

**Images of pain:
Exploration of the characteristics and
functions of pain-related mental imagery
in chronic pain**

Thomas Gosden

**D.Clin.Psychol.
The University of Edinburgh
2008**

Abstract

Introduction

A recent study by Potter *et al.* (in submission) reported that many chronic pain sufferers experience a spontaneous mental image of their pain, and that these individuals also report higher levels of anxiety and depression. However, little is known about the nature of pain-related mental imagery or the role it might have in chronic pain problems.

Research Aims

This project aimed to replicate these findings with a larger sample, and to discover more about the characteristics of pain-related mental imagery. It also aimed to explore the possible function of mental imagery in inducing physiological arousal and negative emotional reactivity.

Methodology

The research consisted of two discrete studies. In the first study, questionnaire measures of mental imagery, pain self-report, depression, anxiety, and use of imagery in everyday life were obtained from a naturalistic sample of chronic pain sufferers ($N=105$). The second study interviewed fourteen participants who reported experiencing pain-related mental imagery. These participants were also asked to intentionally generate their image and subjective measures of physiological and emotional reactivity were recorded.

Results

A significant proportion (40%) of participants reported experiencing pain-related mental imagery. Those who did also reported significantly higher levels of depression, though a trend towards higher levels of anxiety was not statistically significant. Mental images were predominately reported to be distressing, to occur frequently (at least every day), to interfere with daily living, to be longstanding (on average of three years duration), and to be largely stable over time. The majority of participants who were asked to intentionally self-generate their image during interview reported increases in physiological arousal and negative emotional reactivity.

Discussion

Experiencing a mental image of pain is a common phenomenon among chronic pain sufferers. Furthermore, the images experienced are long-standing, stable, and appear to be linked with physiological and negative emotional reactivity. It therefore seems possible that these images have a role in psychological adjustment to chronic pain for some sufferers and may contribute to long-term distress and disability. These findings suggest that a greater understanding of pain-related mental imagery may contribute to the psychological assessment and treatment of chronic pain sufferers.

Table of Contents

Abstract	1
Acknowledgements	6
Introduction	7
Chronic pain.....	7
Definition of chronic pain.....	7
Prevalence and impact of chronic pain.....	9
Historical developments in the understanding of pain.....	10
Key factors in development and maintenance of chronic pain.....	13
Psychosocial management of chronic pain.....	16
Mental imagery.....	19
Defining “mental imagery”.....	19
General psychological research into mental imagery.....	20
Mental imagery in psychological disorders.....	24
Mental imagery in chronic pain.....	31
Hypotheses.....	41
Study one: Questionnaire Study	42
Methodology.....	42
Results.....	50
Study two: Semi-structured Interview Study	65
Methodology.....	65
Results.....	71
Discussion	85
Summary of findings.....	85
Strengths and limitations of the project.....	87
Interpretation of findings.....	90
Imagery prevalence.....	90
Mental imagery themes.....	92
Presence of mental imagery and links with depression and anxiety.....	94

Presence of mental imagery and links with pain ratings.....	96
Presence of mental imagery and use of imagery in everyday life.....	98
Physiological, emotional and pain reactivity	99
Links between imagery characteristics and physiological, emotional and pain reactivity to image.....	101
Theoretical implications.....	103
Imagery as a form of pain-related cognition.....	103
Understanding the role of mental imagery in chronic pain.....	103
Clinical implications	105
Assessment of mental imagery.....	106
Imagery interventions.....	106
Future research directions	108
References	111

Appendices

Appendix 1: Letter of ethical approval
Appendix 2: Letter of invitation to participants
Appendix 3: Participant information sheet
Appendix 4: Chronic Pain Mental Imagery Questionnaire
Appendix 5: McGill Pain Questionnaire- Short Form
Appendix 6: Depression, Anxiety, and Positive Outlook Scale
Appendix 7: Spontaneous Use of Imagery Scale
Appendix 8: Thematic analysis of imagery descriptions
Appendix 9: Interview response option materials
Appendix 10: Interview schedule
Appendix 11: Verbal cognitions associated with mental image

Word Count- 22,451

Acknowledgements

I am deeply indebted to the participants who gave up their time to take part in this study, and who were willing to share their experiences with me. I hope this work might go some way to repaying that debt by contributing to a greater understanding of the experience of living with chronic pain.

I am also very grateful to the Consultants in Anaesthesia and Pain Medicine at the Chronic Pain Service for their assistance in recruitment, and to the administrative staff within the Service for their invaluable help with the practical management of this project.

Both Paul Morris and David Gillanders deserve a great deal of credit and thanks for their guidance as academic and clinical supervisors. In particular, I would like to thank Paul for his advice on resolving methodological issues and for his feedback on drafts of this thesis, and David for his limitless enthusiasm and open discussion of the possibilities and challenges inherent in the study of mental imagery.

Finally, I would like to thank my family and friends for their support and, most of all, I'd like to thank my girlfriend, Jenny, for her practical help and for her love, support, and tolerance during the times I have been preoccupied with my work, and have had less time to spend with her than we both would have liked.

Introduction

Chronic pain

Definition of chronic pain

The experience of pain is an integral part of human existence, and something that everyone is familiar with to a greater or lesser degree in their own life. Although it seems that we have a shared understanding of what pain is, and we may believe we understand what other people mean when they say they are in pain, if we are asked to describe exactly what pain is this task proves surprisingly difficult. When we consider pain more closely it becomes clear that it is a highly complex and multi-faceted phenomenon involving physiological and psychological factors. In recognition of this, the International Association for the Study of Pain currently defines pain as:

”An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage..... Pain is always subjective..... Many people report pain in the absence of tissue damage or any likely pathophysiological cause; usually this happens for psychological reasons. There is usually no way to distinguish their experience from that due to tissue damage if we take the subjective report. If they regard their experience as pain and if they report it in the same ways as pain caused by tissue damage, it should be accepted as pain. This definition avoids tying pain to the stimulus. Activity induced in the nociceptor and nociceptive pathways by a noxious stimulus is not pain, which is always a psychological state, even though we may well appreciate that pain most often has a proximate physical cause.” (www.iasp-pain.org)

This definition recognises that the experience of pain is subjective and involves psychological factors in addition to sensory stimuli. It also accepts that significant

individual differences exist in pain experience between people in response to similar physical damage.

Pain which persists is termed chronic pain, in contrast with short-lived acute pain which resolves within a shorter time period. Currently, the length of time for which pain must be present before it may be deemed chronic is six months. People who experience chronic pain often present with a wide range of difficulties linked with their pain. Their level of disability is often out of proportion to objective findings on medical investigation and such individuals often report high levels of anxiety, depression, dependence on carers and substance misuse problems. Those presenting with the pattern of difficulties above may also be diagnosed as having a “pain disorder” within the Diagnostic and Statistical Manual- 4th Edition, Text Revision classification system (American Psychiatric Association, 2000). A pain disorder is diagnosed by the presence of pain in one or more anatomical sites which causes clinically significant distress and/or impairment in social, occupational or other areas of functioning. The diagnosis further specifies that psychological factors are believed to have an important role in the development and maintenance of the pain. This diagnosis essentially represents a diagnosis of exclusion once an underlying physical aetiology has been ruled out.

Prevalence and impact of chronic pain

Chronic pain is both a highly prevalent problem, and one which is often associated with significant distress and disability. Verhaah *et al.* (1998), in a review of epidemiological studies of benign chronic pain in the community reported a median prevalence rate of 15%. They report that chronic benign pain is more common among females, the elderly, and those with a low income. More recently, a large-scale European study of chronic pain in the community which included samples from 15 European countries including the UK found that 19% of European adults interviewed ($N=7400$) reported moderate to severe chronic pain at a level which impacted upon their occupational and social functioning (Breivik *et al.*, 2006). In terms of the impact of their chronic pain, 21% had been diagnosed with co-morbid depression due to their chronic pain and 19% had lost a job due to their pain. Similarly, high levels of distress and disability associated with chronic pain have been reported by Smith *et al.* (2001) in an exclusively UK-based community sample. Smith *et al.* (2001) also found that increased severity of chronic pain was associated with greater impairment in employment, activities of daily living, and general health. Although the actual economic cost of chronic pain to society is difficult to assess, Smith *et al.* (2001) suggest that an estimated 45 million working days are lost in the UK due to back pain alone.

Historical developments in the understanding of pain

Because pain is such an integral part of the experience of being human, it has been the subject of philosophical, medical, and religious interest for thousands of years. Ancient Greek philosophers provide what may be the earliest writings regarding the role of pain in human life. Epicurus, born in 371BC, wrote that pleasure and pain were key to human morality, and that the actions of people were driven by the seeking out of pleasure and the avoidance of pain. Indeed, Epicurus believed that a happy life could be achieved through the absence of pain and fear (Rist, 1972). Pain has also been an important feature of many religious practices, and pain-inducing rituals have been used as a means to achieve spiritual or religious ends. For example, self-flagellation, involving whipping of one's own body, remains common to this day among some Christians in the Philippines and Latin America, and many pilgrims attending the Hindu festival of Thaipusam in Malaysia undertake pain-inducing practices involving the piercing of their flesh using hooks or skewers. Interestingly, pilgrims who undertake pain-inducing practices at Thaipusam claim that their spiritual preparation enables them to enter a trance-like state in which pain is not felt (Ward, 1984).

The understanding and relief of pain have been central goals of healers and medical practitioners through the ages, and concepts of pain have changed considerably over time. In medieval times the dominant school of thought believed pain to be the result of an imbalance in the four bodily humours (blood, phlegm, bile, and black bile). The characteristics of pain were believed to vary with both the mixture of these humours and

the location in which this imbalance occurred. Medical treatments for the relief of pain therefore focused upon the correction of this imbalance and involved techniques such as blood letting (www.welcome.ac.uk/en/pain/microsite/history2.html). This model continued to guide medical practice in pain control until Rene Descartes proposed his specificity theory of pain in 1664. Descartes proposed that pain messages travel from the body to the brain in a mechanical fashion, following a fixed pathway from the site of injury. Furthermore, Descartes famously proposed that the workings of the mind and of the body were essentially separate processes. Although the notion of mind-body dualism is now widely recognised to be conceptually flawed, his ideas resulted in significant advances in medical study because it introduced a rationale for studying the human body in a mechanistic way, and paved the way for the use of methods from the natural sciences in the study of the workings of the human body.

The specificity theory of Descartes remained the dominant model for the understanding of pain until the mid 20th century, when observations inconsistent with this model began to emerge in the medical and scientific literature. On returning from treating wounded soldiers during the Second World War, Dr Henry Beecher noted differences in subjective pain reports and morphine use between civilians and wounded soldiers despite similar levels of physical injury (Beecher, 1946). These observations led him to conclude that, in contradiction to Descartes' specificity theory, there is not a direct relationship between physical injury and the subjective experience of pain. Pain management as a distinct field within medicine began to emerge around the middle of the 20th century, and Dr John Bonica's (1953) book "The Management of Pain" is often

cited as being the first textbook within this field. Reflecting the shift away from the purely physiologically-based specificity theory, Bonica stated that pain is neither purely a neurophysiological nor a psychological phenomenon, and that pain should be recognised as a highly complex interaction of psychological and physiological processes.

Moves toward a more holistic model of pain including psychological factors were given scientific grounding in Melzack and Wall's (1965) seminal Gate-Control Theory. This theory was highly influential primarily because it provided a physiologically-based mechanism to account for the influence of psychological factors in pain experience. In essence, the theory proposed that once a nociceptive input has opened a pain "gate", the brain and central nervous system can play an active part in receiving, modulating and transmitting pain impulses, and hence contribute to the exacerbation and maintenance of the subjective experience of pain. On a neuronal level, Melzack and Wall's theory explained this process by proposing that nerves which do not transmit pain signals could interfere and inhibit signals from pain-transmitting nerves. The Gate-Control theory was so influential because it opened the way for non-physiological interventions in pain management, and provided further momentum in the ongoing shift in pain medicine away from a purely medical model of pain towards a biopsychosocial model (Engel, 1977). The Gate-Control theory received further development in the form of the Neuromatrix model (Melzack, 1992), which proposes that our subjective experience of pain is stored in hard-wired, genetically programmed neural networks in the brain. This theory has been developed to explain the phenomenon of phantom-limb pain, and

suggests that the shooting pains experienced in phantom-limb pain are the result of the brain's attempts to move a limb that is no longer present.

Key factors in the development and maintenance of chronic pain

In order to place this research within the wider context of current understandings of the phenomenon of chronic pain, factors currently believed to be key in the experience of chronic pain will be described. Whilst a comprehensive review of these factors is beyond the scope of this review, the following aims to provide a brief overview of some of the most important factors in biological, social, and psychological domains.

Biological factors

Despite the growing awareness of the multifactorial nature of pain, and the acceptance that a direct relationship between physical damage and pain experience does not exist, the role of biological factors in both pain generally, and in chronic pain specifically remains highly important. Smith *et al.* (2007), in a review of biological mechanisms related to risk of development of chronic pain, report studies in both animals and humans that have identified a range of important biological mechanisms in the development of chronic pain. They review evidence for the role of endocrine and immunological factors, such as hypothalamo-pituitary-adrenal axis activation and the role of neurotransmitters such as dopamine and noradrenaline in the development and maintenance of widespread chronic pain. They also point out that people with chronic

pain display characteristic patterns of brain activation during functional MRI imaging studies.

Genetic contributions to risk for development of a chronic pain problem have also been investigated using classical twin study methodology. Significant levels of genetic influence have been found in young adults with back pain (Hestbaek *et al.*, 2004) and in older men, but not older women with back pain (Hartvigsen *et al.*, 2004). Clearly, the results of these studies cannot be generalised across different forms of chronic pain, however they do suggest that inherited factors may be important in at least some chronic pain problems. However, such studies cannot shed light on important questions regarding the extent to which the mechanism of heritability is via vulnerability to physiological pathology at the pain site or via heritable dispositions toward psychosocial vulnerabilities.

Research at the neuronal and molecular level is beginning to illuminate the mechanisms underlying the processes of peripheral and central sensitisation, which are believed to underlie the phenomenon of pain “wind-up” and are hence important in the development and maintenance of chronic pain (Scholz & Woolf, 2002). A number of other processes have also been implicated in chronic pain, including the potential involvement of glial cell activity (Suter *et al.*, 2007), and the role of the sympathetic nervous system in complex regional pain syndromes (Baron *et al.*, 2002).

Social factors

Social factors relating to close personal relationships, broader social networks such as the workplace, and wider cultural influences such as socio-economic status and legal and welfare systems have been found to be important in the development and maintenance of some chronic pain problems. As examples, an inverse relationship between socio-economic status and chronic pain prevalence has been reported (Elliott *et al.*, 1999), and those receiving workers' compensation have been found to have poorer outcome following surgery, even when controlling for other potential confounding factors (Harris *et al.*, 2005). At the level of close personal relationships, both self-report (Flor *et al.*, 1987), and observational (Romano *et al.*, 1995) study methodologies have found an association between higher levels of reinforcing responses by spouses to the pain behaviours of chronic pain sufferers, and higher levels of disability. It is hypothesised that some chronic pain sufferers' avoidance of physical activity may be maintained through operant conditioning as a result of reinforcement by spouses, and that this leads to physical disuse, deconditioning, and disability in the longer term.

Psychological factors

Psychological factors in the development and maintenance of chronic pain are receiving increasing amounts of study, and are important in the assessment and treatment of chronic pain problems. A complete review of psychological factors in chronic pain is beyond the scope of this review, however a recent review of this area by Keefe *et al.* (2004) highlighted those factors which have received most support in the literature so

far. Keefe *et al.* (2004) categorised psychological factors into those which are broadly associated with an exacerbation of pain, and those which are broadly associated with an amelioration of pain. Those factors which exacerbate pain are catastrophising, pain-related anxiety and fear, and helplessness. Those factors which ameliorate pain are self-efficacy, active and effective pain coping strategies, readiness to change, and acceptance. Although there would appear to be significant overlaps between some of these concepts they are useful in clinical practice, and such factors are routinely assessed in people presenting to chronic pain clinics in the UK.

Psychosocial management of chronic pain

Although brief, the above review does highlight that a range of important factors exist across all three domains, and that chronic pain is indeed a complex, multifactorial problem. In keeping with this view, current good practice guidelines emphasise the need for provision of a multidisciplinary approach for more complex cases involving input from physicians, nurses, physiotherapists, occupational therapists, and psychologists so that individuals can receive adequate assessment and intervention across these three domains (NHS Quality Improvement Scotland, 2006).

