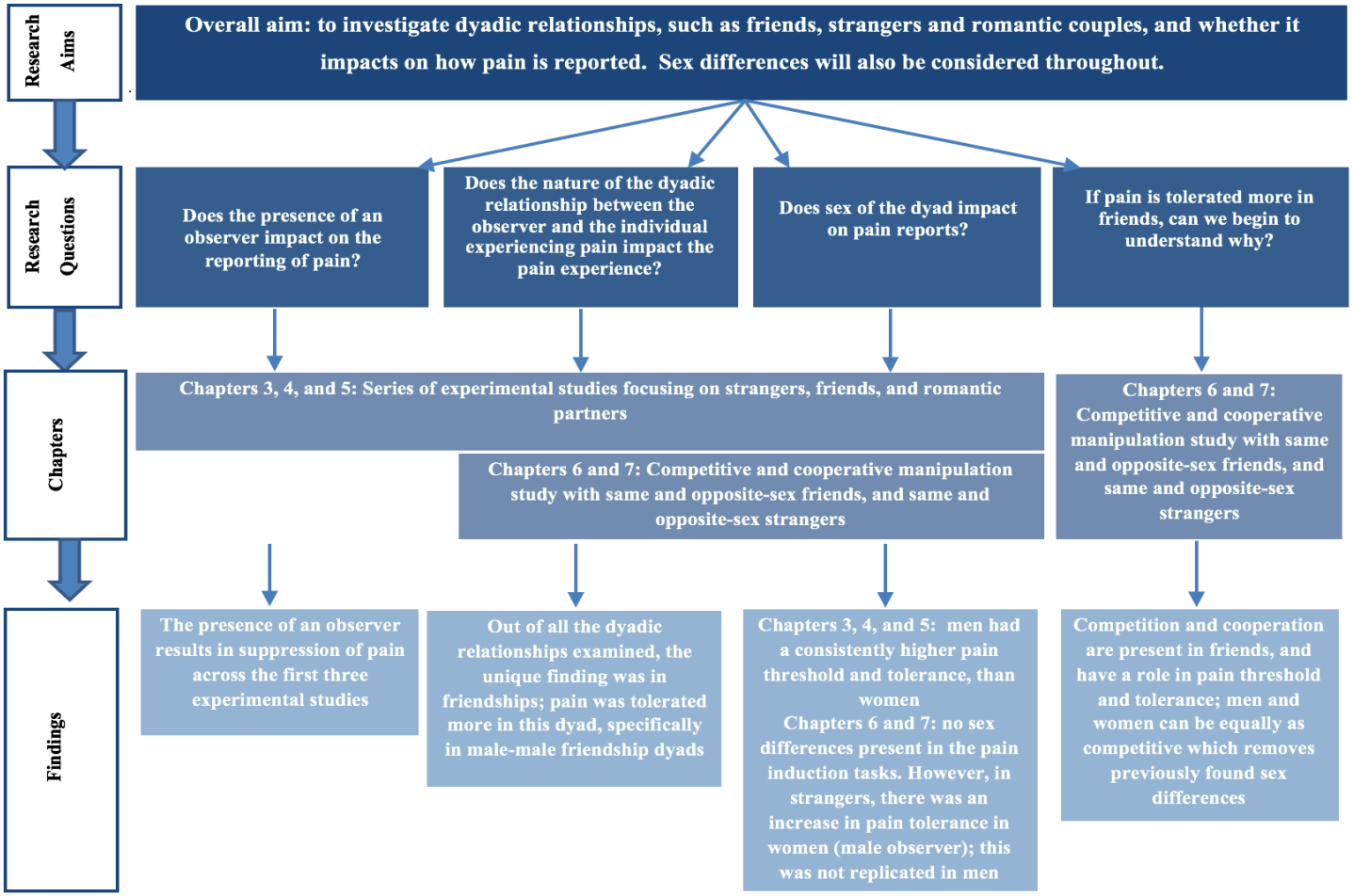

Figure 8.1. Flow diagram of the research questions outlined in Chapter 1, how the chapters in this thesis have addressed each question, and what the key findings were.

8.2. Critical reflection of the collective findings in this PhD thesis

This section will consider the collective findings and themes that emerged across the PhD as a whole, and will examine these in reference to the main research questions.

8.2.1. Observer effects

The first research question for this thesis was to examine whether the presence of an observer could have an impact on pain reporting. This research question specifically focuses on studies 1 – 3, and across all studies there was an effect of observer presence; when an observer was present in the laboratory, the pain tolerance of the person completing the pain task increased. This overarching finding for this research question suggests that the results are reliable, and interestingly, irrespective of the dyadic relationship, the presence of another person is enough to increase pain tolerance. Previous research has focused upon audience effects, and also found that the presence of an observer, or a larger audience (Vigil & Coulombe, 2011), can increase pain tolerance in an experimental setting. The findings for pain threshold were less consistent across studies 1 - 3, but these will be reviewed later on in this section as a standalone point.

The high consistency of observer effect demonstrated within this thesis, allows us to be more confident in the reliability of findings for the latter half of the PhD. For example, given that having someone else present consistently increased pain tolerance allows us to concentrate fully on why those effects may be observed. In this thesis, I explored the nature of relationships further by specifically focusing on the nature of competitiveness and cooperativeness.

Therefore, overall, these consistent findings for presence of an observer allow us to understand more about the social context of pain, and begin to explore the role of context at a deeper level than physical presence, e.g., the different dyadic relationships or the nature of friendship.

8.2.2. Inconsistent findings in effect an observer has on pain threshold

One of the more nuanced findings from this thesis was the inconsistency associated with pain threshold in studies 1-3. Figure 8.2. outlines the studies where

the inconsistencies occurred for pain threshold. Pain tolerance has not been recorded here as there were consistent findings across the three studies.

Figure 8.1. *A summary of the findings from the first three experimental studies to highlight in the inconsistent findings in pain threshold and pressure-pain threshold across the cold pressor task and the algometer, respectively. An asterisk (*) highlights where the inconsistent results occurred.*

Study number	Pain task	RQ 1: Presence of observer on pain threshold
1 (Friends vs. strangers)	Cold Pressor Task	Observer increased pain threshold
	Algometer	Observer increased pressure-pain threshold
2 (Same-sex friends vs. opposite-sex friends)	Cold Pressor Task	No effect*
	Algometer	Observer increased pressure-pain threshold
3 (Opposite-sex friends vs. romantic partners)	Cold Pressor Task	Observer increased pain threshold
	Algometer	No effect*

As can be seen in Figure 8.2., for threshold, the results are inconsistent, and that this may be in part be linked to the type of pain induction method used. When considering the first research question, whether the presence of an observer can have an impact on pain threshold, there were inconsistent results found between the cold pressor task and the algometer.

One reason for inconsistent effects around pain threshold may be due to different pain induction methods. Throughout all of the experimental studies, pain threshold and pain tolerance were measured using the cold pressor task, which was chosen due its frequent use in other studies into social influences and sex differences in pain (Meredith, 2013; Riva et al., 2011; Vigil et al., 2014a). In order to explore

generalisability across methods, a second approach, an algometer, was used to measure pressure pain sensitivity. This equipment has previously been used as a reliable method for assessing sex differences within pain research (Chesterton et al., 2003; Riley et al., 1998). Although it measures a different type of pain, it does not allow for tolerance readings, only pressure-pain threshold readings. The two approaches are different, which may have led to different results for pain threshold. For example, the cold pressor task may not have been as threatening a stimulus as the algometer, which is shaped like a gun (images of the equipment can be found in Chapter 2). Future research could record participants' thoughts on the equipment by asking them to quickly rate how threatening they found them to be. Alternatively, the paradigm could include a threat manipulation built in to it to determine whether the specific threat of pain induction moderates pain threshold. The cold pressor task is an example of thermal pain induction, and the algometer is an example of external mechanical pain induction. Thus, even though both are highly reliable methods of experimental pain induction, given that they both produce slightly different types of pain may be enough to have different effects on participants.

A second reason for this inconsistency may be due to the dyadic relationship recruited. In the studies where by the inconsistencies were found, all participants arrived at the laboratory with someone they knew, i.e. there were no strangers recruited apart from in study 1, where the effect was present. Therefore, one reason why the presence of an observer did not have an impact on pain threshold may be due to the participant having an awareness that the person they arrived with was outside of the testing room. This knowledge and awareness of close proximity may have been enough for the physical presence of the observer not to have an impact on pain threshold.

8.2.3. The role of sex and gender

The third research question (outlined in Chapter 1 and at the beginning of this chapter) relates to sex differences, and whether the sex of the participant and the sex of the observer can have an impact on pain reporting. This is a topic that has been extensively covered throughout this thesis, but it is important to emphasise that I have been successful in replicating, and building upon, previous research findings. In the first three experimental studies, consistent sex differences were found; men could

tolerate more pain than women. This supports previous research on sex differences in pain (Bartley & Fillingim, 2013; Boerner et al., 2014; Fillingim et al., 2009), and also adds to the reliability of the work conducted in this thesis. If I did not replicate previous results on sex differences then I would be less certain on the robust methodology or the findings of the final two experimental studies.

In the second part of this thesis where competition and cooperation were manipulated, these previously seen sex differences were no longer consistent. This suggests that the context had an impact on how pain was reported. During the final two experimental studies in this PhD thesis, it may be plausible that the sex differences we reconceptualised as a gendered context. The manipulation tasks may be perceived to be gendered due to the context, e.g. competitiveness is associated with masculinity.

In order to understand this, I will briefly revisit the definitions of sex and gender. Even though sex and gender are clearly defined as very different (Ritz et al., 2014; Unger, 1979), often in research focusing on either sex or gender, there will be overlapping aspects of both (Lippa, 2005). For example, throughout my work I have controlled for sex differences, i.e. whether there are differences in men or women (as indicated on the demographic information provided during the studies). However, I argue here, the concept of gender is also present, especially in studies 4 and 5 where the manipulation task was used to increase/decrease both competition and cooperation. Therefore, it may be the manipulation of the context which led to different results from the first and second set of studies.

During the second part of this thesis (studies 4 and 5), it could be argued that the manipulation tasks actually created gendered environments; more masculine environments were created in the competitive phase, and more feminine environments were created in the cooperative phase. Previous research indicates that gendered environments are present in everyday situations (Eriksson, Sandberg, & Hellstrom, 2013), and that this can be related to the nature of competitiveness and cooperativeness that occurs. Some have even argued that sex differences are present in the creation of such gender environments, and in a stereotypical manner (Holt & Thompson, 2004). For example, some have also argued that men are more competitive on a day-to-day basis and create a more masculine environment, whereas women are more cooperative and create a more feminine environment

(Cashdan, 2003). It was hypothesised that pain threshold and tolerance would be higher in the competitive condition due to the more masculine environment created. Pain is tolerated more by men than women, and when focusing on stereotypes for masculinity, pain is suppressed in highly masculine environments such as a threating or vulnerable context (Robinson et al., 2001; Wandner, Scipio, Hirsh, Torres, & Robinson, 2012). This hypothesis was supported in studies 4 and 5; in both studies, pain was tolerated more in the competitive condition as opposed to the cooperative condition.

The final two experimental studies didn't support the previously noted sex differences. Studies 1 - 3 showed that men had a higher pain tolerance than women, especially in the presence of a male friend. However, in study 4 (same-sex and opposite-sex friends completing the manipulation task) these sex effects were not found suggesting that when the context is manipulated, there are no longer differences in the way men and women report pain. This suggests that in environments whereby gendered contexts are manipulated, men and women might adapt their pain reporting to conform to perceived stereotypes. The key example within this study is that competitiveness elicits more masculine behaviours like stoicism and an unwillingness to report pain, and within competitive environments women can be as competitive as men (Bateup et al., 2002); the gendered context can provide an explanation as why there are no longer sex differences found in the pain tasks.

Interestingly, this gender context effect may depend on whether friends or strangers are present. In study 5, which involved strangers, a different pattern of results was found. For pain tolerance on the cold pressor task, women had a higher pain tolerance in the competitive condition, especially if the stranger observer was male. This is the only study in this entire PhD that has found women to have a higher pain tolerance than men. However, this interesting finding was not reflected in the pressure-pain threshold reporting's for the algometer; instead, men had a higher pressure-pain threshold than women, especially in the competitive condition. These results highlight the importance of gender context, and that in a competitive environment the nature of stranger dyads is important. It would be interesting to explore stranger dyads further in the context of competitiveness or cooperativeness to test whether this finding is unique to this study.

When considering the differences between men and women, what these studies collectively suggest is that it is important to consider the context in which the pain is experienced in. If the context could be perceived to be gendered, or to draw upon certain stereotypes like stoicism or social support, it is potentially important to consider gender in addition to sex differences. There are many different ways gendered context can be assessed, for example, more experimental based studies could manipulate gender context further or measure gender expectations (Robinson, Gagnon, Riley, & Price, 2003; Wise et al., 2002b). In a more applied setting, gendered contexts could be investigated within real-world competitive environments as this would be closely linked to the virtual gaming environment used in studies 4 and 5.

8.2.4. The importance of considering sex differences and the dyadic relationship

Throughout this thesis I have focused on both dyadic relationships and sex differences. This section will reflect on how they may interact. I wanted to recruit dyads along a continuum of closeness, with strangers at one end and romantic partners at the opposite end, and friends spanning the middle section, to investigate both different dyadic relationships but also the nature of the relationships.

Men and women interact in different ways, and may respond differently to specific dyadic relationships, such as friends (Oswald, Clark, & Kelly, 2004). For example, I found that in men, pain tolerance was lowest when accompanied by a stranger, but highest when a male friend was present. However, in women, pain tolerance was lowest when a romantic partner was present, and highest when a same-sex friend was present. This suggests that not only does the sex of the person experiencing pain and the observer matter, but also the nature of the relationship between them. These results also highlight that pain tolerance does not have a linear relationship with closeness; it is not as simple as assuming that as closeness increases, so does pain tolerance for both men and women. However, instead, the overarching finding from studies 1 – 3 suggests that friends may have the biggest impact on pain reporting.