Within multidisciplinary approaches, the dominant theoretical model guiding assessment and intervention within the psychological domain is the Cognitive Behavioural Model, which focuses on increasing functioning and decreasing pain-related distress through

affecting change in cognitions and behaviour. This approach is well established as being effective in reducing distress and disability in chronic pain sufferers (Morley *et al.*, 1999). One of the key assumptions underlying the CBT model is that cognitions influence mood and behaviour, and that by modifying cognitions or changing a person's relationship to these cognitions through psychological interventions one can effect change in a person's mood, behaviours, and pain experience. As mentioned above, research into psychological factors in chronic pain has identified cognitions related to self-efficacy, helplessness, and catastrophising among others as having a key role in the development and maintenance of problems associated with chronic pain, and these cognitions are common targets within CBT interventions for many chronic pain sufferers. At present, the study of pain-related cognitions within a CBT approach has been almost exclusively limited to verbal, language-based forms of cognition. For example, cognitive assessment measures for chronic pain sufferers typically use questionnaire measures where individuals are asked to rate verbal statements, such as "*I worry all the time about whether the pain will end*" (from the Pain Catastrophising Scale, Sullivan *et al.*, 1995). This focus on verbal forms of cognitions is in keeping with a broader historical emphasis on verbally-represented cognitions within CBT models and interventions for a wide range of psychological difficulties (Edwards, 2007). In recent years, however, there has been a move towards greater interest in cognitions represented as mental images or pictures within the CBT research literature (Hackman & Holmes, 2004). An increasing number of papers describe imagery-based psychotherapeutic techniques in the treatment of a range of psychological disorders (eg. Grunert *et al.*, 2007; Hunt & Fenton, 2007; Morrison, 2004; Rusch *et al.*, 2000; Smucker

et al., 1995; Wheatley *et al.*, 2007; Wild *et al.*, 2007). Special editions dedicated to the study of imagery in psychopathology have recently been published in the journal *Memory* (2004), and the *Journal of Behaviour Therapy and Experimental Psychiatry* (2007). Although these developments are fairly recent in the history of CBT research, they are in keeping with early writings of one of the founders of Cognitive Therapy, Aaron T Beck, who stated that cognitions relevant to psychological distress can take the form of both verbal thoughts and mental images (Beck, 1976), and that mental images are therefore worthy of study.

Naturally-occurring mental imagery in chronic pain has, however, received little research attention as yet. Despite this, clinical experience and anecdote suggest that some chronic pain sufferers do experience mental images of their pain in addition to reporting language based beliefs and thoughts related to their pain. This observation, in the context of growing interest in mental imagery across a range of psychological disorders, forms the motivation behind the current investigation into mental imagery in chronic pain.

Before reviewing existing literature regarding mental imagery in chronic pain, current understandings of mental imagery within academic psychology and as a phenomenon in the development, maintenance, and treatment of other psychological disorders will be reviewed.

Mental imagery

Defining “mental imagery”

Mental imagery is not a term frequently used in day-to-day language, therefore it will be helpful to first clearly define what is meant by the term before proceeding. The common language usage of “mental imagery” can be found in The Chambers Dictionary, 10th Edition (Chambers Harrap, 2006), which defines a mental image as:

“a mental picture or representation resulting from thought or memory rather than sensory perception” (p 742)

As a guide to the understanding of mental imagery within the field of psychology, a more precise definition is provided by Richardson (1969), who claims that:

“Mental imagery refers to all those quasi-sensory or quasi-perceptual experiences of which we are self-consciously aware, and which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts” (p 2)

According to both of these definitions, mental images may occur both spontaneously or be intentionally generated, and include both dreams and memories. Mental images may also involve any of the sensory modalities, including sounds, smells, and touch, although visually-based mental images have been the most extensively studied (Kosslyn *et al.*, 2001).

General psychological research into mental imagery

Mental imagery has been the subject of considerable interest within academic psychology and cognitive science. It is, however a subject which has fallen in and out of fashion within the field, and its study has been victim to broader debates and fashions within psychology as a whole. The most striking example of this occurred in the USA, and to a lesser extent the UK, between the 1920's and 1960's during the time of the behaviourist movement. During this period, there was very little study of mentalistic concepts such as mental imagery (Sheikh *et al.*, 2004a). Some behavioural psychologists, known as methodological behaviourists, believed that it was not even possible to study mental life. Indeed, J.B Watson famously denied the importance of mental images as a subject of psychological study (Watson, 1913), a denial which may have played an important part in the neglect of the study of mental imagery within psychology for the following half a century (Kosslyn *et al.*, 2001).

Debate regarding the nature of mental images resurfaced in the form of the "Great Imagery Debate" in the 1970's and 1980's. Essentially, this debate was between those who held that mental images are specific data structures within the mind which are processed holistically (Kosslyn & Pomerantz, 1977), and those who believed that mental images are simply an epiphenomenon and are therefore reducible to the same underlying mental representations which underlie language (Pylyshyn, 1973). Although this debate continues to this day, it is of peripheral relevance for the purposes of this study, as the

focus of interest here relates to the clinical characteristics and functions of mental images rather than the way in which they are represented in the brain.

Individual differences in mental imagery are a further area of study which has received research attention since the early days of the discipline of academic psychology. Indeed, the first study of individual differences in mental imagery was published by Galton in 1880. The most consistent finding to arise from this area of study is that large individual differences exist between people in their subjective report of the characteristics and use of mental imagery (McAvinue & Robertson, 2006), with individual differences in mental imagery vividness receiving most study.

Recent evidence suggests that individual differences in imagery vividness reported subjectively have a neuronal basis which can be objectively measured using physiological measures. Cui *et al.* (2007) found that differences in the subjective report of the vividness of mental imagery, as measured with the Vividness of Visual Imagery Questionnaire (VVIQ), correlate with differences in functional MRI images from the visual cortex. Although this area of study is in its infancy, this finding does suggest that the subjective experience of mental imagery may have important links with brain functioning, and lends further support to the theory that mental images are more than merely an epiphenomenon.

Both everyday experience and clinical experience strongly suggest that mental images have the capacity to influence mood. The powerful anxiety response observed in those

suffering from Post Traumatic Stress Disorder in response to their intrusive traumatic images provides a striking example of this process. The role of imagery in influencing mood has also been confirmed experimentally with both negative affective states such as anxiety (Holmes & Mathews, 2005), and positive mood states (Holmes *et al.*, 2006). Furthermore, both these studies found that participants reported significantly greater changes in affect when asked to use imagery than when asked to consider verbal meanings.

Mental imagery has also been repeatedly found to have measurable effects upon physiological functioning (Sheikh *et al.*, 2004b). Examples include self-generated taste images increasing salivary flow (Barber *et al.*, 1964); self-generated images of emotional and bodily arousal increasing galvanic skin response (Bauer & Craighead, 1979); and self-generated images of physical activity producing changes in heart rate (Jones & Johnson, 1978). Jones and Johnson (1980) went on to demonstrate that those mental images involving high levels of activity produce greater changes in heart rate than mental images involving lower levels of activity.

Interestingly, Gruzelier and colleagues have reported several studies which have found that imagery can have objectively measurable effects on immune functioning (Gruzelier, 2002). They have found that hypnosis (including imagery as a central technique) results in better immune function among healthy adults facing exam stress compared with a control intervention (Gruzelier *et al.*, 1997). Fascinatingly, Gruzelier and colleagues have also reported that hypnosis including imagery involving the immune system has

greater objectively measured benefits in immune response that hypnosis including relaxation-based imagery (Gruzelier *et al.*, 2006). Positive effects upon immune functioning have also been obtained as a result of hypnosis and imagery with people who are being treated for cancer, or have recently recovered from cancer. It remains uncertain, however, whether these changes can be maintained in the longer-term (Bakke *et al.*, 2002), or if the measured changes lead to clinically important outcomes such as improved survival rates (Hudacek, 2007). Clearly, this is a fascinating area of research and raises interesting questions about the influence of psychological activity on immune functioning and health, however it is at an early stage and studies reported so far have been small-scale and lack longer-term follow-up. Conclusions drawn from this work, therefore, must be tentative for the time being.

In addition to having measurable emotional and physiological effects, mental images can have a significant function in influencing classical conditioning and extinction processes, and may actually be able to function as an unconditioned or conditioned stimuli (Dadds *et al.*, 1997). This finding suggests one theoretical route by which mental images may have a role in psychological distress, and underlies a theoretical rationale for the known effectiveness of imaginal exposure techniques for the treatment of anxiety problems first popularised by Wolpe (1958) in his systematic desensitisation method.

In summary, it is clear that the subject of mental imagery has been somewhat controversial, and its study has been a victim of broader movements within psychology and fundamental issues regarding the validity of studying subjective phenomena which

are highly idiographic and difficult to measure. Despite this, there appears to be strong evidence that mental images can have a powerful effect upon mood and physiological functioning, that individual differences in the subjective experience of mental imagery correlate with objectively measurable physiological effects, and that mental images can function in a similar fashion to external stimuli in basic learning processes such as classical conditioning. It therefore seems very possible that mental images may have a role in psychological disorders and in health problems such as chronic pain.

Mental imagery in psychological disorders

Theoretical models and intervention approaches utilising mental imagery

The phenomenon of mental imagery may be understood in a variety of ways within different models of psychological distress. Psychoanalytic approaches have primarily considered mental imagery as a route through which unconscious processes can be accessed. Freud believed the content of dreams (a form of mental image) provides a particularly accessible route into a person's unconscious, and his technique of dream analysis is among the most well-known of his therapeutic techniques (Snowden, 2006a). Another founding father of analytical psychology, Carl Jung proposed that the imagery occurring during dreams also continues during waking life in the form of undercurrents of fantasy (Snowden, 2006b). He encouraged his clients to develop a greater awareness of their own unconscious through a process of active imagination. Active imagination

involves entering a day-dream like state whereby images and fantasies emerging during waking life can be expressed and explored.

Within Cognitive Behavioural Therapy (CBT), mental images are considered to be a form of cognition, and distressing mental images have been conceptualised by some as functioning in a manner analogous to negative automatic thoughts (Beck, 1995). Images, therefore, may have a causal role in influencing emotion and behaviour. Within a traditional CBT model the meaning of the image is considered to be a key factor in its influence upon affect and behaviour.

CBT intervention approaches utilising imagery typically take one of three forms:

The first form involves teaching clients skills in the self-generation of pleasant, relaxing mental images. This technique is often termed guided imagery, and is believed to have positive effects through the production of helpful physiological and emotional states resulting from the image.

The second form, imaginal exposure, involves repeated exposure to an image or memory in imagination until habituation occurs, according to a classical conditioning paradigm.

The third form, imagery modification or rescripting, aims to help clients modify the content of their naturally occurring distressing or unhelpful images as a means of alleviating the emotional and behavioural symptoms of psychological disorders. The

first two techniques do not explicitly target cognitive change at the level of meanings, although it is likely that habituation occurring as a result of imaginal exposure can change the meaning of a feared stimuli, such that something that previously should be avoided at all costs becomes something that can be confronted and mastered. Imagery modification does attempt to explicitly achieve change at the level of meaning, and is hypothesised to have its effects by this route. This technique has not, however, received a great deal of attention within the CBT model which has historically emphasised verbally-based cognitive change techniques, with some notable exceptions such as the work of Jeffrey Young in schema therapy (Young *et al.*, 2003) and that of Arntz and Weertman (1999) in rescripting of childhood memories.

Despite the relative lack of interest in cognitively-based imagery techniques, there have been suggestions that imagery may in fact be a particularly powerful way by which schema-level cognitive structures and emotion can be accessed. This theory is beginning to gain support in experimental research (Holmes & Mathews, 2005). Clinically, it has also been recognised that the verbal cognitions typically focused on in CBT interventions may not always provide a strong link with emotion. More specifically, verbal techniques such as thought challenging may be effective at altering cognitions at a rational, intellectual level but may be less powerful in leading to change in beliefs and emotions at a deeper, more intuitive level (Bennett-Levy, 2003). People who experience this phenomenon during therapy characteristically report that, while they can rationally understand that their distressing cognitions are distorted or incorrect, this knowledge does not change the way they feel at a more emotional level.

In an attempt to account for these phenomena, theories have been proposed which have in common the idea that cognitions exist on two levels; a propositional level consisting of those cognitions traditionally represented verbally, for example “*I am a success/failure in my work life*”, and a schematic or implicational level, where cognitions are thought to be holistic and often communicated via artistic medium such as poetry, metaphor and imagery. Teasdale and Barnard’s (1993) Interacting Cognitive Subsystems model (ICS) and Power and Dalgleish’s (1997) Schematic, Propositional, Analogical, and Associative Representation Systems model (SPAARS) are both well known examples of such multi-level theories and both propose that cognitions at the propositional level of meaning are not directly linked with emotion. Therefore, while traditional, language-based cognitive therapy techniques alter propositional-level meanings and impact emotion indirectly, imagery techniques have the potential to lead more directly to change at the schematic level and hence may have greater impact upon emotion.

In recent years, therapeutic approaches have been developed which take account of these models. One such approach is Mindfulness-Based Cognitive Therapy (Segal *et al.*, 2001) which has been developed from ICS theory. Mindfulness-Based Cognitive Therapy does not attempt to directly change the content of distressing thoughts and feelings, instead seeking to develop new schema regarding the relationship between the self and these distressing internal events through the use of mindfulness and decentring techniques. The development of such schema enable the individual to behave in ways which are flexible and adaptive rather than rigid and unhelpful, even in the presence of

distressing cognitions and emotions. Other approaches with a similar focus upon changing the relationship a person has with their distressing thoughts and feelings include Acceptance and Commitment Therapy (Hayes *et al.*, 2004) and Dialectical Behaviour Therapy (Linehan, 1993). It would be reasonable to propose that, within these approaches, imagery-focused interventions may involve using mindfulness and acceptance techniques to decentre from distressing mental images and counter rigid inflexible ways of responding to these images. Such ideas have interesting potential, but clearly require further study.

Research into mental imagery within distinct psychological disorders

The historical focus within traditional CBT on verbally-based cognitions has led to a lack of research into mental imagery within psychological disorders until relatively recently. However, studies of mental imagery within a number of psychological disorders have now been published, and the field is growing fast. The disorder which has received most research in this area is post traumatic stress disorder (PTSD), due to the striking clinical phenomenon of intrusive imagery, one of the cardinal symptoms of this disorder. Intrusive images are considered to be meaningful fragments of a trauma memory that lack adequate contextual information, are retrieved from memory unintentionally, and contain important meanings related to themes of threat and helplessness (Hackmann & Holmes, 2004). In keeping with the importance of imagery in the maintenance of this disorder, clinical practice guidelines recommend the use of psychological interventions which have imaginal exposure at their core (ie. Trauma-Focused CBT and EMDR) as first line treatments (NICE, 2005). Such interventions are

broadly based upon the assumption that repeated exposure to intrusive images will lead to habituation and a reduction in distress associated with the images according to a classical conditioning model. Although these techniques are often effective, it is also recognised that an important aspect of treatment for many PTSD sufferers involves cognitive change regarding trauma-related cognitions, particularly those related to threat and helplessness. Although this is often done using traditional, verbally-based cognitive techniques, it may also be possible that such cognitive change can be effectively achieved using imagery modification techniques whereby a client is guided through a process of actively modifying trauma-related images in an effort to change their meaning and give the client a greater sense of mastery over their distressing images. It has been suggested that such an approach may be particularly effective for non-fear related emotions which are often present in PTSD (eg. guilt, shame and anger) (Grunert *et al.*, 2007; Arntz *et al.*, 2007). It has also been noted that these non-fear based emotions may not respond well to imaginal exposure-based treatments alone (Dalgleish & Power, 2004).

Although PTSD is the psychological disorder in which imagery is most striking, there is increasing evidence that characteristic mental images are present in a range of other psychological disorders. Examples of other anxiety disorders in which characteristic mental imagery has been identified include social phobia (Hackmann *et al.*, 1998, 2000) obsessive-compulsive disorder (de Silva, 1986; Rachman, 2007; Speckens *et al.*, 2007), agoraphobia (Day *et al.*, 2004), and snake fear (Hunt *et al.*, 2006). Non anxiety-related psychological disorders in which characteristic mental images have also been found

include depression (Brewin *et al.*, 1996; Patel *et al.*, 2007), body dysmorphic disorder (Osman *et al.*, 2004), bulimia nervosa (Somerville *et al.*, 2007), suicidal ideation (Holmes *et al.*, 2007), and psychosis (Morrison *et al.*, 2002). Importantly, research in this area is beginning to move beyond simply describing mental imagery within psychological disorders toward integrating imagery findings within theoretical models of the development and maintenance of specific disorders. For example, Clark and Well's (1995) model of social phobia proposes that social phobics switch to processing distorted images of the self which are seen from an observer perspective when sensing threat in a social situation. Consistent with this model, studies into mental imagery in social phobia have found that social phobics do indeed experience recurrent, spontaneous images of themselves which are both seen from an observers perspective and which are distorted in characteristic ways, whereas non-social phobics do not (Hackmann *et al.*, 1998). These images have also been found to be linked to memories of adverse social events occurring around the time of the onset of the individual's social phobic disorder (Hackmann *et al.*, 2000). Such findings have been used to inform novel imagery-based psychotherapeutic interventions, and Wild *et al.*, (2007) report findings on the use of imagery modification techniques in an uncontrolled trial with 14 social phobics. In this study they found significant within session change in beliefs, imagery vividness and imagery distress as a result of their intervention. Furthermore, they found significant positive changes in a self-report measures of social anxiety at 1 week follow-up. Although preliminary, these findings suggest that imagery has an important role for at least some people who suffer from social phobia both in the maintenance and treatment of their specific difficulties. There is hope that developing links between

theory, research and clinical practice related to mental imagery in other psychological disorders may also lead to important progress in effective assessment and treatment.

In summary, the evidence reviewed here demonstrates that characteristic mental imagery exists in a wide range of psychological disorders, that these images appear to be linked with the development and maintenance of these problems, and that mental images are potential targets for effective psychological interventions.

Mental imagery in chronic pain

As yet, naturally-occurring mental imagery associated with pain problems (acute or chronic) remains unexplored, with the exception of a recent study by Potter *et al.* (in submission) which will be described in more detail later. Furthermore, research into the use of mental imagery intervention techniques in pain is largely limited to evaluation of the effectiveness of guided imagery techniques. A few isolated descriptions of imagery modification techniques have been published, however these techniques have not yet received empirical evaluation as to their effectiveness.

Before continuing, it should be noted that, although techniques using mental imagery have been described as “imagery techniques”, there is in fact little difference between those techniques which have been described as imagery techniques, those which are

described as hypnosis, and those described as meditation techniques. Indeed, Syrjala and Abrams (2002) state:

“...other [imagery] strategies share more commonalities than differences with hypnosis. Upon reading, a clinician is hard pressed to properly designate which script is meditation, which imagery, and which hypnosis.” (p 187-188)

The present review will therefore include imagery techniques, hypnosis, and meditation techniques where appropriate and will assume these three terms refer to similar techniques.

The most frequently used imagery technique for pain is guided imagery. As mentioned above, guided imagery refers to a technique whereby a client is taught to self-generate a mental image, which usually has relaxing or soothing qualities, and it is theorised that the client achieves relief due to the beneficial emotional and physiological response arising as a result of the mental image. The effectiveness of guided imagery in relieving pain and pain-related distress has been studied under experimental conditions and with both naturally occurring acute and chronic pain.

Fernandez and Turk (1989) conducted a meta-analysis into the effect of a range of cognitive techniques in increasing pain tolerance and threshold, and attenuating pain

ratings. In their analysis, Fernandez and Turk categorised the techniques used across a range of studies according to six categories, two of which represented guided imagery techniques. They found that all of the cognitive strategies examined were more effective than no treatment or expectancy effects. Interestingly, with regards to imagery techniques, they also found that guided imagery was the most powerful of all the cognitive techniques studied in impacting upon pain tolerance, threshold, and intensity. Although their analysis provides strong evidence for the effectiveness of guided imagery in pain, it should be noted that the studies included in their analysis primarily studied acute, experimentally-induced pain and therefore caution is necessary in generalising their results for use with those suffering from naturally-occurring chronic pain.

In addition to work investigating the effects of guided imagery on experimentally-induced pain, a number of studies have attempted to investigate the effects of guided imagery for naturally occurring pain. In a sample including both acute and chronic pain sufferers Raft *et al.* (1986) found that guided imagery using pleasant images presented in conjunction with progressive muscular relaxation (PMR) resulted in a significant decrease in pain immediately after the intervention. They do note, however, that their intervention was effective only for those participants with acute and not chronic pain. In addition to this, they did not provide any follow-up so the longer-term impact of their intervention on pain is not known. Achterberg *et al.* (1988) compared the effectiveness of PMR alone, PMR with guided imagery, and PMR with guided imagery and thermal biofeedback in burns sufferers undergoing a painful medical procedure. They reported

that all three intervention groups benefited compared with a control group, but that those who received a guided imagery intervention benefited most. Among a sample of people with chronic low back pain, Turner and Jensen (1993) found that PMR and guided imagery in combination was as effective as cognitive therapy alone, and that the addition of cognitive therapy to the PMR and imagery intervention did not increase its effectiveness.

Guided imagery, combined with PMR has also been reported to relieve cancer pain (Sloman, 1995; Syrjala *et al.*, 1995). Similarly to Turner and Jensen's (1993) findings with chronic low back pain, Syrjala *et al.* (1995) found in their controlled trial that the addition of cognitive techniques to guided imagery and PMR did not increase the effectiveness of this intervention in the relief of cancer pain. The effect of guided imagery on acute, perioperative pain has also been studied. Tusek *et al.* (1997) conducted a randomised trial comparing usual perioperative care with the addition of a guided imagery audiotape for individuals undergoing elective colorectal surgery. They found that, in comparison with usual perioperative care, those making use of the imagery tape reported significantly lower levels of anxiety, pain, analgesic medication use, and a significantly shorter time to first bowel movement following surgery. Guided imagery as an adjunctive treatment for tension-type headache has been studied in a large controlled trial ($N=260$) (Mannix *et al.*, 1999). Mannix *et al.* noted significantly greater improvements in a range of measures of well-being in addition to pain ratings in the group receiving guided imagery. Recent studies have also reported significant

improvements in pain ratings with a guided imagery intervention over a control treatment among people with fibromyalgia (Flors *et al.*, 2002), a heterogeneous clinical sample from a chronic pain clinic (Lewandowski *et al.*, 2004), pain as a result of osteoarthritis (Baird & Sands, 2004), and recurrent abdominal pain in children (Wegdart *et al.*, 2006).

In addition to its effect on pain ratings, guided imagery with people suffering from chronic pain has also been reported to produce significant improvements in self-efficacy beliefs regarding ability to cope with pain (Illecqua, 1994), and significant reductions in mobility difficulties related to a painful condition (Baird & Sands, 2004).

There is some evidence to suggest that it is not simply the act of imagining that produces the helpful effects found as a result of guided imagery, but that the content of the image used is important. In an experimental study using acute, laboratory induced pain, Alden *et al.* (2001) found that the degree of impact on pain tolerance experienced as a result of guided imagery depended upon the affective quality and directional focus of the image induced. Specifically, they report that images with positive affect and external focus have the greatest effect on increasing pain tolerance.

As noted above, it has been theorised that guided imagery techniques work through emotional and physiological reactions to the image. However, a recent study suggests

that cognitive factors may also have a role. Lewandowski *et al.* (2005) used a mixed qualitative/quantitative study design to observe how the pain descriptions given by chronic pain sufferers receiving a guided imagery intervention might change as a result of this intervention, compared with a control group who did not receive this intervention. They report that the perception of “pain as never ending” decreased significantly among those receiving a guided imagery intervention, but that this perception did not change in the control group.

Although promising, these studies need to be interpreted with caution. Firstly, the use of imagery techniques has been frequently confounded with the use of muscular relaxation techniques, and the relative contributions of these two interventions are difficult to determine. In addition, the methodological quality of many of the studies reported has been poor, with lack of randomisation, inadequate control groups, and potential investigator bias effects being common. Overall, however, there does appear to be a convergence of evidence that guided imagery techniques produce significant benefits for those experiencing both acute and chronic pain, at least in the short term. Further study of the longer-term effects of guided imagery will provide an essential addition to this field of study.

Underlying the generally positive group effects of guided imagery techniques, it has been noted that a consistent feature of studies reported in this area has been large between subject variability in response to treatment (Pincus *et al.*, 2006). It therefore

appears that responses to even simple, standardised imagery interventions are highly idiosyncratic. As mentioned above, research in this area has almost exclusively studied guided imagery, a standardised imagery technique which does not take into account an individual's naturally-occurring mental images of their pain, nor explicitly target cognitive change. Pincus *et al.* (2006) go on to suggest that more in depth, imagery modification techniques may allow for idiographic factors in spontaneous imagery to be taken into account, and may therefore result in more consistent treatment effects. Furthermore, spontaneous imagery may provide access to key facets of an individual's self-schema and pain-schema and therefore imagery techniques which explore naturally-occurring mental images may have the potential to help those suffering with chronic pain access, articulate, and modify beliefs and feelings relating to their pain which are less readily accessible via verbal cognitive techniques.

Descriptions of imagery modification techniques for pain problems do exist, however these descriptions are rare and have often been published outside the mainstream clinical literature in books which can be difficult to access. Such techniques may originate within Eastern spiritual practices or New-Age practices. Indeed, Sheikh *et al.* (2004a) describe deep imagery techniques which have been used for physical and spiritual healing by shamanistic practitioners and Buddhist healers for centuries. Pincus *et al.* (2004a) provide an overview of a range of imagery transformation techniques which have been used to help people with acute and chronic pain. Many of the techniques they describe involve therapist-guided transformation of a patient's mental image of their pain

or discomfort. Frequently, transformational techniques aim to modify properties of the person's mental image such as the size, colour, and location of their pain (Pincus *et al.*, 2004a). Other imagery techniques described attempt to help sufferers dissociate from their experience of pain, generate a symbolic representation of their pain, or otherwise alter their relationship to their mental image. Such techniques are essentially idiographic and must be based upon the individual person's naturally-occurring imagery.

Perhaps as a result of the origin of many imagery transformation techniques within spiritual and new-age practices, or within the field of hypnosis, they have not been widely studied in mainstream clinical journals. Empirical investigations into their effects have also not been conducted, or if they have, they have not been published in accessible sources. Furthermore, again as a result of their origins, such techniques lack a sound, scientifically-based theory as to the mechanism of their effects. For example, it appears that at least some imagery modification techniques rely on the implicit theoretical assumption that naturally-occurring images of pain can be unhelpful, and that by transforming such images the sufferer can achieve relief and healing. Despite this assumption, there is little understanding, as yet, of the properties and functions that spontaneously occurring mental images of pain might have. This situation is in contrast with recent work developing links between theory, research and practice in mental imagery in psychological disorders, of which the work of Hackmann and colleagues in social phobia is a clear example.

At the present time, only one study has sought to investigate naturally-occurring mental images among chronic pain sufferers. Potter *et al.* (in submission) used a questionnaire methodology to investigate the presence of mental imagery and links with depression, anxiety, and catastrophising among a heterogeneous sample of individuals presenting to a chronic pain clinic. Their findings were that a significant proportion (24%) of chronic pain sufferers reported experiencing pain-related mental imagery. Furthermore, those who reported having an image also reported significantly higher levels of anxiety, depression, and catastrophising. These effects were of medium to large size ($d= 0.76$, 0.51 , and 0.67 respectively). This study did report participants' written descriptions of the content of their mental images, however the small number and idiographic nature of the mental images described made it difficult to analyse this data or draw themes from the images. Although this study suggests that a significant proportion of chronic pain sufferers do indeed experience a mental image of their pain, and that those who do also have higher levels of distress and catastrophising, the study does not provide a great deal of information regarding the characteristics of chronic pain sufferers' mental images, nor does it illuminate ways in which mental imagery might be related to distress or catastrophising. These are important questions in helping develop an understanding of the role of mental imagery in chronic pain and in guiding the development of effective interventions.

As already noted, this field of study is largely unexplored, and therefore a great number of opportunities exist for building upon Potter *et al.*'s (in submission) findings. This

research project will attempt to carry this work forward in a number of ways. The project will consist of two studies, the first of which will attempt to replicate Potter, *et al.*'s findings of an association between the experience of pain-related mental imagery and higher levels of depression and anxiety. In addition to this, further data will be collected regarding the characteristics of mental imagery and themes emerging from image descriptions will be explored qualitatively. Potential differences between those chronic pain sufferers who experience mental images of their pain and those who do not, in their tendency to utilise imagery in everyday life will also be investigated.

The second study, utilising a semi-structured interview methodology, will serve as an exploratory investigation into the possible functions of pain-related mental imagery. Specifically, this study will investigate physiological and emotional reactions to participants' mental images, in addition to gathering further information regarding the characteristics of the mental images experienced.

In order to specify the expected findings of this research, the following hypotheses will be explored:

Hypotheses

Study one

1. Those participants who report experiencing a mental image of their pain will experience higher levels of self-reported anxiety than participants who do not report experiencing a mental image of their pain.
2. Those participants who report experiencing a mental image of their pain will experience higher levels of self-reported depression than participants who do not report experiencing a mental image of their pain.
3. Significantly greater use of mental imagery in everyday life situations will be reported by those participants who report experiencing mental images of their pain than those participants who do not report a mental image of their pain.

Study two

4. Participants will report having experienced increases in physiological arousal during the time that they were contacting their mental image.
5. Participants will report having experienced a shift toward a more negative emotional state during the time that they were contacting their mental image.

Study one: Questionnaire Study

Methodology

Design

A postal questionnaire methodology was used in this phase of the study, providing both quantitative and qualitative data.

Participants

Participants were drawn from a heterogeneous population of chronic pain sufferers attending a chronic pain specialist clinic within a large teaching hospital. People attending this service suffer from chronic pain of a range of types and causes, however those with pain as a direct result of cancer are not routinely seen within the service. Some people who experience chronic pain as a result of past surgical or medical interventions for cancer, but who have been successfully treated for the disease are seen within the service. Participants were selected for the study using the following inclusion and exclusion criteria:

Inclusion criteria

All participants were NHS patients who had been referred to and attended an initial assessment appointment at the chronic pain clinic. The chronic pain clinic from which participants were recruited was an outpatient service based within a large teaching

hospital, and all patients referred to the service received an initial assessment appointment with a Consultant in Anaesthesia and Pain Medicine. Only those who attended an initial assessment appointment during the period 1/4/07– 1/6/08 were selected for inclusion, in order to exclude those who had participated in a previous study into mental imagery (Potter *et al.*, in submission). All participants were over 18 years old at time of inclusion. There was no upper age limit, in keeping with the clinic's referral criteria.

Exclusion criteria

All those who were receiving psychology input from the researcher or another qualified clinical psychologist within the clinic were excluded from participation in the study in order to avoid the possibility that these individuals might feel pressure to take part. In addition, those who were already taking part in a concurrent longitudinal study into emotion in chronic pain within the service were excluded to prevent overburdening them with research.

Sample size

With regards to power analysis, it was estimated that the effects being investigated in hypotheses 1 and 2 were likely to be of large size. This estimate was based on the medium to large effect sizes (Cohen, 1992) reported by Potter *et al.* (in submission) regarding group differences between imagers and non-imagers in self-reported anxiety ($d=0.76$) and depression ($d=0.51$).

Sample size calculations based on Cohen (1992) indicated that a minimum of 26 participants would need to be recruited into each group in order to achieve adequate power at the .80 level to detect a large effect at the $p < .05$ significance level.

Based upon Potter et al.'s finding that 24% of chronic pain sufferers report pain-related mental imagery, it was calculated that a total of 109 questionnaire returns would be necessary in order to ensure at least 26 participants with mental images would be recruited. Again, using Potter et al.'s findings as a guide, the probable questionnaire return rate was estimated to be 23%, hence a total of at least 474 postal questionnaire packs would need to be sent out to obtain 109 returns.

Using the inclusion and exclusion criteria outlined above, 491 participants were identified for participation in the study. This number exceeds the 474 indicated by the power analysis as being an adequate sample size.

Ethical approval

Ethical opinion for this project was sought prior to commencing data collection, and the study was assessed and approved by the local Research Ethics Committee (see Appendix 1 for letter of ethical approval).

Ethical issues

A number of potential ethical issues were considered regarding the design of study one of this project. In order to ensure participants were able to give informed consent, a participant information sheet was sent out with postal questionnaires as part of study one, with contact details for the researcher should potential participants have any questions. The decision not to send questionnaire packs to those individuals who were attending for psychological intervention by the researcher and another qualified clinical psychologist within the clinic was made on ethical grounds, as it was thought that their receiving intervention from healthcare professionals involved in the study might unintentionally bias them towards feeling obliged to take part.

Measures

The following measures were included in the postal questionnaire pack, in addition to a covering letter (Appendix 2) and a participant information sheet (Appendix 3).