In study 1, the results highlighted that the participants with a friend present (and by coincidence these were all same-sex friends) had a higher pain tolerance

than with a stranger. However, the results from study 2 and 3, suggest that the effect of having an opposite-sex friend present may also have an impact on how pain is reported. Therefore, when reconsidering the results of study 1, it may be suggested that this large effect of (coincidentally, same-sex friends) friends may not have been found if the friend's condition was also made up of opposite-sex friend dyads. Given the differences in same-sex and opposite-sex friends, and no differences between opposite-sex friends and heterosexual romantic partners, future research could further this series of experimental studies by investigating whether there are any differences in same-sex romantic partners and same-sex friends. This would add further detail to the continuum of closeness, and would provide further details of why pain is tolerated most when a same-sex friend is present.

Interestingly, the results from studies 4 and 5 also offer some insights into the interpretation of the first three studies. When placing friends in either a cooperative or competitive context, results from study 4 did not replicate the findings from study 2. This highlights that context can play a role in pain reporting, and on this occasion, may dominate, possibly due to the gendered context around competitiveness and cooperativeness. In these last two experimental studies, it was highlighted that the role of context, e.g. the nature of relationships and gender context, may have previously been underestimated in experimental research.

When considering the results of all of the studies, the importance of context and nature of the relationships is emphasised further; firstly, women have a higher pain tolerance when a stranger is present than when either a romantic partner or an opposite-sex friend is present, highlighting the differences in men and women, as well as dyadic relationships. This result can be carried across the final two studies, and suggests that overall, the unique relationship with a stranger is enough to make women tolerate more pain.

8.3. Social contextual influences on pain: a theory of relationship and sex differences

I have replicated findings that show men have a higher pain tolerance than women, but these general main effects are then eliminated when components of friendship are manipulated, including competitiveness and cooperativeness. The social context of pain is a rapidly developing area of interest, and this thesis has

presented new and novel findings to sex differences and the social context of pain. Based on the literature already known, and the studies included in this thesis, I think it is important to continue to research sex differences. Sex and gender are terms that are often used interchangeably in the literature, but are defined very differently. This PhD has specifically focused on sex differences, but gender-based contexts were applied in the final two studies. It would be of interest to expand on the work done in this thesis to investigate how gender differences as a whole can have an impact on pain. Gender is much more context specific, so it would be of interest to see if there are any gender differences in the experience of pain, and whether the differences are still apparent when the dyadic relationship is manipulated.

The first three studies focused on dyadic relationships and whether there was a difference in how pain was communicated, and the second half covered the manipulation of competitive and cooperativeness and how it impacted on pain. However, there is still a need for more of a focus on the social and contextual influences on the reporting of pain. In Chapter 1, I outlined the Social Communication Model of Pain (Craig, 2009), which highlights that the communication between two people during a pain experience. Overall, this PhD thesis continues to build on this Model and adds knowledge on how interpersonal influences can have an impact on pain experiences within an experimental setting. There are a few aspects of the Social Communication Model that I have specifically addressed in this thesis, including: the importance of considering the nature of the relationship; the context whereby pain is experienced; and, sex differences.

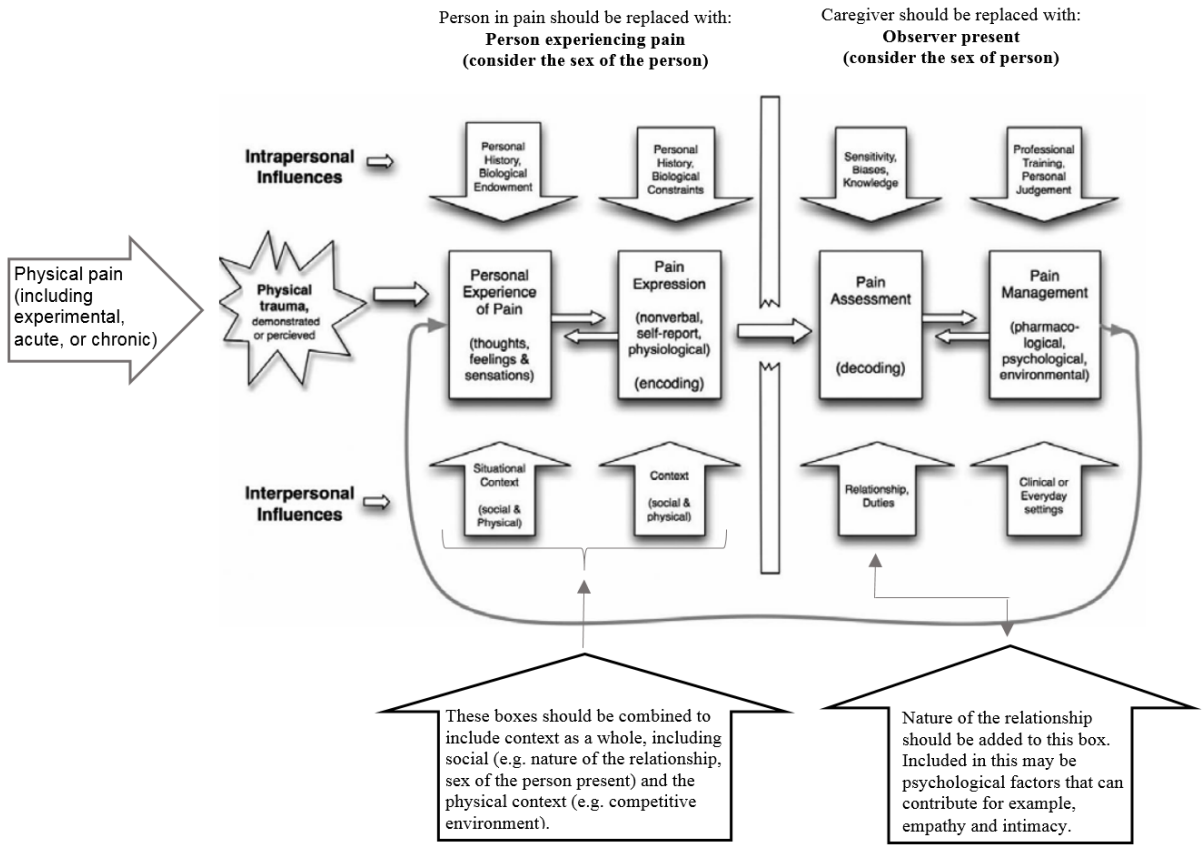

Figure 8.1. The Social Communication Model (Craig, 2009) has been adapted to highlight how this PhD thesis has contributed to the theory. The Model was taken from the original article: Craig, K. (2009). The social communication model of pain. *Canadian Psychology/Psychologie canadienne, 50*(1), 22-32. Replicated the original with permission.