Chronic Pain Mental Imagery Questionnaire

As no suitable measure of pain-related mental imagery currently exists, a three-page questionnaire was designed specifically for this study (see appendix 4). The questionnaire asked participants to give a detailed initial description of their pain, before asking more specifically about mental imagery. Mental images or mental imagery were not mentioned in the title of the questionnaire, the invitation letter, or the participant

information sheet in order to avoid possible contamination of participants' initial description of their pain and to reduce the effects of suggestibility on participants' mental imagery report. Some questionnaire items allowed for only fixed choice responses, using visual analogue scales, Likert scales, or other fixed choice response formats, in order to provide quantitative data. Other items provided an opportunity for participants to give open-ended, qualitative responses in order to provide richer data about participants' experience of their pain, the perceived cause of their pain, and their mental image of their pain. Items were adapted from established measures where possible, for example fixed choice responses to the item regarding the vividness of participants' mental image were drawn from the Vividness of Visual Imagery Questionnaire (Marks, 1973), the most widely used measure of imagery vividness (McAvinue & Robertson, 2007).

McGill Pain Questionnaire- Short Form (MPQ-SF)- Melzack (1987)

The McGill Pain Questionnaire- Short Form (Appendix 5) is a brief self-report measure of pain severity during the preceding week. The MPQ-SF includes 15 pain descriptive words in the sensory ($N=11$) and affective ($N=4$) dimensions drawn from the full length McGill Pain Questionnaire (Melzack, 1975). Each pain descriptor is rated on a four point severity scale, providing severity measures in the sensory (range=0-33) and affective (range=0-12) dimensions, in addition to a total score (range=0-45). The MPQ-SF also includes a visual analogue scale measure of overall pain intensity, which is scored on a range from 0 to 10. Melzack (1987) do not report internal or test-retest reliability statistics for the MPQ-SF, however the measure was found to be highly

correlated with the full version of the McGill Pain Questionnaire (Melzack, 1987), which itself has good levels of internal reliability ($\alpha=.84$, Turk et al., 1985) and test-retest reliability (Graham *et al.*, 1980; Melzack, 1975).

Depression, Anxiety and Positive Outlook Scale (DAPOS)- Pincus et al. (2004b)

The DAPOS (Appendix 6) is an 11-item brief self report measure of depression, anxiety and positive outlook that has been developed specifically for a chronic pain population. The scale was developed from two commonly used self-report measures (the Beck Depression Inventory- 2nd Edition, and the Hospital Anxiety and Depression Scale) using exploratory factor analysis in order to provide a concise, chronic pain specific measure which does not have problems resulting from criterion contamination by somatic items. The DAPOS has three subscales, depression (range=5-25), anxiety (range=3-15) and positive outlook (range=3-15). The measure has primarily been used as a research tool at this stage, and hence clinical cut-offs have not been developed. Although the DAPOS was found to have a robust internal structure through factor analysis across three discrete samples of pain sufferers (Pincus *et al.*, 2004b), statistics on the internal or test-retest reliability of this measure have not yet been reported.

Spontaneous Use of Imagery Scale (SUIS)- Reisberg et al. (2003)

The SUIS (Appendix 7) is a 12-item self report measure of use of imagery in everyday situations. Items such as, “*when going to a new place, I prefer directions that include detailed descriptions of landmarks (such as the size, shape and colour of a petrol station) in addition to their names*” are rated on a five-point Likert scale from 1, “*never*

appropriate” to 5, “*always appropriate*”, producing a mean item score, averaged across all items (range=1-5). Reisberg *et al.* (2003) report a mean item score of 3.11 (SD= 0.66) in a sample of 150 academics, however normative data has not been published on other populations. Unfortunately, Reisberg *et al.* did not report an adequate measure of internal consistency for the SUIS, nor has the scale’s test-retest reliability been established. The scale has been used in subsequent research into mental imagery (Mast *et al.*, 2003; Holmes *et al.*, 2006). Reisberg *et al.* (2003) report that mean scores on the SUIS correlate significantly with scores on the Vividness of Visual Imagery Questionnaire (Marks, 1973), a well established measure of self-reported imagery vividness, indicating that those with more vivid images tend to use imagery more in everyday life.

Procedure

Four hundred and ninety-one postal questionnaire packs were sent to participants’ home addresses. The questionnaire pack included a letter of invitation, a participant information sheet, the Chronic Pain Mental Imagery Questionnaire, the MPQ-SF, the DAPOS, and the SUIS, in addition to a stamped addressed envelope allowing for return of questionnaires. Questionnaire returns were deemed to be spoilt if they did not indicate whether or not the participant experienced an image of their pain, or if they provided no information regarding the characteristics of their mental image (if experienced) and also did not complete the standardised self-report measures (the MPQ-SF, the DAPOS and

the SUIS). Those participants who returned unspoilt questionnaires were included in the study. Participants who reported experiencing pain-related mental imagery were asked to provide their contact details should they be interested in taking part in interviews as part of study two of this project.

Data analysis

The returned questionnaires provided both qualitative and quantitative data for analysis. Independent t-tests were used to examine hypotheses regarding differences between imagers and non-imagers on measures of anxiety, depression and spontaneous use of imagery in everyday life (hypotheses 1, 2, and 3). Qualitative data, in the form of participants' written descriptions of their mental images was thematically analysed in order to categorise mental images into distinct themes. This analysis was conducted by the researcher.

The DAPOS and SUIS questionnaires were scored pro-rata if up to two data points were missing, and deemed spoilt if three or more data points were missing. Statistical analysis was undertaken using Statistical Package for the Social Sciences, Version 15.

Results

Overall sample characteristics

Of the 491 questionnaires sent, 112 were returned by participants, and 6 packs were returned undelivered. Seven returns were deemed to be spoilt and therefore not included in the final analysis. Therefore, 105 unspoilt questionnaire returns were included in the analysis. Taking into account the 6 questionnaire packs that were returned undelivered, this represents an unspoilt return rate of 22%. Of the 105 valid returns, 33 were male and 72 female. The mean age of the sample was 59 years, with a range of 19 to 90 years.

The mean score on the Spontaneous Use of Imagery Scale was 3.03, which is comparable to other published data and suggests that the sample as a whole does not differ greatly in their use of imagery in everyday life from other groups on which this measure has been reported.

Proportion of participants reporting mental imagery

Forty percent of participants reported experiencing a mental image of their pain ($N=41$).

Group comparisons between those who report imagery and those who do not

There were no significant differences between those who reported imagery and those who did not in terms of age, gender, DAPOS positive outlook scores, or in pain intensity

as measured by the visual analogue scale of the MPQ-SF. Significant differences in MPQ-SF total scores were found however, such that those who reported imagery also reported higher levels of pain unpleasantness [$t=2.453$ (d.f.=102), $p=0.016$, $d=0.49$].

Results relating to hypotheses

Hypothesis 1

Those participants who report experiencing a mental image of their pain will experience higher levels of self-reported anxiety than participants who do not report experiencing a mental image of their pain.

Table 1. DAPOS anxiety subscale scores

Imagery Yes/No	<i>N</i>	Mean Anxiety Score	SD
Yes	41	6.83	3.79
No	52	5.75	3.46

Means and standard deviations for DAPOS anxiety scores of those who did, and those who did not report having a mental image of their pain are displayed in Table 1. An independent samples t-test found the difference in DAPOS anxiety scores between the two groups was not statistically significant [$t=1.432$ (d.f.=91), $p=0.156$, $d=0.30$]. Although the difference between the two groups was in the direction predicted, and the

effect is of sufficient magnitude to be deemed a small effect (Cohen, 1992), the difference was not statistically significant, and therefore hypothesis 1 was not supported.

Hypothesis 2

Those participants who report experiencing a mental image of their pain will experience higher levels of self-reported depression than participants who do not report experiencing a mental image of their pain

Table 2. DAPOS Depression subscale scores

Imagery Yes/No	<i>N</i>	Mean Depression Score	SD
Yes	41	11.54	5.90
No	52	9.19	5.16

Means and standard deviations for DAPOS depression scores among imagers and non-imagers are displayed in Table 2 above. An independent samples t-test found the difference in DAPOS Depression scores between the two groups to be statistically significant [$t=2.042$ (d.f.=91), $p=0.044$, $d=0.43$] and in the predicted direction. According to Cohen (1992), the magnitude of this effect would be deemed to be small to medium. Hypothesis 2 was therefore supported.

Hypothesis 3

Significantly greater use of mental imagery in everyday life situations will be reported by those participants who report experiencing mental images of their pain than those participants who do not report a mental image of their pain

Table 3. Reported use of mental imagery in everyday life (SUIS= Spontaneous Use of Imagery Scale)

Imagery Yes/No	<i>N</i>	Mean SUIS score	SD
Yes	40	3.25	0.80
No	60	2.91	0.83

Means and standard deviations for Spontaneous Use of Imagery are displayed above in Table 3. An independent samples t-test found the difference in reported use of mental imagery in everyday life (SUIS scores) between the two groups was statistically significant [$t=2.024$ (d.f.=97), $p=0.046$, $d=0.41$] and in the predicted direction. As with the difference in depression scores between the two groups, the size of this effect is small to medium. Hypothesis 3 was therefore supported.

In summary, those participants who reported experiencing a mental image of their pain also had higher levels of anxiety, depression, and spontaneous use of imagery in everyday life. These effects were found to be of small, or small to medium size. Only the

differences in depression scores and in spontaneous use of imagery were found to be statistically significant, however.

Exploratory analysis

The Chronic Pain Mental Imagery Questionnaire gathered data regarding the characteristics of mental images of pain from those who reported experiencing mental images. The dimensions explored were imagery vividness, frequency, distress, degree of interference, and controllability.

Imagery vividness

The subjective vividness of participants' mental images of their pain was recorded on a five point Likert scale adapted from the Vividness of Visual Imagery Questionnaire (Marks, 1973). The total number of responses at each point of this scale is displayed in Figure 1 overleaf. It is notable that thirty-four respondents (85%) rated their mental image as being at least moderately clear and vivid.

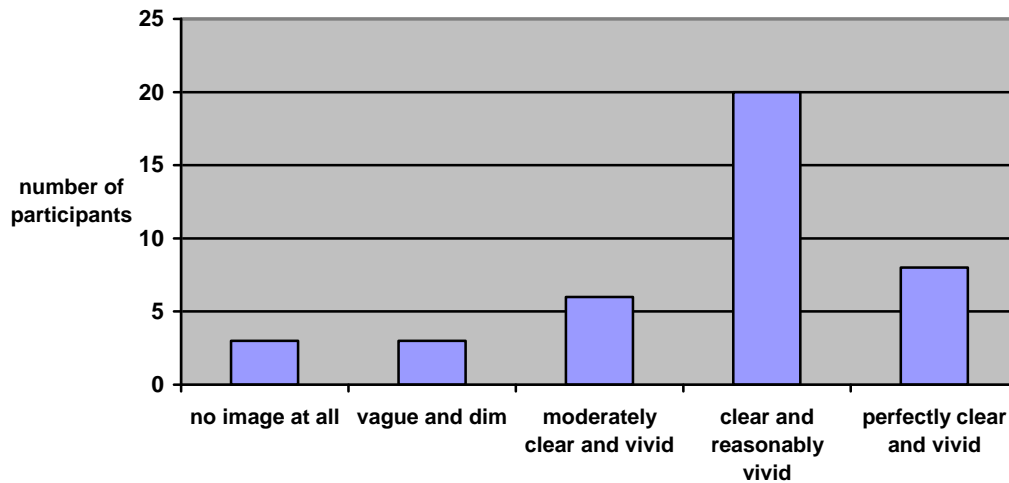


Figure 1. Participants' ratings of the vividness of their mental image

Imagery frequency

The frequency at which participants experience their mental image was also recorded on a five-point Likert scale. Figure 2 displays the sum of participants' responses on this measure. Thirty-three respondents (80%) indicated that they experienced their mental image at least daily.

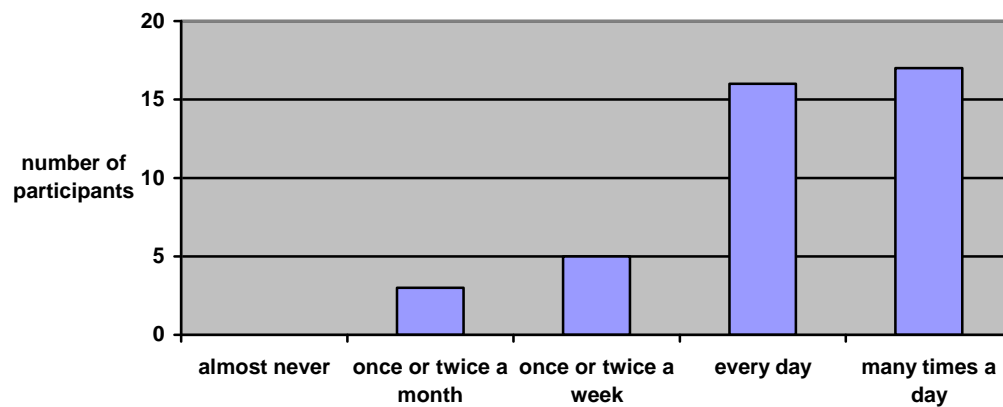


Figure 2. Participants' ratings of the frequency of their mental image

Distress

Participants rated how distressing or pleasant their mental image was on a scale from -50 (“very distressing”), through 0 (“neither distressing nor unpleasant”) to +50 (“very pleasant”). Responses on this item are displayed below in Figure 3.

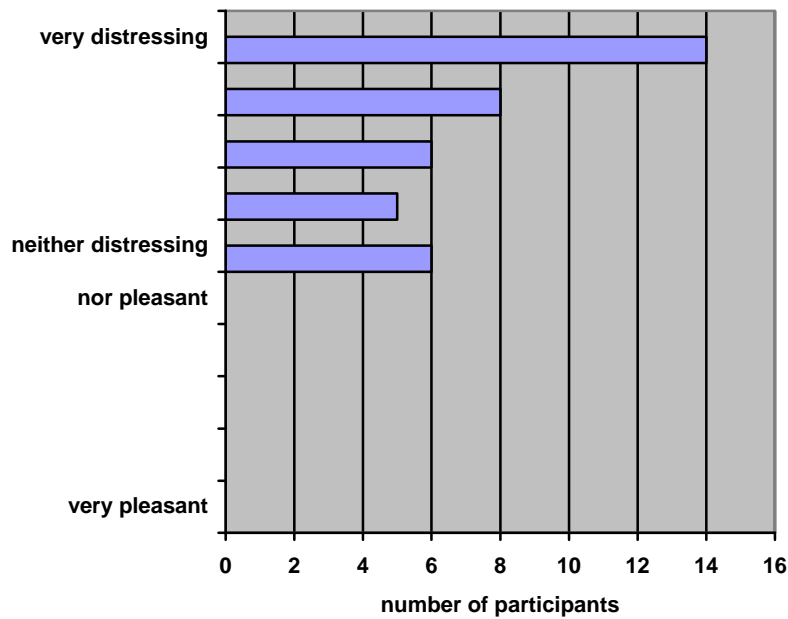


Figure 3. Participants' ratings of the degree of distress associated with their mental image

All participants rated their images as either neutral, or distressing to some degree. No participant rated their image as being pleasant to any degree.

Interference

Participants rated the degree of interference in daily life as a result of their image on a scale from 0 (“does not interfere at all”) through 50 (“moderately interferes”) to 100 (“severely interferes”). Their responses are displayed below in Figure 4.

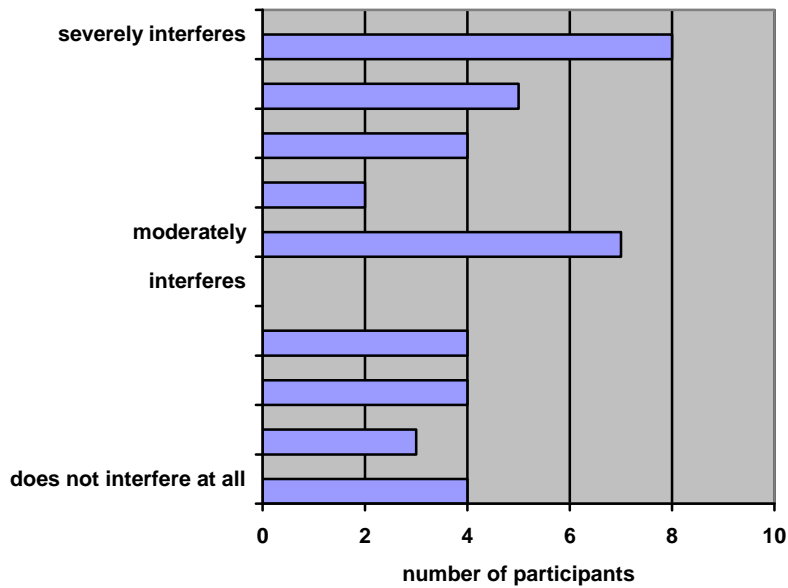


Figure 4. Participants' ratings of degree of interference in daily life resulting from their image

Controllability

Participants rated the degree of control they have over what happens in their image on a scale from 0 (“no control at all”), through 50 (“moderate control”) to 100 (“complete control”). Their responses are displayed below in Figure 5.