Throughout this PhD thesis, I have considered the dyadic relationship in each experimental chapter. In all Chapters, the dyadic relationship has been carefully selected and there have been differences in results, depending on the type of relationship. For example, when referring back to the continuum of closeness presented in Chapter 1, I have presented multiple findings. Participants in the friends group had a higher pain tolerance than strangers, and when focusing on friends, the biggest difference was a same-sex friends (especially male-male dyads). Finally, there were no differences between friends and romantic partners. When considering these findings and matching them to Craig's (2009) Communication Model, this thesis suggests that the dyadic relationships needs to be considered further. In Craig's Model, the relationship is between the person in pain and their caregiver,

however, this PhD thesis suggests that psychological factors that contribute to relationships should be considered, for example, closeness, levels of empathy, and intimacy. By considering the psychological factors that impact on dyadic relationships, a greater understanding could be gained about how someone may encode their pain, before expressing it.

Additionally, this thesis also highlights that context is important when considering pain experiences. Craig's Model has context as one of the interpersonal influences on the person in pain. While I completely agree that this is where it should be placed in the Model, future research should not disregard context, and should consider it as a much broader concept. For example, this PhD thesis manipulated context and found very different results when doing so. In the first three studies, there were consistent results found with regards to the presence of someone else and sex differences. However, when the context was manipulated to be more competitive or cooperative, I failed to identify consistent results; thus, context is important in experiencing pain and should be considered as one of the social interpersonal influences on pain.

Finally, throughout this PhD thesis I have considered sex differences. At many points throughout this thesis, I have managed to replicate previous findings that men have a higher pain threshold and tolerance than women. However, when considering sex differences within a gendered context (i.e. in the final two studies of this thesis), the previously noted sex differences where no longer consistent. This highlights the importance of continuing with research on sex differences on pain, and potentially with the inclusion of gender differences. Craig's (2009) model doesn't specifically address sex differences, and I would suggest that based the findings from this thesis, sex differences should always be considered, especially as they can help inform results. By including both sex and gender differences, a richer Model could be created, which would allow for more detailed understanding in how and why pain is experienced differently between men and women.

8.4. Limitations

In the discussion section of each of the empirical chapters, the specific limitations from each study were addressed. However, there are several broader limitations.

8.4.1. Presence of the experimenter

Firstly, the presence of the experimenter is an acknowledged limitation in the use of experimental pain induction paradigms. Extensive research has been conducted that focuses on the presence of an experimenter during laboratory based studies, and whether the sex of the experimenter can also have an impact on the outcome of the study (Sanford 2002). The evidence can be a little mixed, but overall research has shown that the sex of the experimenter can impact on pain reports (Aslaksen et al., 2007; Gijsbers & Nicholson, 2005). Specifically, when the experimenter was perceived to have a professional status, there was an increase in pain tolerance on the CPT (Kallai, Barke, & Voss, 2004). Kallai et al (2004) found when the participant perceived the experimenter to be of a higher professional status or in an authoritative position, they had an increased tolerance to pain during the cold pressor task, due to an increase in the willingness to endure the pain from the cold pressure task for up to three minutes. In addition to this, Kallai et al., (2004) also found that pain tolerance was higher when the experimenter was of the opposite-sex to the participant. Other research also reports similar results; there are clear sex differences present, with males having a higher pain tolerance on the cold pressor task than females, particularly when the experimenter is female (Aslaksen, Myrbakk, Hoifodt, & Flaten, 2007; Gijsbers and Nicholson, 2005; Levine & De Simone 1991). Interestingly, female participants are not influenced by the sex of the experimenter as much as male participants, which coincides with the findings from the first half of this thesis: women's reporting of pain is less likely to fluctuate depending on who they are telling, whereas men will suppress their pain, depending on the social setting. However, there are also some studies that fail to identify any effects of the sex of the experimenter, or produce inconsistent findings (Vigilet et al., 2014; Weisse, Foster, & Fisher, 2005).

The above literature indicates is that the presence, as well as the sex of, an experimenter observer can have an effect. While I have noted that this could be considered a limitation throughout this thesis, it is important to highlight that the same experimenter was used throughout the whole of the data collection for this thesis. Thus, even though there may have been potential experimental effects, the experimenter was consistent. However, the replication of results with independent participants highlights that the robust methodology used, and that while the sex of the experimenter should be acknowledged, it had minimal impact throughout this PhD. There are two ways to overcome this limitation; an ideal paradigm would involve the experimenter being behind a mirror which enabled them to control the pain induction tasks, but remaining out of view for the participants. Additionally, another option is to use both a male and female experimenter to either both be present, or to test half of the participant each. However, both of these adjustments would result in a different experimental paradigm, and this is something which could not be achieved during this PhD.

8.4.2. The manipulation task

The second consideration is the manipulation game task for competition and cooperation. The manipulation task was used to manipulate the competitiveness and cooperativeness felt by the participants completing the pain induction tasks. In the design phase many different tasks were explored as options for the manipulation, but after completing a search of the literature a sporting game emerged as the best way of manipulating the key components of friendship: competitiveness and cooperativeness. Previous research has indicated that players do not need to engage with a games console for long periods of time before participants report perceived changes, with the optimal time to play on a games console in order to feel the effects of competitiveness as low as ten minutes of game time. A tennis based game was used as it's a popular choice in the manipulation literature, particularly when trying to measure competitiveness between two people. Therefore, by asking participants to play a tennis game, a doubles match (cooperativeness manipulation) and a singles match (competitiveness manipulation) were employed to manipulate the conditions required.

One of the perceived limitations to using a games console, is that it isn't an accurate way of manipulating competitiveness or cooperativeness as the player is not as involved as they would be if they were physically playing tennis, for example. However, the results from the analysis indicated the tennis-based game successfully induced increased competitiveness and cooperativeness, in the respective game conditions. Even though the competitive and cooperative manipulation appeared to work immediately after playing the game, I cannot be sure that the manipulation effect carried through to the pain induction tasks in Chapter 6, which focused on friends. The results in Chapter 7, the mean for competitiveness was higher after the pain induction tasks than at baseline, but this was not a consistent finding, so should be interpreted with caution. However, the results of the competitiveness and cooperativeness manipulation task suggest that the games console was a successful was of inducing competitiveness and cooperativeness immediately.

Therefore, when competitiveness and cooperativeness are experimentally manipulated in future studies, it is important to employ a manipulation task that could have a stronger effect on participants so better conclusions and more certainty can be gained from the analysis. This could be achieved by allowing participants to play longer matches, or by changing the games console game. However, given that the means were higher post-pain induction tasks than at baseline, I am confident that Virtua Tennis 4 is an appropriate method for manipulating competitiveness and cooperativeness.

8.4.3. The environment the studies were conducted in

A third limitation is the experimental nature of the pain studies. For each of the five experimental studies a controlled laboratory setting was used. There were two different methodologies used, but both focused on the social context of pain; the same methodology was used in the first three experimental studies, and then a slightly different experimental manipulation methodology for competitiveness and cooperativeness was employed for the final two studies. Throughout the whole PhD, two different pieces of pain induction equipment were used: the cold pressor task and the algometer. These two pieces of equipment are widely used, and are recognised in the field of experimental pain research as robust methods for

examining pain threshold and tolerances, however, some caution needs to be applied when considering the interpretation of experimental results.

While this PhD replicated previously found sex differences, and then developed a new competitive manipulation task, I have been wary of the wider implications as chronic pain, naturally occurring pain, and experimental pain induction tasks are very different. At present, the findings allow comparisons to be made to other experimental paradigms, but not to clinical populations such as chronic pain patients. Thus, there are two logical next steps; 1) is to devise a paradigm which can investigate interpersonal characteristics in the context of pain in an applied environment, for example, a naturally competitive environment like sport, and 2) the other logical pathway to pursue is to continue with an experimental paradigm but adopt a more robust method for manipulating cooperativeness and competitiveness to see if the results from this PhD thesis can be replicated.

Even though more applied research is necessary in order for researchers to gain more of an understanding on the social influences on the reporting of pain, I do firmly believe that the research conducted in this PhD provides a strong foundation of knowledge regarding interpersonal relationships and how they impact on pain.

8.4.4. Recruitment

The complete spectrum of different types of dyadic relationship has now been investigated in this PhD thesis, but there are two demographic based limitations that should be addressed. Firstly, the participants were mainly recruited from an undergraduate cohort, with a low mean age. Thus, the types of friendships that have been explored are likely to be relatively new friendships, especially in those participants who were recruited using the recruitment scheme, as they will be in their first year at the University. In addition, and more specifically, the participants in the romantic partner condition were in relatively new relationships. The average length of relationship was approximately three years, but there was a large standard deviation. Observers from couples that have been together longer may have a different impact on pain, which would be worth considering. By replicating the methods of this study in older adults who have been in a relationship for a longer period of time, more direct links could be made between the impact on a romantic

partner being present, and the previous literature based upon social support and pain in older adults.

8.5. Potential real-world impact

It is important to consider the potential impact of this PhD research, and what the key findings might mean if they translate to real-world situations. This section will consider some of these situations, including individuals living with chronic pain and pain management, competitive environments whereby injury occurs, and where observers of pain are particularly important, such as in the case of birthing partners. I should acknowledge that this is a somewhat speculative section, and approached with some degree of caution, but still provides an interesting direction for future work. I will look at each of these subtopics individually below.

8.5.1. Individuals living with acute and chronic pain

This thesis has highlighted the importance of types of dyadic relationships within adult relationships. This PhD thesis has outlined how, not only do different dyadic relationships impact on pain reporting, but the nature of the relationship is also an important factor. It would therefore be worth considering the impact this may have within other dyadic relationships present in adults, e.g., in healthcare settings, such as healthcare professional and patient interactions. Research has previously shown that healthcare professional-patient dyads are important in children and adolescents (Vervoort et al., 2011c), but there is limited research conducted in adults (Yorkston et al., 2010). My research builds upon the dyadic methodology previously studied in experimental settings with adults (Kallai et al., 2004; Levine & De Simone, 1991; Vigil et al., 2014a), and indicates that healthcare professional-patient dyads may be important in adults, as well as children. For example, my research has shown that the nature of everyday relationships in adults have an impact on how pain is reported, so the nature of relationships within a healthcare setting may not be unique to children. Additionally, the results in this thesis suggest that the level of closeness within the dyad is important, and differing levels of closeness may have an impact on how pain is reported. Within a healthcare professional-patient dyad, the level of closeness may also be connected to levels of trust and confidence between the healthcare professional and patient. This is potentially an important dyadic

relationship, and the nature of it, to consider; the outcome of a consultation between the healthcare professional and patient may be different if the dyad are close, or not, which may have a long-term impact on treatment.

In addition to healthcare professional-patient interactions, other dyadic interactions include the effect of other people present during a health consultation, for example, the presence of a friend or a spouse. The findings from this PhD have highlighted that pain is better tolerated when a friend is present. Thus, it is possible that an observer may have an effect during a General Practitioner consultation; if pain is suppressed due to the presence of another person, in particular a friend, this may have a negative impact on the treatment the patient may receive (Raftery et al., 1995; Veldhuijzen et al., 2013). Alternatively, if the patient is accompanied by someone who they typically exaggerate their pain in front of, this could also have detrimental effects on their treatment as they may receive the inappropriate amount of analgesics for the pain they are experiencing.

A third example could be to explore whether same- or opposite-sex friends provide better support in a painful setting. The findings from study 2 suggest that pain is tolerated more when a friend of the same-sex is present, so it would be interesting to assess the impact same-sex friends have within a caring role. For example, individuals living with chronic pain may attend a pain management programme, and these are typically attended by the person with chronic pain and a family member (Eccleston, Malleson, Clinch, Connell, & Sourbut, 2003). During a pain management programme, patients are taught coping strategies for their pain, as well as other aspects such as physical exercises to help alleviate the pain. It would be of interest to see whether the outcome of the pain management programme is different when the individual experiencing pain is supported by a friend of the same-sex, as opposed to a family member such as a parent. Based on the results from this PhD thesis, it would be interesting to assess the outcomes of a pain management programme when supported specifically by a friend; I have found that pain is tolerated more in the presence of a friend, but yet friends also provide social support, so the context of the programme would be an important contributing factor to pain reporting.

As well as chronic pain, individuals experiencing acute pain, for example post-surgical pain, may also report their pain differently, depending on who is

present. Post-surgical patients, who have typically undergone replacement surgery for knees and hips, are encouraged to attend group sessions in the form of therapy and/or rehabilitation (Moffet et al., 2004). Similar to other clinical settings, these sessions often require the person experiencing pain to take someone with them for support. In line with the results from this PhD, it would be important to consider whether or not the therapy and/or rehabilitation sessions should be attended by partners/friends/relatives. The results from this thesis suggest that depending on the person attending with the patient, this may affect how pain is reported. Given the consistent sex differences found throughout this thesis, it may also be worth considering whether or not same-sex or opposite-sex group therapy sessions would be more or less beneficial to the patient.

In summary, the dyadic relationships present in the lives of both acute and chronic pain patients is important to consider. I have outlined some examples of when the dyadic relationship may be important.

8.5.2. Competitive environments

While the last two studies in this PhD focused on competitive and cooperative environments via a virtual tennis game, it would be of interest to see if these results can be replicated in a real-world setting. For example, real-world sporting environments are highly competitive and often team based (cooperative), so it would be of interest to investigate whether the findings from the experimental paradigm can be replicated. Sporting environments are naturally competitive as by default, all players are competing to win. However, team player sports are also cooperative, to a certain extent. Team player sports such a football, rugby and hockey require the players to all cooperate and work as a team to try and score more points against the opponents. The virtual sporting environment used in this thesis was selected carefully; the singles tennis game evoked more competitiveness than cooperativeness, and the doubles tennis game against the games console evoked both competitiveness to win and cooperativeness to work together. By using a virtual tennis game, I was able to target both single player and team player sports, which is applicable to real-life sporting environments.

Experimental based studies also suggest athletes will have a higher pain tolerance when experiencing high levels of competitiveness, as opposed to

individuals who are not considered athletes (Johnson, Stewart, Humphries, & Chamove, 2012; Tesarz, Schuster, Hartmann, Gerhardt, & Eich, 2012). Previous research as indicated that pain may be expressed differently, depending on whether the player is a single player or playing as part of a team; in single athlete sports, pain is more likely to the 'played through', even though athletes are aware of the consequences (Deroche, Woodman, Stephan, Brewer, & Le Scanff, 2011). In addition to this, female ballet dancers have the same pain threshold as healthy controls, however, the dancers have the ability to withstand more pain for longer periods of time (Paparizos, Tripp, Sullivan, & Rubenstein, 2005), suggesting that pain threshold may not differ between athletes and non-athletes, but the ability to withstand pain in a single player sport is why pain is tolerated more.