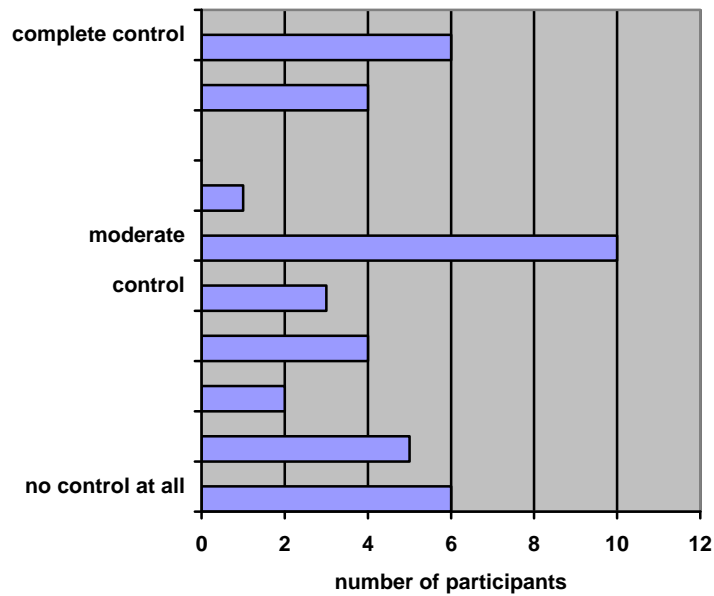


Figure 5. Participants' ratings of degree of control over their image

Exploratory correlational analysis

In order to explore the data further, correlations between imagery characteristics were conducted. The non-parametric Spearman's ρ was used for this purpose as the data, particularly that relating to measures of imagery vividness and frequency were at the ordinal rather than interval level, and hence the assumptions underlying the use of a parametric test such as Pearson's r were not met. A correlation matrix is displayed in Table 4.

Table 4. Correlations between imagery characteristics

	Image vividness	Image frequency	Image distress	Image interference	Image controllability
Image vividness	-	.142	.338*	.313*	-.135
Image frequency	-	-	.070	.151	.034
Image distress	-	-	-	.713**	-.244
Image interference	-	-	-	-	-.065
Image controllability	-	-	-	-	-

* significant at the 0.05 level (two-tailed)

** significant at the 0.001 level (two-tailed)

The strongest correlation was between the imagery characteristics of distress and interference ($r_s=0.713$), such that more distressing images are more interfering in daily life. In addition to this, moderate positive correlations were found between imagery vividness and imagery distress ($r_s=0.338$), and between imagery vividness and imagery

interference ($r_s=0.313$), although these may be chance findings as a result of the number of correlations conducted in this exploratory analysis.

To summarise, participants' mental images of their pain were found, predominately, to be distressing, clear and reasonably vivid, frequent, and to interfere with daily life to some degree. In addition, the level of distress caused by the image was found to be strongly correlated with the level of interference in daily life experienced as a result of the image.

Thematic analysis of image descriptions

Forty-one participants reported experiencing a mental image of their pain and provided a written description of their image. These descriptions were compiled and themes across participants' images were explored. Results of this thematic analysis, including examples, are presented over the next three pages. The complete thematic analysis, including all of the imagery descriptions obtained is provided for reference in appendix 8. Eight of the forty-one responders who claimed to experience pain-related mental imagery provided descriptions of more than one image. This occurred exclusively where the person experienced two or more distinct areas or types of pain. Where it is clear the participant has described two separate images these have been treated and reported as discrete images in the analysis.

Theme 1. Representations of sensory qualities of pain

Sub-theme: Pressure or weight

- *“...Sometimes as if I am under a giant metal press crushing my chest and throat, head” (Participant 28)*
- *“As if I’m lying in the middle of a road and a road roller keeps driving over me” (Participant 33)*
- *“I have a mental image of a large hand inside the base of my spine squeezing as hard as it can, relentlessly...” (Participant 97)*

Sub-theme: Sharpness

- *“Like a knife or broken glass being stabbed in my leg” (Participant 23)*
- *“Very sharp, jagged teeth searing into my neck like the jaws of a shark” (Participant 25)*
- *“If the pain is very sharp I imagine it as knitting needles being launched down various routes both in my back and legs” (Participant 104)*

Sub-theme: Burning Heat

- *“I can feel sometimes as though an electric heat is being applied to my right leg” (Participant 5)*
- *“It’s like a red hot poker inserted anally...” (Participant 26)*
- *“Fire going up and down my left side as if someone has a lighted torch trying to set my left side on fire” (Participant 27)*

Sub-theme: Electricity

- *“Electricity running along wires, electric shocks...” (Participant 16)*
- *“...The pain down my leg is like a bolt of lightning, unpredictable and you never know where or when it’s going to strike.” (Participant 97)*
- *“I have an image of an electric short circuit running down my legs!!” (Participant 93)*

Sub-theme: Vibration

- *“Like a piano string being twanged” (Participant 13)*

Theme 2. Anatomical Representations of Damage

- *“...I think there is all this redness, inflammation, muscle damage around the herniated disk” (Participant 22)*
- *“Bones grinding together” (Participant 32)*
- *“The discs in my spine crumbling or grinding together causing my body to grind to a halt” (Participant 111)*

Theme 3. Pain as an Externalised Object

- *“I often think that the pain is like a burning coal just smaller than a golf ball but bigger than a marble that rolls around my breasts” (Participant 1)*
- *“My image looks like a large ball about the size of a tennis ball and it looks spongy and horrible” (Participant 14)*

- *“It’s like a ball of pain- almost a knot of my kidney/right-hand side area and it gets hot and sore and moves about, and throbs” (Participant 18)*

Theme 4. Victim of Attack

- *“Like my body is being attacked (where problems are) by someone with a voodoo doll or a little army inside me making sure I am in agony!” (Participant 6)*
- *“It is like all the inflamed area of my lower back has been pinpointed for attack so everything just moves to this area, making the pain worse...” (Participant 22)*
- *“Yes, a big pain worm or bug eating at the site of pain. Only relief is to keep squashing it with as much pressure as possible” (Participant 30)*

Theme 5. Expressions of distress

- *“When the pain comes very stronger I scream and cry, I can’t take it and usually I get stress that’s why I get depression tablets from the doctors. I feel a bit calm with I hope to god the doctors can give me something better than that and take the pain away” (Participant 4)*
- *“I can visualise the pain that I know IS coming, so I hate later on in the day as I know what’s coming” (Participant 9)*
- *“The pain sometimes makes me wonder if I will end up a cripple or housebound. I also wonder if I will get dementia as my illness causes me to have extremely bad memory and I haven’t slept for years (through a whole night)” (Participant 94)*

Study two: Semi-structured Interview Study

Methodology

Design

Study two involved semi-structured interviews with a sample of participants who reported experiencing pain-related mental images in their questionnaires as part of study one. This phase of the study was primarily exploratory, given the lack of prior research or theory in this area. Interviews provided some quantitative data to enable statistical testing of hypotheses relating to physiological and emotional reactivity as a result of participants contacting their images (hypotheses 4 and 5). Interviews also produced further exploratory data regarding participants' experience of mental imagery.

Participants

Participants were recruited from those who returned questionnaires as part of study one. Specifically, participants who returned a completed questionnaire, reported experiencing pain-related mental images, and indicated that they were willing to take part in interviews were considered for inclusion in study two. To ensure the safety of both interviewer and participant, advice was sought from the Consultants in Anaesthesia and Pain Medicine within the Chronic Pain Service regarding each participant's suitability to take part in an interview. A small number of participants were deemed not to be suitable following discussion with a Consultant, primarily due to high distress levels, and were

therefore not invited to interview. Those who were deemed suitable were contacted by the researcher in order to provide further information, obtain consent, and arrange for a face-to-face interview. All potential participants contacted by the researcher in this way chose to take part in an interview.

Ethical approval

Ethical approval was sought for this study in a joint application with study one of this project, and was granted by the local Research Ethics Committee (see Appendix 1 for a letter confirming ethical approval).

Ethical issues

A number of ethical considerations were taken into account in the design of this study. With regards to ensuring participants were able to provide informed consent, participants received information about this study within the participant information sheet accompanying study one, in addition to being given the opportunity to discuss the study and ask questions of the researcher in person prior to deciding whether to take part. Participants were informed at several stages of this process that their participation was entirely voluntary, and that they could withdraw from the study at any time and for any reason without negative consequence. Participants also read and signed a written consent form to confirm their awareness of these issues.

A further ethical issue which was considered in the study design was the possibility that participants might become distressed during interviews as a result of discussing their pain experience or imagery. This issue was discussed with a qualified clinical psychologist who was supervising the project and it was agreed that the interviewer (who was also the researcher) had the appropriate skills and knowledge developed through training and clinical experience working with distressed individuals, including those suffering from post traumatic stress disorder, to be able to adequately assess and manage such situations. A further ethical consideration was the potential that a participant might make a disclosure to the interviewer which had implications for the safety of the participant, or the safety of other people. Again, it was agreed that the interviewer possessed the suitable risk assessment and management skills to appropriately respond to such situations.

In order to ensure participants were aware of the limits of confidentiality with regards to risk assessment and management, participants were asked prior to interview to give consent for the interviewer to contact their GP should he have any concerns regarding their safety or the safety of others.

Procedure

Interviews lasted for around 30 minutes and took part either at outpatient clinic rooms at the teaching hospital, or at participants' homes, to suit individual participant's preference. Prior to interview, participants were given the opportunity to ask the

interviewer any questions about the format or content of the interview, and completed a consent form. The researcher conducted all interviews, with participants' responses recorded by hand on the interview schedule in addition to being recorded using digital audio recording equipment to ensure important data provided by participants was not missed during interview. These audio recordings were not transcribed for in-depth analysis due to time constraints.

Interview format

The interviews followed a semi-structured format, allowing for both closed and open-ended responses where appropriate to each individual item. Initial interview questions were standardised and read verbatim by the interviewer, with response options presented to participants on a laminated sheet to assist them in providing answers to fixed-choice items (Appendix 9). For open-ended items, the interviewer followed-up participants' initial responses in order to gain richer data.

The interview schedule (see Appendix 10) was adapted from previous studies into mental imagery in social phobia (Hackmann *et al.*, 1998, 2000) for the purposes of the present study. The second item in the schedule asked participants to make contact with and describe their mental image in detail. Participants were encouraged to allow themselves a few moments to try to bring their image to mind as clearly as possible, and the full range of sensory modalities were enquired about to determine their presence in the image. After eliciting and describing their image, participants were asked to

retrospectively rate the degree of physiological, emotional, and pain reactivity they experienced while contacting their image. Measures of physiological and emotional reactivity included in the interview schedule were newly devised for the purposes of this study.

The four facets of physiological arousal included in this measure were derived both from knowledge of common symptoms of autonomic arousal and from selected items in the somatic anxiety subscale of the Pain Anxiety Symptoms Scale or PASS (McCracken *et al.*, 1992). The somatic anxiety subscale of the PASS was developed to assess symptoms of physiological arousal linked with the experience of pain, however the scale itself was not in a suitable format to be used in the present study, and was therefore not used in its original form.

A single item was developed to assess emotional reactivity. This item asked participants if they had experienced a change in emotional valence, and if so whether this change was towards a more negative or more positive emotional state. Other measures, including the PASS, have measured specific emotions such as fear as emotional reactions to pain. It was not known, however, which specific emotions might be experienced by participants as a result of recalling their image, and therefore a broad measure of change in affective valence was believed to be appropriate. Established broad measures of affect were considered for use in this study, such as the Positive and Negative Affect Scale (Watson *et al.*, 1988). The PANAS was not deemed suitable for the purposes of the present study however, primarily because it required too much time

to administer and was therefore impractical. Specific emotions experienced while contacting the image were enquired about in the subsequent item of the interview schedule.

Data analysis

Interviews produced both quantitative and qualitative data for analysis. Quantitative data in the form of Likert scale responses allowed hypotheses relating to physiological and emotional reactivity (hypotheses 4 and 5) to be explored. The interview also produced exploratory data, both quantitative and qualitative, which was explored and reported using descriptive statistics.

Results

Sample characteristics

Sixteen participants took part in interviews. Data from two interview participants were deemed to be void and not included in the analysis as they could not elicit an image of their pain during interview, despite reporting experiencing a mental image of their pain in their questionnaires. Of the fourteen participants included in the analysis, four were male, and ten female. These fourteen interviewees were not significantly different from those who reported mental imagery in study one but who did not take part in an interview in terms of their age, gender, MPQ-SF total and intensity scores, DAPOS depression, anxiety and positive outlook scores, SUIS mean scores, or ratings on any of the imagery characteristics measured in study one. It should be noted, however, that the limited numbers of participants who took part in study two limit the power of such comparative analyses to detect more modest differences between the groups. Table 5 overleaf provides mean scores for each of these two groups to allow for comparison.

Table 5. Comparisons between those participants who took part in study two, and those who reported mental imagery in study one but who were not included in study two

	Participated in interview	Did not participate in interview
Number of participants	14	27
Mean age	55 years	59 years
Percentage female	71%	63%
MPQ-SF Total	19.64	23.27
MPQ-SF Pain intensity	6.93	7.77
DAPOS Depression	9.57	12.56
DAPOS Anxiety	6.14	7.19
DAPOS Positive Outlook	8.79	8.70
SUIS mean score	3.47	3.14

Hypotheses

Hypothesis 4

Participants will report having experienced increases in physiological arousal during the time that they were contacting their mental image.

Subjective degree of physiological arousal was measured across four items using a seven-point Likert scale. The four aspects of physiological arousal measured were muscular tension, sweatiness, heart rate, and breathing rate. The number of participants reporting physiological arousal in each of these domains is presented below in Figure 6.

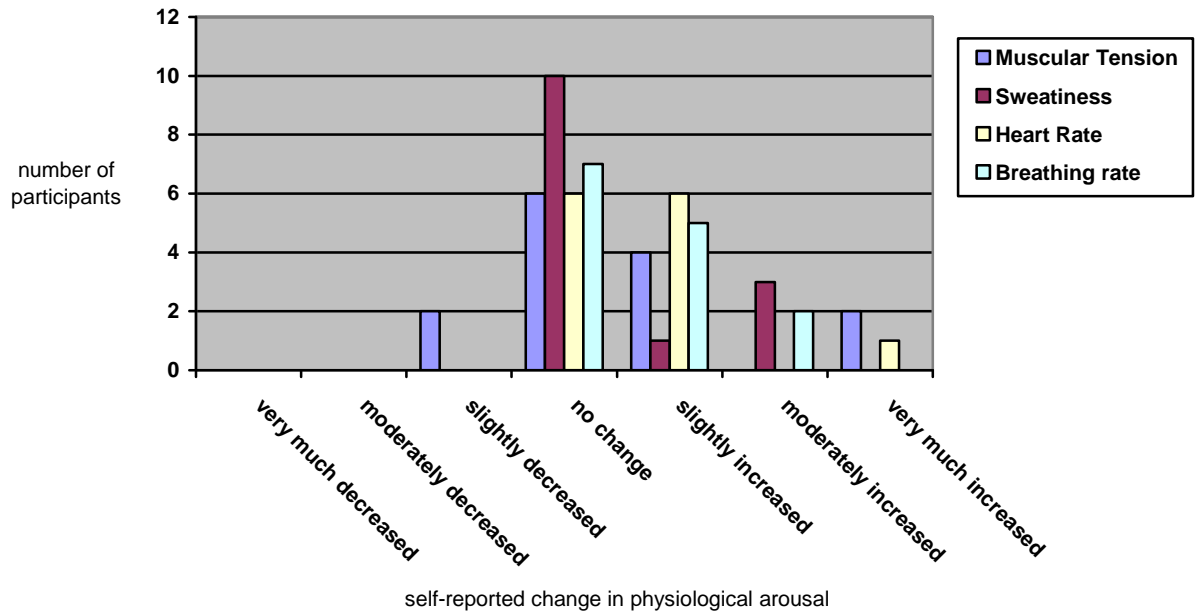


Figure 6. Participant's ratings of physiological response to contacting image

An overall measure of physiological arousal was derived by taking the mean of each individual's scores on the four items described above. Those participants whose average physiological arousal score indicated an increase in arousal were categorised as having experienced increased physiological reactivity to their image, and those whose mean score indicated a decrease or no change in arousal were categorised as not experiencing increased physiological reactivity. Numbers of participants categorised into each group are displayed in Table 6.

Table 6. Number of participants who did, or did not experience physiological reactivity while contacting their image

Increased Physiological Arousal	Number of Participants
Yes	12
No	2

The results displayed in Table 6 indicate that most participants did indeed report experiencing increased self-reported physiological arousal while contacting their image. Hypothesis 4 was therefore deemed to be supported.