Within team player sports, rugby has had a lot of attention in the context of injuries and pain, purely because it's a contact sport. Despite rugby players being more susceptible to injury, professional rugby athletes often experience commercial or financial pressures to continue playing, even when injured (Liston, Reacher, Smith, & Waddington, 2006). Based on these findings, and the findings of the research in this thesis, it would be interesting to investigate whether athletes are aware of their ability to tolerate more pain, or their ability to play through the pain. It would also be of value to learn more about how far athletes are willing to push themselves through a pain barrier in order to win. Given that pain is the body's natural response to get you to stop engaging, it is important that all athletes know when they're at their limit and may injure themselves. Based on the findings from this thesis, it would be of interest to specifically focus on singles and doubles matches in tennis, which will enable replication of the results but also allow for dyads vs alone players to be tested in a real-world setting. It could be hypothesised that pain tolerance would be highest in the highly competitive environments, but there may not be any sex differences present in the athletes due to the more masculine environment created by competition.

The impact of team players may have a critical role in injury; if pain is tolerated more in a competitive environment, athletes may be more inclined to suppress their pain in order to achieve the goal of winning against their opponents (Kleck et al., 1976). However, on a long-term basis, this may be detrimental to the athlete's health and performance. Reflecting on the results from this thesis, it is

likely that athletes would tolerate more pain, and women would be more likely to tolerate pain against an opponent (i.e. a stranger) as opposed to their team player (Gneezy et al., 2003). Pain tolerance in the context of a sporting injury may also be reported differently, depending on who the athlete is reporting the pain to; when reporting to a team player, previous findings suggest that the pain may be tolerated more if the person is of the same-sex, as opposed to a team mate of the opposite-sex.

Overall, the impact my research could inform those working in sporting environments, with suggestions that pain is tolerated more in a competitive environment, and this could ultimately lead to injury. Awareness of this is important for the health of the athletes, but also it is important for coaches to be aware of the impact of dyadic relationships, especially when considering recovery like rehabilitation. It would be of interest to gain more of an understanding of the differences between pain experienced as part of an injury and pain experienced during rehabilitation, and whether athletes are less likely to tolerate rehabilitation pain due to the lack of competitiveness in the environment. This would allow differentiations to be made between competitive environments, and at what point does the competiveness within an athlete impact on their pan.

In summary, there is still a lot to learn about real life sporting environments and the impact competitiveness can have on pain. However, the findings from this thesis indicate that there may be differences in pain expression between single player and team player athletes, as well as how pain would be reported to a team player, coach, or stranger opponent. There is still a lot of research to be conducted but the experimental studies conducted in this thesis give a brief oversight as to how athletes may report their pain.

8.5.3. Birthing partners and dental procedures

The final real-world application of findings from this PhD that I will consider here, relates to situations where another person is present during a real-world painful situation. One good example where this may be relevant is during childbirth, and the role that birthing partners may have in how pain is expressed. The results from the first part of my thesis (studies 1-3) suggest that having someone else present will increase pain tolerance, so in the context of childbirth, having someone else present might result in being able to tolerate the pain more. In some situations, spouses may

not be the most appropriate birth partner due to them not being able to cope with seeing their partner in so much pain during childbirth (Ip, 2000; Kennell, Klaus, McGrath, Robertson, & Hinkley, 1991; Nolan, 1994). The presence of the spouse has also been perceived to result in a longer birth; women who had their partner present consumed more analgesics due to perceived lack of social support, and as a result of not experiencing natural pain for contractions, the birthing labour was longer (Ip, 2000; Thomson & Hillier, 1994). What my research suggests is that whilst fathers are often present, same-sex friends may also be worth considering as birthing partners. If pain tolerance is greater when accompanied by friends, it may be plausible to encourage mothers to think of different options for birthing partners, including same-sex friends. Collecting further data on birthing partners would be an interesting direction for future studies.

Other real-world pain example of where my work may have an impact is when considering people present during painful procedures, such as undergoing dental treatment. Dental treatment and procedures other than a regular visit to the dentist are sources of anxiety (Candido, Andreatini, Zielak, de Souza, & Losso, 2015; Mendoza-Mendoza, Perea, Yañez-Vico, & Iglesias-Linares, 2015), and dental treatment can result in high levels of pain being experienced. However, to my knowledge, there is limited research available on the role of an observer during dental procedures. Recently, it has been understood that a distraction during a dental procedure can result in lower levels of reported anxiety (Horovitz, Roitburd, Abend, Ziskind, & Shechner, 2016). If the results from this thesis can be transferred into real-world settings such as low-risk medical procedures like dental treatment, it is worth considering the accompanying partner present, and whether or not they can provide a distraction to the procedure. My results suggest that a same-sex friend would allow an individual to tolerate more pain.

8.6. Conclusions

In summary, along with clear sex differences in the reporting of pain, pain is communicated differently, depending on who is present. Men had a consistently higher pain tolerance than women, irrespective of the dyadic relationship. However, when the relationship was considered further, the role of a friend had a large impact, especially when the friend was male. Thus, there are characteristics in friendship that

need to be considered further to try and understand why male-male dyads suppress their pain the most. Competitiveness and cooperativeness are two characteristics that are present in friendships, and that can also be linked to expectations and societal norms in the context of pain. Previous research has indicated that societal norms and sex-related expectations can have an impact on how pain is reported, so the next logical part of the these was to manipulate the competitive and cooperatives aspects of friendships within an experimental paradigm. The characteristics were manipulated via a tennis-based game, Virtua Tennis 4, on a PlayStation3. The manipulation task was completed with friends and strangers, and overall, pain tolerance was higher in the competitive condition. This could be due to competitiveness being linked to goal motivation, such as winning, which is why participants had a higher pain tolerance. However, there were no consistent sex differences present. One of the explanations for this could be that men and women have similar levels of self-reported competitiveness, within a competitive environment. Thus, men and women compete at similar levels which would eliminate the sex differences previously established. Based on these findings, there are multiple avenues for future research which can all aid our understanding of the social and contextual influences on the reporting of pain in men and women.

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Appendices

Appendix A: Example of the self-report pain questionnaire given to participants after completing the algometer

Pain Questionnaire - Algometer

How much pain did you experience/feel during the task?
Please mark the line

No pain Worst pain imaginable

_____

SF – MPQ - 2

*This questionnaire provides you with a list of words that describe some of the different qualities of pain and related symptoms. Please put an **X** through the numbers that best describe the intensity of each of the pain and related symptoms you felt during the task. Please use 0 if the word does not describe your pain or related symptoms.*

Throbbing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Shooting pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Stabbing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Sharp pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Cramping pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Gnawing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Hot-burning pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Aching pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Heavy pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tender	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Splitting pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tiring-exhausting	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Sickening	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Fearful	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*

Punishing-cruel	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Electric-shock pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Cold-freezing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Piercing	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Pain caused by light touch	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Itching	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tingling or 'pins and needles'	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Numbness	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*

Appendix B: Example of the self-report pain questionnaire given to participants after completing the Cold Pressor task

Pain Questionnaire – Cold Pressor Task

How much pain did you experience/feel during the task?
Please mark the line

No pain Worst pain imaginable

_____

SF – MPQ - 2

*This questionnaire provides you with a list of words that describe some of the different qualities of pain and related symptoms. Please put an **X** through the numbers that best describe the intensity of each of the pain and related symptoms you felt during the task. Please use 0 if the word does not describe your pain or related symptoms.*

Throbbing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Shooting pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Stabbing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Sharp pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Cramping pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Gnawing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Hot-burning pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Aching pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Heavy pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tender	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Splitting pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tiring-exhausting	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Sickening	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Fearful	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Punishing-cruel	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Electric-shock pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*

Cold-freezing pain	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Piercing	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Pain caused by light touch	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Itching	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Tingling or 'pins and needles'	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*
Numbness	*None*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	*Worst possible*

Appendix C: DASS administered to all participants

DASS	*PID:*	*Date:*

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

1	I found myself getting upset by quite trivial things	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I just couldn't seem to get going	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I had a feeling of shakiness (eg, legs going to give way)	0	1	2	3
8	I found it difficult to relax	0	1	2	3
9	I found myself in situations that made me so anxious I was most relieved when they ended	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting upset rather easily	0	1	2	3
12	I felt that I was using a lot of nervous energy	0	1	2	3
13	I felt sad and depressed	0	1	2	3
14	I found myself getting impatient when I was delayed in any way (eg, lifts, traffic lights, being kept waiting)	0	1	2	3
15	I had a feeling of faintness	0	1	2	3
16	I felt that I had lost interest in just about everything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3

18	I felt that I was rather touchy	0	1	2	3
19	I perspired noticeably (eg, hands sweaty) in the absence of high temperatures or physical exertion	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life wasn't worthwhile	0	1	2	3

Reminder of rating scale:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

22	I found it hard to wind down	0	1	2	3
23	I had difficulty in swallowing	0	1	2	3
24	I couldn't seem to get any enjoyment out of the things I did	0	1	2	3
25	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
26	I felt down-hearted and blue	0	1	2	3
27	I found that I was very irritable	0	1	2	3
28	I felt I was close to panic	0	1	2	3
29	I found it hard to calm down after something upset me	0	1	2	3
30	I feared that I would be "thrown" by some trivial but unfamiliar task	0	1	2	3
31	I was unable to become enthusiastic about anything	0	1	2	3
32	I found it difficult to tolerate interruptions to what I was doing	0	1	2	3
33	I was in a state of nervous tension	0	1	2	3
34	I felt I was pretty worthless	0	1	2	3
35	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3

36	I felt terrified	0	1	2	3
37	I could see nothing in the future to be hopeful about	0	1	2	3
38	I felt that life was meaningless	0	1	2	3
39	I found myself getting agitated	0	1	2	3
40	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
41	I experienced trembling (eg, in the hands)	0	1	2	3
42	I found it difficult to work up the initiative to do things	0	1	2	3

Appendix D: URCS administered to all participants

The Unidimensional Relationship Closeness Scale (URCS)

Instructions: The following statements refer to your relationship with the person present in the room. Please think about your relationship with the person present when responding to the following questions.

Please respond to the following statements using this scale:
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

Statement	***Response***
My relationship with person X is close	
When we are apart, I miss person X a great deal	
Person X and I disclose important personal things to each other	
Person X and I have a strong connection	
Person X and I want to spend time together	
I am sure of my relationship with person X	
Person X is a priority in my life	
Person X and I do a lot of things together	
When I have free time I choose to spend it alone with person X	
I think about person X a lot	
My relationship with person X is important in my life	
I consider person X when making important decisions.	

Appendix E: THE RCI administered to all participants

The Relationship Closeness Inventory

We are currently investigating the nature of interpersonal relationships. As part of this study, we would like you to answer the following questions about your relationship with another person. Specifically, we would like you to choose the person *present (the person observing you or the person you are observing),* and answer the following questions with regards to this person.

With this person in mind, please respond to the following questions:

1. Who is this person? (initial of first name only) ____

a. What is this person's age? ____ What is your age?____
b. What is this person's sex? ____ What is your sex?____

2. Which one of the following best describes your relationship with this person? (Check *only one)*
WORK:
__ co-worker __ your boss / supervisor __ your subordinate
FAMILY:
__ aunt/ uncle __ sister /brother __ parent __ cousin
ROMANTIC:
--- married __ engaged __ living together
__ dating: date only this person
__ dating: date this person and others
FRIEND:
__ close friend (non-romantic) __ casual friend
OTHER:
__ (please specify _____

3. How long have you *known* this person? Please indicate the *number* of years and/ or months
__ years __ months

We would like you to estimate the amount of time you typically spend alone with this person (referred to below as "X") during the day. We would like you to make these time estimates by breaking the day into morning, afternoon, and evening, although you should interpret each of these time periods in terms of your own typical daily schedule. (For example, if you work a night shift, "morning" may actually reflect time in the afternoon, but is nevertheless time immediately after waking.) Think back over the past week and write down the average amount of time, per day, that you spent *alone with* X, *with no one else around,* during each time period. If you did not spend any time with X in some time periods, write __ 0__ hour(s) __ 0__ minutes.

4. DURING THE PAST WEEK, what is the average amount of time, per day, that you spent *alone with* X in the MORNING (e.g., between the time you wake and 12 noon)?

5. DURING THE PAST WEEK, what is the average amount of time, per day, that you spent *alone with* X in the AFTERNOON (e.g., between 12 noon and 6 pm)?

6. DURING THE PAST WEEK, what is the average amount of time, per day, that you spent *alone with* X in the EVENING (e.g., between 6 pm and bedtime)?

Compared with the "normal" amount of time you usually spend alone with X, how typical was *the past week?* (Check one)

_____ Typical _____ Not typical

The following is a list of different activities that people may engage in over the course of one week. For each of the activities listed, please tick all of those that you have engaged in *alone with* X *in the past week.* Tick only those activities that were done *alone with* X and *not* done with X in the presence of others.

In the past week, I did the following activities *alone with* X: (Tick all that apply)

__ did laundry

__ watched TV

__ went to an auction/ antique show

__ attended a non-class lecture or presentation

__ went to a restaurant

__ went to a grocery store

__ went for a walk/ drive

__ discussed things of a personal nature

__ outdoor recreation (e.g., sailing)

__ went to a play

__ prepared a meal

__ went to a museum/ art show

__ planned a party / social event

__ attended class

__ went on a trip (e.g., vacation or weekend)

__ cleaned house/ apartment

__ went to church/religious function

__ worked on homework

__ went to a bar

__ visited family

__ visited friends

__ engaged in sexual relations

__ discussed things of a non-personal nature

__ went to a clothing store

__ talked on the phone

__ went to a movie

__ ate a meal

__ participated in a sporting activity

__ went to a department, book, hardware store, etc.

__ played cards/board game

__ attended a sporting event

__ exercised (e.g., jogging, aerobics)

__ played music/ sang

__ went on an outing (e.g., picnic, beach, zoo, winter carnival)

__ wilderness activity (e.g., hunting, hiking, fishing)

__ went to a concert

__ went dancing

__ went to a party

The following questions concern the amount of influence X has on your thoughts, feelings, and behaviour. Using the 7-point scale below, please indicate the extent to which you agree or disagree by writing the appropriate number in the space corresponding to each item.