Cronbach's Alpha statistic indicated that the four separate measures of physiological arousal did not in fact measure the same underlying construct ($\alpha = .209$). This does present difficulties for the conceptualisation of physiological arousal presented here. However, as the purpose of combining the measures was simply to provide a

dichotomous categorisation of whether or not participants had experienced any sort of autonomic or muscular physiological arousal, and because the small sample size prevented separate analyses on each of the four measures, this approach was deemed appropriate.

Hypothesis 5

Participants will report having experienced a shift toward a more negative emotional state during the time that they were contacting their mental image.

Emotional reactivity was recorded using a seven-point Likert scale. Participants' emotional reactivity ratings are displayed in Figure 7.

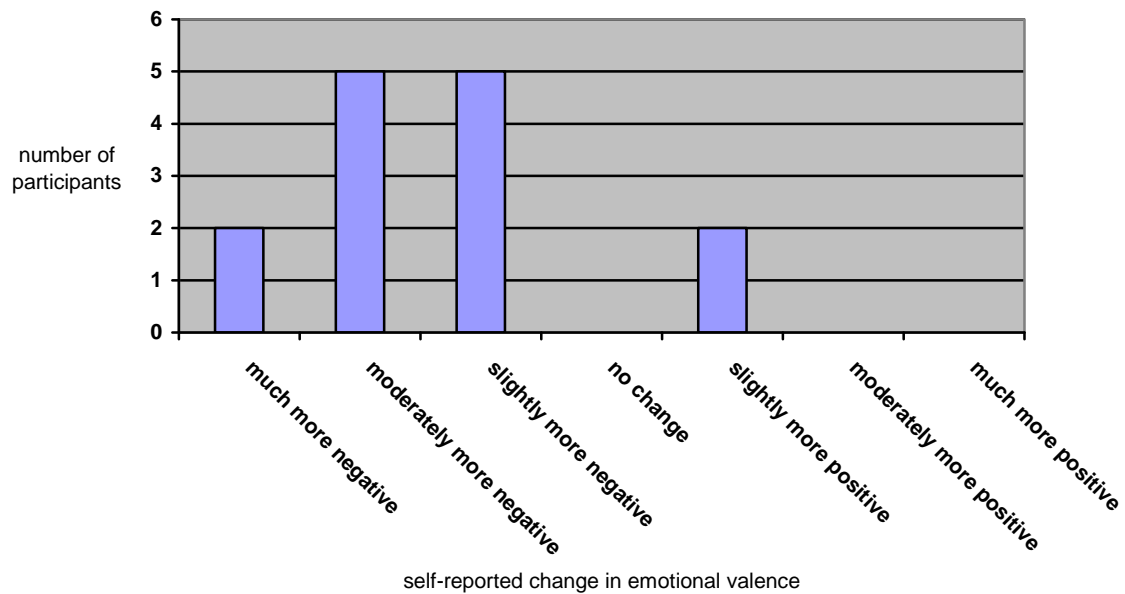


Figure 7. Participant ratings of emotional response to contacting image

Prior to further analysis, participants' responses were dichotomised as either having experienced a shift to a more negative emotional state (having rated their emotional state as slightly, moderately, or much more negative), or not having experienced a shift to a more negative emotional state (having rated their emotional state as unchanged, or as slightly, moderately, or much more positive). The number of participants categorised into each group is displayed below in Table 7.

Table 7. Number of participants who did, or did not experience negative emotional reactivity

Negative Emotional Reactivity	Number of Participants
Yes	12
No	2

These results indicate that the majority of participants did indeed report negative emotional reactivity while contacting their image. Hypothesis 5 was therefore deemed to be supported.

Exploratory analysis

Specific emotions reported

A range of specific emotions were reported by participants in response to describing their image. The emotions described were *sad or tearful* (7 participants), *anxious* (5 participants), *angry or resentful* (6 participants), *helpless* (4 participants), *self-pitying* (3 participants), *ashamed or guilty* (2 participants), *embarrassed* (2 participants), and *amused* (1 participant). Participants' specific emotional responses are displayed graphically in Figure 8.

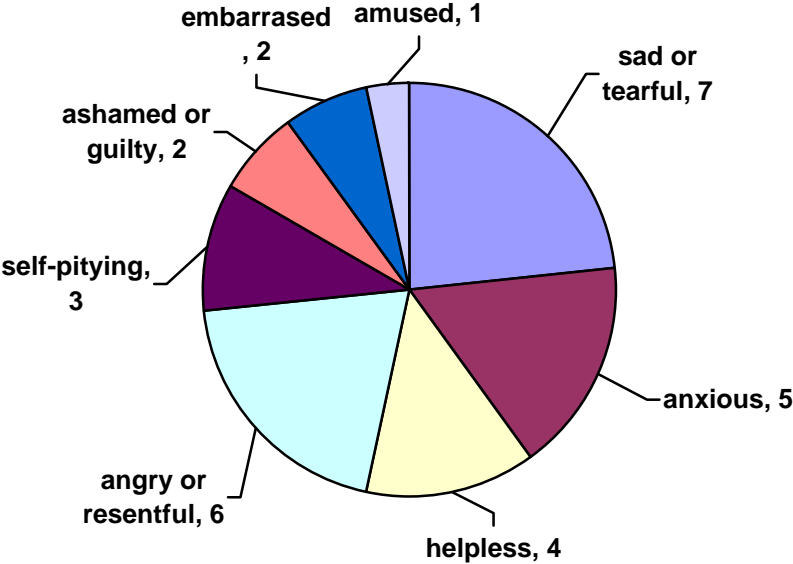


Figure 8. Participants' specific emotional reactions to contacting their image

Pain reactivity

Change in pain intensity while contacting the image was recorded on a seven-point Likert scale, using the same descriptors as those used to record physiological arousal. Participants' responses on this measure are displayed in Figure 9 below.

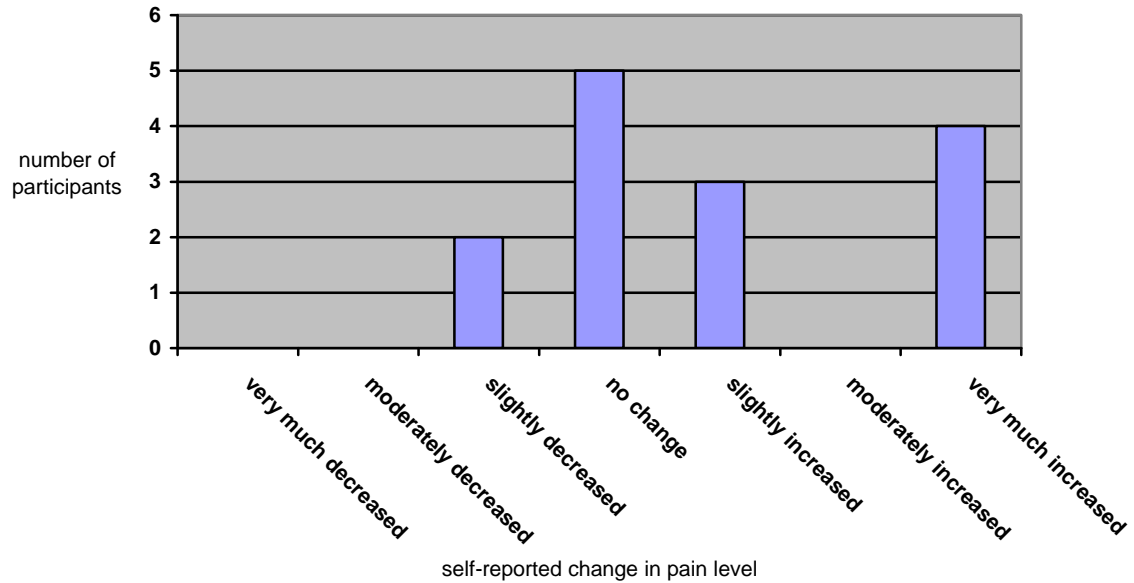


Figure 9. Participant ratings of change in pain intensity in response to contacting image

Visual inspection of Figure 9 indicates that contacting a pain-related mental image did increase pain levels for half of the participants taking part in this study, and that four of the fourteen participants reported that their pain levels had “*very much increased*”.

Sensory modalities in images

Analysing image descriptions given during interview revealed that participants described a range of sense modalities as being present in their images. All fourteen participants reported the visual modality being present in their images, two reported aspects of taste in their image, and a single participant reported each of auditory and olfactory modalities in their image. The touch or tactile modality was also present in ten of the fourteen participants, however the degree to which this aspect of experience may be due to actual sensory input from the pain area or from damaged nerves, rather than mental imagery alone is impossible to clearly determine. Examples of tactile aspects of imagery include sensations of smoothness, sponginess, and prickliness.

Associated verbal cognitions

Of the fourteen participants who completed interviews, eleven were able to identify verbal cognitions which occur at the same time as their image. Although there were insufficient data to allow for thematic analysis of the associated verbal cognitions, the examples overleaf illustrate the kinds of verbal thoughts described. A complete record of verbal cognitions reported can be found in Appendix 11.

“I can’t live the rest of my life with this pain”
(Participant 6)

“In fifteen or twenty years I’ll end up on a hospital bed writhing in pain”
(Participant 20)

“I can’t lead a normal life”
(Participant 18)

“I can’t do anything about it”
(Participant 36)

“Has something like a blood vessel burst”
(Participant 14)

Recalled time since first experience of mental image

On average, participants recalled having first experienced their mental image three years previously, with a range from one to eight years. Using information given by participants about the onset of their pain, it was calculated that the mean length of time between the onset of pain and the first appearance of their image was twenty months.

Anecdotally, it was noted during interview that attempting to clearly identify the time of onset of a pain-related mental image proved a difficult and thought-provoking challenge for many participants. Furthermore, a significant proportion of participants explained that, while they were certain their image had been with them for a long time, they had not been as aware of its presence until prompted by the questionnaire in study one. When questioned further on this issue, participants felt confident in the accuracy of their estimates regarding the time their image had first appeared, but also reported that

thinking about and discussing the image had made them more aware of what they had been experiencing, and brought the phenomenon more clearly into their consciousness.

Stability of image

In order to determine the degree of stability of their image, participants were asked to rate how much their image changed over time using a fixed five-point Likert scale. Participants' ratings on this measure are displayed in Figure 10 below.

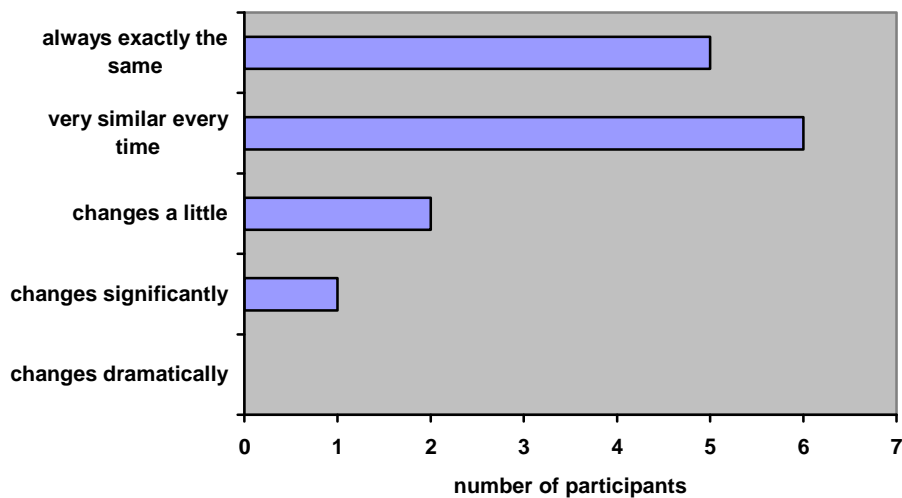


Figure 10. Participants' ratings of degree of change in image over time

Anecdotally, it was noted by the interviewer that those participants who described their image as being changeable to a significant degree reported that the change in their image was reliably linked to the intensity of their pain. For example, participant 30 described how her image changed from a small worm which seemed to be “*grazing, like taking*

bites out of me” to a worm with a “*big open mouth, fire coming out of its mouth*” when her pain increased. Accepting that such changeability in imagery as a result of varying pain levels may occur without significant change to participants’ images over the longer-term, it appears that the participants experienced images that are stable and relatively unchanging over time.

Image triggers

Thirteen of the fourteen interview participants were able to identify things that commonly trigger their mental image. All thirteen identified an increase in pain as being a key trigger. In addition, a further two stated that activities which led them to notice the limitations their pain or disability imposes upon them are significant triggers, and two stated that boredom or lack of stimulation was a common trigger. Several other idiosyncratic triggers were also described. As an example, one participant reported that she frequently experienced her vivid image of seeing bones grinding together in response to actually hearing her bones clicking.

Reactions to image

During interview, common reactions to images were enquired about. Care was taken to emphasise that reactions to participants’ images of their pain, and not simply the pain itself were being explored, however, bearing in mind that pain was reported as a major image trigger it may be difficult to clearly differentiate imagery from sensory pain in

their causal roles upon behaviour. Bearing this in mind as a caveat, all participants were able to describe typical reactions to their image and, despite the small sample size, a common theme does appear to emerge from this data. The theme of avoidance could be interpreted as accounting for all but two participants' reactions. Examples of specific reactions within this theme include; trying to ignore or suppress the image, immediately stopping ongoing activity, withdrawing from activities and from other people, and trying to shake off the image by moving or shaking the affected part of the body.

Two participants reported a qualitatively different reaction, in that they described engaging with their image and trying to have an interaction or conversation with the image. It is perhaps interesting that these two participants, who appeared to be reacting to their image in a non-avoidant and more accepting manner, were the only participants who reported a positive emotional reaction to contacting their image during interview. Such isolated findings may be the result of chance variability, however they may also suggest ways in which chronic pain sufferers reactions to their images may have implications for their levels of distress.

Exploratory correlational analysis

Exploratory analyses were conducted to explore correlations between participants' imagery characteristics, as recorded in study one, and degree of physiological, emotional and pain reactivity to their image, as recorded in study two. A correlation matrix is displayed in Table 8.

Table 8. Spearman's correlations between imagery characteristics and physiological, emotional and pain reactivity

	Image vividness	Image frequency	Image distress	Image interference	Image controllability
Physiological reactivity	-.169	.161	.000	-.077	.051
Emotional reactivity	-.579*	-.087	.061	-.170	.281
Pain reactivity	-.512	-.104	.156	-.173	.473

* significant at the 0.05 level (two-tailed)

The limited number of interview participants ($N=14$) limit the statistical significance of these findings, however correlations of large size (Cohen, 1992) were found between increasing image vividness and lower levels of both emotional reactivity [$r_s = -.579$] and pain reactivity [$r_s = -.512$], and between increased levels of perceived control over what happens in the image and greater pain reactivity [$r_s = .473$].

Discussion

Summary of findings

The combined findings of both studies in this project provide a great deal of new information about the largely unexplored phenomenon of naturally-occurring mental imagery in chronic pain.

With regards to the prevalence of naturally-occurring pain-related mental imagery, 40% of people drawn from a heterogeneous sample of chronic pain sufferers were able to identify having a mental image of their pain and to give a description of what that mental image was like. Furthermore, those who were able to identify a mental image had significantly higher levels of self-reported depression and rated their pain as more unpleasant on the MPQ-SF than those who did not report imagery, despite having the same level of pain intensity. Chronic pain sufferers who were able to identify having a mental image of their pain also reported using mental imagery more in everyday life than those who did not.

The majority of those who claim to have a mental image were able to intentionally generate their image and explore its qualities when requested to do so during interview. The mental images reported occurred primarily in the visual and tactile modality, however auditory, olfactory, and taste modalities were also reported by some. The mental images were described by the majority of participants as being at least

moderately clear and vivid, as occurring at least every day, and as being distressing. Furthermore, the images reported were long-standing and largely stable, having been first experienced an average of three years prior to interview.

With regard to the content of these mental images, distinct themes emerged from the analysis of participants' image descriptions. Dominant themes appear to relate to the sensory qualities of the pain, the individuals' beliefs about the physical cause of pain, and personal meanings that the presence of pain has for the individual, with themes of victimisation or punishment most common.

In participants' day to day lives, naturally-occurring pain-related mental images occur most frequently when triggered by an increase in pain levels, however other cues may also trigger the images including interference with activities as a result of pain-related disability or lack of stimulation. Reactions that participants were able to identify as frequently following the occurrence of their image appeared to almost exclusively have the function of reducing, avoiding, or suppressing the image in some way.

Study two provides some initial support for the idea that these images are more than simply epiphenomenon, as the majority of participants reported increases in physiological arousal and negative affective reactivity in response to contacting their pain-related mental images during interview. Although inconclusive, it seems that accessing images in this way may also lead to increases in pain levels for a proportion of chronic pain sufferers.