1	2	3	4	5	6	7
I strongly Agree						I strongly Disagree

__ X will influence my future financial security.

__ X does *not* influence everyday things in my life.

__ X influences important things in my life.

__ X influences which parties and other social events I attend.

__ X influences the extent to which I accept responsibilities in our relationship.

__ X does *not* influence how much time I spend doing household work.

__ X does *not* influence how I choose to spend my money.

__ X influences the way I feel about myself.

__ X does *not* influence my moods.

__ X influences the basic values that I hold.

__ X does *not* influence the opinions that I have of other important people in my life.

__ X does *not* influence when I see, and the amount of time I spend with, my family.

__ X influences when I see, and the amount of time I spend with, my friends.

__ X does *not* influence which of my friends I see.

__ X does *not* influence the type of career I have.

__ X influences or will influence how much time I devote to my career.

__ X does *not* influence my chances of getting a good job in the future.

__ X influences the way I feel about the future.

__ X does *not* have the capacity to influence how I act in various situations.

__ X influences and contributes to my overall happiness.

__ X does *not* influence my present financial security.

__ X influences how I spend my free time.

__ X influences when I see X and the amount of time the two of us spend together.

__ X does *not* influence how I dress.

__ X influences how I decorate my home (e.g., dorm room, apartment, house).

__ X does *not* influence where I live.

__ X influences what I watch on TV.

Now we would like you to tell us how much X affects your future plans and goals. Using the 7-point scale below, please indicate the degree to which your future plans and goals are affected by X by writing the appropriate number in the space corresponding to each item. If an area does not apply to you (e.g., you have no plans or goals in that area), write a 1.

1 2 3 4 5 6 7
I strongly disagree I strongly agree
Agree Disagree

__ my vacation plans

__ my marriage plans

__ my plans to have children

__ my plans to make *major* investments (house, car, etc.)

__ my plans to join a club, social organization, church, etc.

__ my school-related plans

__ my plans for achieving a particular financial standard of living

Appendix F: IRI administered to all participants in the last two empirical studies

INTERPERSONAL REACTIVITY INDEX

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate letter on the scale at the top of the page: A, B, C, D, or E. When you have decided on your answer, fill in the letter on the answer sheet next to the item number. READ EACH ITEM CAREFULLY BEFORE RESPONDING. Answer as honestly as you can. Thank you.

ANSWER SCALE:

A	B	C	D	E
DOES NOT DESCRIBE ME WELL				DESCRIBES ME VERY WELL

1. I daydream and fantasize, with some regularity, about things that might happen to me.

2. I often have tender, concerned feelings for people less fortunate than me.

3. I sometimes find it difficult to see things from the "other guy's" point of view.

4. Sometimes I don't feel very sorry for other people when they are having problems.

5. I really get involved with the feelings of the characters in a novel.

6. In emergency situations, I feel apprehensive and ill-at-ease.

7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it.

8. I try to look at everybody's side of a disagreement before I make a decision.

9. When I see someone being taken advantage of, I feel kind of protective towards them.

10. I sometimes feel helpless when I am in the middle of a very emotional situation.

11. I sometimes try to understand my friends better by imagining how things

look from their perspective.

12. Becoming extremely involved in a good book or movie is somewhat rare for me.

13. When I see someone get hurt, I tend to remain calm.

14. Other people's misfortunes do not usually disturb me a great deal.

15. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.

16. After seeing a play or movie, I have felt as though I were one of the characters.

17. Being in a tense emotional situation scares me.

18. When I see someone being treated unfairly, I sometimes don't feel very much pity for them.

19. I am usually pretty effective in dealing with emergencies.

20. I am often quite touched by things that I see happen.

21. I believe that there are two sides to every question and try to look at them both.

22. I would describe myself as a pretty soft-hearted person.

23. When I watch a good movie, I can very easily put myself in the place of a leading
character.

24. I tend to lose control during emergencies.

25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while.

26. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.

27. When I see someone who badly needs help in an emergency, I go to pieces.

28. Before criticizing somebody, I try to imagine how I would feel if I were in their place.

Appendix G: GIS administered to all participants in the last two empirical studies

Goal Interdependence Scale

On a Likert Scale 1 (strongly disagree) – 5 (strongly agree) please rate each item on the questionnaire. In this instance, *your partner* is the person present with you in the room.

My partner and I "swim or sink" together.

My partner and I want each other to succeed.

My partner and I seek compatible goals.

When my partner and I work together, we usually have common goals.

My partner structures things in ways that favour their goals rather than my goals.

My partner and I have a "win–lose" relationship.

My partner and I like to show that we are superior to each other.

My partner's goals are incompatible with my goals.

My partner gives high priority to the things they want to accomplish and low priority to the things we want to accomplish.

My partner and I each "do my own thing."

My partner likes to be successful through their own individual work.

My partner and I work for our own independent goals.

My success is unrelated to my partner.

My partner is most concerned about what they accomplish when working by themselves.

Appendix H: VAS scores for Chapter 6

VAS for competitiveness

1. How competitive did you feel while playing the PlayStation game?

_____

Not at all competitive Very competitive

VAS for cooperativeness

1. How cooperative did you feel while playing the PlayStation game?

_____

Not at all Cooperative Very Cooperative

Appendix I: VAS scores for Chapter 7

VAS for competitiveness – Pre game and pain

2. Mark on the scale how competitive you feel now

_____

Not competitive at all Very competitive

VAS for cooperativeness - Pre game and pain

2. Mark on the scale how cooperative you feel now

_____

Not Cooperative at all Very Cooperative

VAS for competitiveness – Post game, pre pain

1. Mark on the scale how competitive you feel now

_____

Not competitive at all Very competitive

2. Did you feel competitive while playing the PlayStation game?

_____

Not at all competitive Very competitive

VAS for cooperativeness – Post game, pre pain

1. Mark on the scale how cooperative you feel now

_____

Not Cooperative at all Very Cooperative

2. Did you feel cooperative while playing the PlayStation game?

_____

Not at all Cooperative Very Cooperative

VAS for competitiveness – post pain

3. Mark on the scale how competitive you feel now

_____

Not competitive at all Very competitive

4. Did you feel competitive while playing the PlayStation game?

_____

Not at all competitive Very competitive

VAS for cooperativeness – post pain

3. Mark on the scale how cooperative you feel now

_____

Not Cooperative at all Very Cooperative

4. Did you feel cooperative while playing the PlayStation game?

_____

Not at all Cooperative Very Cooperative