Strengths and limitations of the project

There are several limitations of this project which should be taken into account in interpreting the findings, many of which are the result of a lack of prior methodological development due to the undeveloped nature of this field of research.

The imagery questionnaire measure was unvalidated, as were the measures of physiological, emotional, and pain reactivity used during interview. It is therefore necessary to interpret the findings with a degree of caution. In particular, the lack of correlation between the four items measuring physiological arousal raises questions about the validity of the concept of physiological arousal as presented here. Future studies should use objective measures of physiological arousal such as galvanic skin response and heart rate monitoring, and validated measures of emotion such as the PANAS, to overcome the limitations of the measures used in this study.

The sample used in the project was highly heterogeneous, and will have included people with a wide range of types and locations of pain, and a wide range of psychological profiles. The exclusion criteria may also have meant that some of those with the highest levels of psychological distress were excluded from the study, as they would be most likely to be receiving psychological intervention from the researcher or another qualified clinical psychologist working within the service at the time of the study. The relatively low questionnaire return rate in study one also has implications for the generalisability of these findings. The population from which the sample was drawn did include some

participants whose pain was the result of past treatment for cancer, and it may be that this group experience qualitatively different imagery. Future studies might benefit from using a more discrete sample, perhaps focusing on a single type of chronic pain, for example chronic low back pain, or on those with distinct psychological profiles, such as those with high levels of catastrophising.

Only fourteen participants provided useful data from interviews as part of study two, and this relatively small sample size limits the generalisability of the findings of this part of the project. A larger sample size in study two may also have enabled more in depth analysis of qualitative data related to participants' verbal cognitions and behavioural reactions linked to their images, and may also have enabled the potential effect of intentional self-generation of mental imagery upon pain intensity to become clear.

The finding that two of the sixteen participants who were invited to interview in study two could not identify their mental image despite reporting having a mental image in their questionnaires, raises some questions about how some participants may have understood the definition of mental imagery provided in study one. It may be, therefore, that the 40% prevalence rate obtained from questionnaire responses in this study is somewhat inflated.

Finally, the reliance of this study on self-report during questionnaire and interview is an obvious weakness, and leaves the project open to the potential influence of problems with subjectivity and responder biases. In particular, the potential influence of the effects

of suggestibility on participants' reports regarding the presence, frequency, and time of onset of their image must be carefully considered. Evidence for the possible effects of suggestibility comes from the observation that several interview participants claimed that receiving a questionnaire as part of study one had made them more consciously aware of the presence of their mental image. On the other hand, several other participants claimed to have been consciously aware of their image long before receiving the questionnaire. Indeed, carers of two of the participants, who happened to be present during interviews, volunteered the information that the interview participant had first talked about their specific mental image a considerable length of time before ever becoming involved in this research project. Whether those who reported having become more aware of their image through contact with this research had actually become more conscious of a mental image that had already been present in a "semi-conscious" sense, or simply had the presence of their mental image "implanted" through suggestion is a fascinating question.

Overall, it is the view of the researcher that the evidence presented in this study strongly supports the existence of naturally-occurring pain-related mental images among chronic pain sufferers, and it seems very unlikely that the results reported here could be accounted for simply by the effects of suggestion. It is accepted, however, that participants' awareness of mental imagery, and their ratings of the onset and frequency of their image in particular, are likely to change to varying degrees in response to questioning and exploration.

Particular strengths of the study relate to the opportunistic sample used, and therefore the ability to generalise the findings to the clinical population routinely seen within NHS chronic pain services. Other particular strengths of the study design relate to the large sample size in study one, and the opportunity to follow up on questionnaires with interviews, which allowed for corroboration of questionnaire data.

Interpretation of findings

Imagery prevalence

Study one of this project used a very similar methodology to that used by Potter *et al.* (in submission) with a very comparable group of participants. Notwithstanding the issues discussed above regarding the degree of suggestibility inherent in the methodology, it is notable that the proportion of participants who were able to identify experiencing a mental image of their pain in this project was a great deal larger than that found by Potter *et al.* (40% compared with 24%) despite the similarities in methodology. Although a degree of chance variability is likely between studies, the magnitude of this difference suggests that differences between the questionnaire used in this study to measure mental imagery and that used by Potter *et al.* may underlie this difference.

In the Potter *et al.* study, participants were asked to answer the following item to determine the presence of mental imagery:

“Some people report having mental images and/or pictures of their pain, do you have these?”

By contrast, the item used in the present study was:

“We are particularly interested in finding out if you have a picture or a mental image of what your pain is like. A mental image is like having a picture in your head which may include things you can imagine seeing, hearing or feeling”

It may be that the definition of mental imagery provided here prompted a greater number of participants to identify their own mental images, even among those who may not have previously been fully aware of their image. It may also be that those whose mental image was partly characterised by other sensory modalities such as hearing and taste may have responded positively in this project and may not have in Potter *et al.* (in submission). It may therefore be that this study identified a broader group of chronic pain sufferers who experience mental imagery of their pain, whereas Potter *et al.* identified only those whose mental image was particularly striking or noticeable to them, or particularly visual.

Other studies reporting prevalence rates for mental imagery in psychological disorders have used semi-structured interview methodology alone, and have reported a higher prevalence of mental imagery than found in this study (eg. Hackmann et al., 1998; Day et al., 2004). It may be that using a semi-structured interview methodology rather than a questionnaire methodology with chronic pain sufferers may allow for a clearer definition of mental imagery to be presented to participants, alongside descriptions of example images. Such an approach may uncover a significantly larger prevalence rate for mental imagery than the rates found using a questionnaire methodology, however it may also increase the potential influence of suggestibility on prevalence rates.

Mental imagery themes

Thematic analysis of participants' mental image descriptions uncovered several recurrent themes, the most pervasive of which relates to being a victim of some form of attack. A broader view of the themes emerging from this study may suggest ways in which participants' images are constructed. Broadly, the data suggest that three major factors may be integrated into the construction of a pain-related mental image.

The first factor appears to relate to the sensory qualities of the pain, and subthemes involving crushing, burning, stabbing, electricity, and vibration emerged. These themes may simply be ways of representing and making sense of the sensory experiences involved in pain.

The second theme around which images appear to be constructed relates to understandings regarding the physical cause of pain. Specifically, anatomical or medical representations were described which integrate understandings about the cause of pain and which may have their origin in cultural understandings of pain, or in information given to patients by health professionals. Such representations may provide clinicians with important information about an individual's beliefs regarding the cause, consequences, and prognosis of their pain problem, which may not be as easily accessible through verbal enquiry.

The third organising theme in the construction of images may be interpreted as relating to the personal meaning pain has for the individual, and may reflect the influence of schema-level beliefs about the self, others and the world on the individual's relationship with their pain. As mentioned above, the theme of being a victim of attack was common to a large proportion of images and could be viewed as reflecting schema-level beliefs about victimisation or punishment, and beliefs about the world as cruel and vindictive. The theme of pain as some form of externalised object inside the body may also relate to schema-level beliefs about the personal meaning of pain. It may be that externalising images relate to dimensions of high perceived external locus of control over pain, or to low levels of acceptance of pain, factors which have both been found to be associated with poorer psychological adjustment to chronic pain (Crisson & Keefe, 1988; McCracken, 1998). It may, alternatively, be that the origins of the schema-level beliefs around which these externalising images originate may relate to early experiences of some form of abuse. Indeed, higher rates of child abuse have been reported in chronic

pain sufferers, although these studies have used the retrospective report of participants to measure prevalence of child abuse, and are therefore open to bias (Sacks-Ericsson *et al.*, 2007; Walsh *et al.*, 2007).

In summary, in light of the fact that meaningful themes relating to personal meanings of pain can emerge from brief descriptions given on a postal questionnaire, it does seem possible that mental images may indeed provide rapid access to important pain-relevant cognitions. Confirming this observation is an empirical question with clear clinical implications.

Presence of mental imagery and links with depression and anxiety

In keeping with the findings reported by Potter *et al.* (in submission), this project did find that those participants who reported having a mental image of their pain also had higher self-reported depression and anxiety levels (although the difference between the groups in anxiety scores was not significant). However, the size of this effect is much smaller than found by Potter *et al.*. Specifically, Potter *et al.* report effect sizes of $d=0.76$ and $d=0.51$ for anxiety and depression respectively, compared with the effect sizes of $d=0.30$ and $d=0.43$ found in the present study. There are a number of possible reasons for this effect.

Firstly, this study used a different self-report measure of depression and anxiety. The DAPOS was chosen as an alternative to the HADS for a number of reasons. The

DAPOS is a measure which has been specifically developed for use with pain populations, and therefore was felt to be particularly valid for the purposes of the present study. In addition, the DAPOS includes a positive outlook scale in keeping with a conceptualisation of positive affect as being more than simply the absence of negative affect (Pincus *et al.*, 2004b). In analysing the DAPOS results, however, it is apparent that the distribution of scores on this measure were skewed due to a floor effect, particularly within the anxiety subscale. Such an effect is likely to increase the chance of making a statistical type II error and will reduce the size of effect obtained. Further examination of Potter *et al.*'s results confirms that the HADS measure used in their study did not exhibit the same degree of floor effect as the DAPOS measure did in this study. A related factor is that the DAPOS includes only three items in its anxiety subscale, compared with the HADS seven, therefore the HADS provides a greater range in this sub-scale and is likely to be more sensitive.

An alternative interpretation for the difference between studies in strength of effect linking presence of imagery with depression and anxiety is that the present study identified a broader sample of participants as having mental images, therefore attenuating the effect. The greater prevalence rate of imagery found in this study suggests this may well be true, as explained above. More specifically, Potter *et al.*'s brief description of mental imagery may have led only those participants whose images were particularly apparent or noticeable to them to identify themselves as having a mental image and that those images which are most noticeable are associated with higher levels of psychological distress.

Overall, it may be that what actually has greatest influence on distress among chronic pain sufferers may not be simply the presence or absence of mental imagery alone, but rather the qualities and meanings of the images that are experienced, and the individual's reactions to their image. Such a conclusion is consistent with other studies into mental imagery in psychopathology. For example, Osman *et al.* (2004) reported that those with body dysmorphic disorder could be distinguished from dieting controls not by the presence or absence of imagery about their own physical bodies, but by the quality and meaning of these images.

Presence of mental imagery and links with pain ratings

Differences in scores on the McGill Pain Questionnaire-Short Form were also observed, such that those who reported experiencing images also reported higher levels of sensory and affective pain unpleasantness. This effect occurred in the absence of a difference in ratings of current pain intensity. A number of possible explanations exist for this effect which may have relevance to the interpretation of the present findings.

One explanation may be simply that those who experience more distressing forms of pain are more likely to experience a mental image of their pain, and furthermore are also likely to experience higher levels of depression and anxiety. It may also be that those who experience pain of a more neuropathic nature, which is commonly described using words such as “*shooting*”, “*burning*” or “*tingling*” may score higher on the MPQ-SF and may also be more likely to generate a mental image of their pain than those who

experience pain of a musculoskeletal nature. Unfortunately, a measure of neuropathic pain was not included in the present study, therefore it is not possible to test this hypothesis using the data available to this project.

Reversing the causal direction of the above hypothesis, an alternative interpretation could be that having a mental image of pain leads to a more distressing experience of pain. Examining changes in mental imagery prevalence or vividness before and after effective pain-relieving interventions, or finding means to manipulate and measure change in pain-related mental imagery may provide ways in which these competing explanations could be tested.

A third possibility is that a common factor underlies both the likelihood of experiencing pain-related mental imagery and higher levels of pain unpleasantness. A possible candidate for this third factor is the personality trait of neuroticism, which can be conceptualised as a general tendency toward greater awareness of aversive internal states, both physical and emotional. Neuroticism is known to be a risk factor for the development of both anxiety disorders and depression, and has also been found to lead to increased reporting of physical illness complaints (Johnson, 2003). Furthermore, Raselli and Broderick (2007) have found that higher levels of neuroticism are associated with increased pain unpleasantness ratings but not higher levels of pain intensity. These findings are in keeping with the pattern found in the present study, and it may be that the effects observed in this study and those observed by Potter *et al.* (in submission) may be the result of differential levels of neuroticism and therefore varying levels of awareness

of internal states. Future studies in this area should measure trait neuroticism in order to control for this variable.

Presence of mental imagery and use of imagery in everyday life

A further difference between those who report experiencing imagery and those who do not was the higher use of imagery in everyday life among those who experience imagery. There are two possible interpretations of this finding that have been considered.

It may be that greater tendency towards the use of imagery in everyday life may predispose some chronic pain sufferers toward developing a mental image of their pain, and hence toward greater levels of anxiety and depression. This would be in keeping with suggestions (E. Holmes, personal communication, 18 July 2008) that greater use of imagery in everyday life, as measured by the SUIIS scale, may be a risk factor for the development of distressing imagery in psychopathology.

Alternatively, it may be that the differences in SUIIS scores between the two groups do not in fact represent an actual difference in the use of imagery in everyday life, but rather represent a difference between the groups in self-awareness of their own use of imagery. Such an effect might be expected if trait neuroticism does in fact underlie many of the differences between those who report experiencing an image of their pain and those who do not, as suggested above.

Overall, the finding of higher SUIS scores among those who report pain-related mental imagery is difficult to interpret clearly and requires further study to determine its clinical significance.

Physiological, emotional and pain reactivity

The finding that intentional self-generation of what were normally spontaneously-occurring mental images of pain led to physiological and emotional reactivity during study two may have a number of implications.

If, as suggested by these results, pain-related mental images do elicit physiological and emotional arousal independent of sensory pain, it seems very plausible that the occurrence of these images might lead to an exacerbation of physiological and emotional reactivity to sensory pain. This is an important issue, as higher levels of physiological reactivity to pain (alongside cognitive and behavioural reactivity) have been found to lead to poorer long-term outcomes and increased pain at follow up in people with a range of types of chronic pain (Verhoeven *et al.*, 2006). As an example, Evers *et al.* (2001) found that physiological reactivity (as measured using a similar subjective Likert scale measure of physiological reactivity to that used in the present study) predicted levels of pain at one year follow-up among rheumatoid arthritis sufferers with chronic pain. This issue may also relate to the potential therapeutic role of imagery for chronic pain sufferers. If images frequently activate physiological and emotional reactivity (and potentially pain and behavioural reactivity in addition), using clients' spontaneously

occurring images in therapy may provide an effective route by which links between pain (as a stimulus) and such reactions can be broken using imaginal exposure and imagery modification techniques.

The effect of imagery upon pain levels is less clear than that observed with physiological and emotional reactivity. It is nonetheless of interest that half of the interview participants reported an increase in pain in response to their image, and a third reported that their pain had “*very much increased*”. The small sample size and lack of pre-post pain intensity measurement, in addition to the insensitivity of the measures used, means this study cannot establish that these effects are not due to chance alone however. Future studies could be designed to establish if this effect is robust. Such an effect, should it exist, would be consistent with the broad understanding that pain can occur even in the absence of painful sensory stimulation, and with the broad acceptance of the importance of top-down processes in influencing sensory perception more generally (Pinker, 1997).

The possibility that pain-related mental images might increase pain levels for some chronic pain sufferers is both theoretically and clinically exciting, and provides a clear rationale for imagery interventions which target spontaneous mental images. If spontaneous mental images serve to increase pain levels, modification techniques could actually result in significant levels of pain relief. Further study using more sophisticated methodologies, including potentially functional MRI brain imaging, could provide fascinating data on the role of mental imagery in pain perception.

Links between imagery characteristics and physiological, emotional and pain reactivity to image

While the exploratory nature of study two and the small number of participants involved in the study limit its power to detect significant effects, it is interesting that correlations were found between increasing vividness of imagery and lower levels of emotional and pain reactivity to imagery, and between higher levels of perceived control over imagery and greater levels of pain reactivity. It may be that these correlations are simply due to chance, as a result of the large number of correlations conducted in this exploratory analysis. It is also unclear why imagery vividness should correlate with emotional and pain reactivity, but not physiological reactivity. However, what makes these findings more striking and worthy of some discussion is that they appear so counter-intuitive at first sight. As images were established in study one as being predominately distressing, and there were moderate positive correlations between imagery vividness and imagery distress and interference, it would be natural to hypothesise that those images that are rated as more vivid would therefore lead to greater physiological, emotional and pain reactivity. Furthermore, high levels of perceived control have been widely reported to be a factor associated with lower levels of psychological distress, therefore finding that those who perceive they have greater levels of control over what happens in their image have greater levels of pain reactivity to their image is also somewhat counter-intuitive.

Should these effects be replicated in future studies, (the small sample size used in the present study means replication of these results will be necessary before conclusions can

be confidently drawn), it seems likely that something more complex is occurring with regards to participants' relationship to their images. In light of the dominance of avoidant responses to participants' images reported in study two, a plausible explanation for the above effects might relate to the influence of mental control strategies in response to mental imagery. Those who have more avoidant or suppressing ways of responding to their image are likely to attempt greater control over their image and, to the extent that attempts at control are effective in preventing them from fully experiencing their image, are more likely to rate their images as being less vivid. It is also likely that those who have more avoidant reactions and coping strategies will have more catastrophic beliefs about the consequences of allowing themselves to fully experience their image, and will therefore experience greater emotional and pain reactivity when they do make contact with their image.

Avoidance of distressing thoughts, images, and physiological sensations has been described as a phenomenon within a range of psychological disorders and is a key factor in many cognitive behavioural models of anxiety disorders. Avoidance is thought to prevent emotional processing, leading to a lack of habituation or integration of new information which might alter the meaning that a distressing stimuli has for an individual (Foa & Kozak, 1989). These effects are believed to lead to the maintenance of distress in anxiety disorders, which are characterised by rigid, relatively unchanging fear-related cognitions, and no reduction in distress when exposed to anxiety-provoking stimuli. The stable and long-standing nature of the pain-related mental images reported in this study, and their links with physiological and emotional reactivity, suggest that

similar processes may well be present for at least some who experience a mental image of their pain.

Theoretical implications

Imagery as a form of pain-related cognition

Perhaps the major theoretical contribution of this project is the corroboration of the existence of mental imagery as a part of some chronic pain sufferers' experience of pain, as first reported by Potter *et al.* (in submission). Further to this, these mental images appear to contain important meanings for individuals about their pain, and to have an impact on factors which are known to be important in long-term adjustment to chronic pain such as physiological and emotional reactivity.

These findings support Richardson's (1969) broad assertion that:

“it is a basic assumption that imagery is not merely an epiphenomenon but that our conscious awareness of its presence may make a difference to our behaviour”
(p 143-144)

Understanding the role of mental imagery in chronic pain

This project is largely exploratory, however the results obtained do suggest ways in which the phenomenon of pain-related mental imagery might be understood, and ways

in which a model of the role of imagery in distress and disability related to chronic pain might be developed.

As a result of their studies into mental imagery, Hackmann *et al.* (2000) have proposed a model to account for the role of mental imagery in social phobia. This model may have relevance to mental imagery in chronic pain. Hackmann *et al.* (2000) propose that recurrent, negatively distorted images of the self develop with input from autobiographical memory, and subsequently occur repeatedly in threatening social situations. Furthermore, these images begin to contribute to psychological distress, and to the maintenance of the disorder. The images are maintained due to avoidance of triggering situations, and attentional biases further prevent change in imagery toward less threatening meanings, even in the presence of potentially corrective information.

With regards to mental imagery in chronic pain, some aspects of the Hackmann *et al.* model may be relevant, particularly to the understanding of those pain-related mental images which are associated with high levels of anxiety. The mental images that chronic pain sufferers experience may develop from sensory aspects of their pain, and from understandings about the anatomical or medical cause of pain. Schema-level beliefs about the self, others, and the world also appear to influence the form their mental image assumes. Once activated, such images appear to be associated with negative affect and physiological reactivity, and therefore may well contribute to psychological distress related to pain and to the maintenance of pain and disability in the longer term, as evidenced by the studies highlighted above which link reactivity to pain with poorer

long-term outcomes. Furthermore, there are strong indications from this study that avoidant reactions to these images are common, including suppression and mental control strategies. Such reactions may well be the reason that participants' images are rigid and unchanging over long time periods, and the reason that the physiological and emotional reactions accompanying their images do not habituate.

Whilst provisional, this model suggests a range of testable hypotheses which could be examined in future studies, and which could help to further develop our understanding of this phenomenon. The findings of this project also have a number of important clinical implications.

Clinical implications

As described in the introduction, imagery modification techniques which make use of individuals' spontaneously occurring mental imagery have been described in work with those suffering from acute and chronic pain, and there are a number of anecdotal reports of their effectiveness. Despite this, no empirical evidence regarding the effectiveness of these approaches exists, and there is a lack of theory or research underlying these approaches. Although exploratory, this project does begin to provide some empirically-based data regarding the phenomenon of pain-related mental imagery, and suggests that such imagery techniques may be worthy of further study and development.

Assessment of mental imagery

With regards to the psychological assessment of those suffering from chronic pain, the results of this research suggest that it may be prudent for clinicians to enquire about mental imagery routinely during assessment. It appears clear that a significant proportion of chronic pain sufferers have a mental image of their pain, are able to describe this image, and that these images are linked with higher levels of psychological distress. Furthermore, mental images may provide the clinician with a rapid route into emotion and schema-level beliefs about the personal meanings pain has to an individual.

Clearly, the study also suggests that discussing and exploring mental imagery with chronic pain sufferers can be a distressing experience for these individuals, and therefore assessment of imagery should be conducted with sensitivity and with the consent of the person involved.

Imagery interventions

Imagery interventions based on an imaginal exposure model and on imagery modification may have beneficial effects for chronic pain sufferers who report experiencing a mental image of their pain. Such interventions flow logically from the model which has been proposed above.

Imaginal exposure may have beneficial effects through breaking links between stimulus (pain imagery) and responses (including physiological and emotional reactivity), and

may therefore lead to lower levels of psychological distress and better long-term outcomes. A key research question regards the degree to which achieving habituation to pain-related imagery through imaginal exposure might also attenuate unhelpful reactivity to sensory pain itself. This question could be answered in future studies into the impact of imaginal exposure to pain-related imagery which make use of process measures of physiological, emotional and behavioural reactivity. This would allow the degree of habituation to be measured, and would make it possible to examine if changes in these measures predict change in desired long-term outcomes for chronic pain sufferers including distress, pain, and disability levels at follow-up.

Imagery modification and rescripting techniques may also have an important clinical role, particularly as potential routes by which personal meanings of pain can be modified. Imagery modification methods, such as guiding clients in altering the properties of their mental images, have been described in the literature, however a greater account of the kinds of personal meanings contained in mental images (for example, sense of victimisation, lack of pain acceptance, or external locus of control) may allow creative clinicians to provide more tailored, and therefore more effective modification of clients' mental images, and hence have greater positive impact upon their distress levels and functioning.

Future research directions

Inevitably, due to the largely unexplored nature of this topic, a wide range of research questions remain to be answered, and the possibilities for developing on the work of this study are numerous. In order to provide guidance and structure to potential research development in this area, the model of clinical research development proposed by Barlow and Hofmann (1997) may be useful. Their model suggests that basic research and theoretical developments should form an initial stage in clinical research by providing a sound basis for the generation of new intervention procedures, or the enhancement of existing interventions, for a specified clinical problem. The current research may be seen as an early step in this process by furthering basic knowledge about the clinical phenomenon of mental imagery in chronic pain, and by providing some suggestions for further theoretical development. Once new or refined intervention procedures have been developed in this way their efficacy and effectiveness may be evaluated in a stepped manner, first in case studies and short-term clinical trials, and subsequently using more rigorous controlled trial methodologies with longer-term follow up.

One area of further research, which has been suggested by many who have published research into imagery in psychopathology, is the development of reliable and valid measures of mental imagery relevant to a range of clinical problems. Such measures would greatly improve the accuracy of future research into mental imagery. However, it should be noted that accurate measurement of mental imagery has proved a very

challenging goal in the past, as a result of the subjective nature of the experience. Perhaps a more fruitful approach to this problem is to focus on measuring the impact of imagery on other, more easily measurable factors such as physiological arousal or behavioural reactions. Taking such a functional approach may lead to both more accurate process measures of change in the function of imagery, and could be used in future studies to evaluate the effectiveness of imagery interventions. This would also allow hypotheses regarding the processes by which imagery interventions have their effects to be tested empirically.

A more immediate avenue for future research is to confirm the findings of this project with regard to physiological, emotional and pain reactivity to imagery. Future experimental study designs could use more accurate, objective measures of physiological arousal such as galvanic skin response, heart rate, and electromyography. Objective measurements would overcome difficulties inherent in subjective ratings of physiological arousal. Emotional and pain reactivity could also be more accurately measured using pre-post measures, and could make use of validated measure such as the Positive and Negative Affect Scale (Watson *et al.*, 1988).

Experimental study designs could be developed to also test the hypothesis that imagery may provide stronger links with emotion than verbal report. Such a study could compare a group of participants with chronic pain who are asked to describe their mental image of pain with a group asked to describe their pain in purely verbal terms. Clearly, there are potential difficulties in ensuring participants in a verbal-only condition do not

spontaneously access imagery, however studies have reported significant effects on anxiety levels using similar experimental designs (eg. Holmes & Mathews, 2005), therefore it is possible that similar studies with chronic pain sufferers will be able to effectively detect this effect.

It is hoped that increasing our understanding of pain-related mental imagery through basic research and theoretical development will allow for the development of effective, tailored clinical interventions targeting spontaneous imagery. As described earlier, imagery interventions targeting spontaneous mental imagery are already used by some clinicians, however their use is not currently based upon sound research or theory, and it is likely that theoretical developments and knowledge of basic processes involved in imagery will lead to the development of more effective interventions than those currently in use.

In conclusion, the results of this research project suggest that the further development of a clinical research programme into pain-related mental imagery and imagery intervention techniques will provide a valuable contribution toward to the goal of helping alleviate suffering among those who experience chronic pain. It is hoped that the two studies presented here will provide useful findings from which such a programme may develop.

References

Achterberg, J., Cornelia, K. & Lawlis, G. (1988). Severe burn injury: a comparison of relaxation, imagery and biofeedback for pain management. *Journal of Mental Imagery*, 12(1), 71-88.

Alden, A., Dale, J., de Good, D. (2001). Interactive effects of the affect quality and directional focus of mental imagery on pain analgesia. *Applied Psychophysiology and Biofeedback*, 26(2), 117-126.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (Forth Edition, Text Revision). Washington DC: American Psychiatric Association.

Arntz, A., Tiesema, M. & Kindt, M. (2007). Treatment of PTSD: a comparison of imaginal exposure with and without imagery rescripting. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 345-370.

Arntz, A. & Weertman, A. (1999). Treatment of childhood memories: theory and practice. *Behaviour Research and Therapy*, 37(8), 715-740.

Baird, C.L. & Sands, L. (2004). A pilot study of the effectiveness of guided imagery with progressive muscle relaxation to reduce chronic pain and mobility difficulties of osteoarthritis. *Pain Management Nursing*, 5(3), 97-104.

Bakke, A.C., Purtzer, M.Z. & Newton, P. (2002). The effect of hypnotic-guided imagery on psychological well-being and immune function in patients with prior breast cancer. *Journal of Psychosomatic Research*, 53(6), 1131-1137.

Barber, T.X., Chauncey, H.H. & Winer, H.A. (1964). Effect of hypnotic and non-hypnotic suggestions on parotid gland response to gustatory stimuli. *Psychosomatic Medicine*, 26, 374-380.

Barlow, D.H. & Hofmann, S.G. (1997). Efficacy and dissemination of psychological treatments. In D. Clark & C. Fairburn (Eds.) *Science and practice of cognitive behaviour therapy* (pp.95-117). Oxford: Oxford University Press.

Baron, R., Schattschneider, J., Binder, A., Siebrecht, D. & Wasner, G. (2002). Relation between sympathetic vasoconstrictor activity and pain and hyperalgesia in complex regional pain syndromes: a case-control study. *Lancet*, 359, 1655-1660.

Bauer, R.M. & Craighead, W.E. (1979). Psychophysiological responses to the imagination of fearful and neutral situations: The effects of imagery instructions. *Behavior Therapy*, 10, 389-403.

Beck, A.T. (1976). *Cognitive therapy and the emotional disorders*. New York: International University Press.

Beck, J.S. (1995). *Cognitive therapy: Basics and beyond*. New York: Guildford Press.

Beecher, H.K. (1946). Pain in men wounded in battle. *Annals of surgery*, 123(1), 96-105.

Bennett-Levy, J. (2003). Mechanisms of change in cognitive therapy: the case of automatic thought records and behavioural experiments. *Behavioural and Cognitive Psychotherapy*, 31, 261-277.

Bonica, J. (1953). *The management of pain*. Philadelphia: Lea & Febiger.

Brewin, C.R., Hunter, E., Carroll, F. & Tata, P. (1996). Intrusive memories in depression: an index of schema activation? *Psychological Medicine*, 26(6), 1271-1276.

Breivik, H., Collett, B., Ventafridda, V., Cohen, R. & Gallacher, D. (2006). Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain*, 10(4), 287-333.

Chambers Harrap. (2006). *The Chambers Dictionary* (10th edn.) Edinburgh: Chambers Harrap Publishers Limited.

Clark, D.M., & Wells, A. (1995). A cognitive model of social phobia. In R.G. Heimberg, M.R. Liebowitz, D.A. Hope, & F.R. Schneier (Eds.) *Social phobia: Diagnosis, assessment, and treatment* (pp.41-68). New York: Guilford Press.

- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155-159.
- Crisson, J.E. & Keefe, F.J. (1988). The relationship of locus of control to pain coping strategies and psychological distress in chronic pain patients. *Pain*, 35(2), 147-154.
- Cui, X., Jeter, C.B., Yang, D. Montague, P.R. & Eagleman, D.M. (2007). Vividness of mental imagery: individual variability can be measured objectively. *Vision Research*, 47(4), 474-478.
- Dadds, M.R., Bovbjerg, D.H., Redd, W.H. & Cutmore, T.R. (1997). Imagery in human classical conditioning. *Psychological Bulletin*, 122(1), 89-103.
- Dalgleish, T. & Power, M.J. (2004). Emotion specific and emotion non-specific components of post-traumatic stress disorder (PTSD): implications for a taxonomy of related psychopathology. *Behaviour Research and Therapy*, 42(9), 1069-1088.
- Day, S.J., Holmes, E.A. & Hackmann, A. (2004). Occurrence of imagery and its link with early memories in agoraphobia. *Memory*, 12(4), 416-427.
- de Silva, P. (1986). Obsessional-compulsive imagery. *Behaviour Research and Therapy*, 24(3), 333-350.
- Edwards, D. (2007). Restructuring implicational meaning through memory-based imagery: some historical notes. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 306-316.
- Elliott, A.M., Smith, B.H., Penny, K.I., Smith, W. C. & Chambers, W.A. (1999). The epidemiology of chronic pain in the community. *Lancet*, 354(9186), 1248-1252.
- Engel, G.L. (1977). The need for a new medical model: a challenge for biomedicine. *Science*, 196(4286), 129-136.
- Evers, A.W., Kraaijmaat, F.W., van Riel, P.L. & Bijlsma, J.W. (2001). Cognitive, behavioural and physiological reactivity to pain as a predictor of long-term pain in rheumatoid arthritis patients. *Pain*, 93, 139-146.

Fernandez, E. & Turk, D.C. (1989). The utility of cognitive coping strategies for altering pain perception: a meta-analysis. *Pain*, 38(2), 123-135.

Flor, H., Kerns, R.D. & Turk, D.C. (1987). The role of spouse reinforcement, perceived pain, and activity levels of chronic pain patients. *Journal of Psychosomatic Research*, 31(2), 251-259.

Fors, E.A., Sexton, H. & Götestam, K.G.(2002). The effect of guided imagery and amitriptyline on daily fibromyalgia pain: a prospective randomised controlled trial. *Journal of Psychiatric Research*, 36(3), 179-187.

Foa, E.B. & Kozak, M.J. (1989). Emotional processing of fear: exposure to corrective information. *Psychological Bulletin*, 99(1), 20-35.

Graham, C., Bond, S.S., Gerkovich, M.M. & Cook, M.R. (1980). Use of the McGill Pain Questionnaire in the assessment of cancer pain: replicability and consistency. *Pain*, 8(3), 377-387.

Grunert, B.K., Weis, J.M., Smucker, M. R. & Christianson, H.F. (2007). Imagery rescripting and reprocessing therapy after failed prolonged exposure for post-traumatic stress disorder following industrial injury. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 317-328

Gruzelier, J.H. (2002). A review of the impact of hypnosis, relaxation, guided imagery and individual differences on aspects of immunity and health. *Stress*, 5(2),147-163.

Gruzelier, J., Levy, J., Williams, J. & Henderson, D. (2006). Self-hypnosis and exam stress: comparing immune and relaxation-related imagery for influences on immunity, health and mood. *Contemporary Hypnosis*, 18(2), 73-86.

Gruzelier, J., Smith, F., Nagy, A. & Henderson, D. (1997). Immune function and exam stress: beneficial effects of hypnosis training and an individual difference associated with immune competence. *International Journal of Psychophysiology*, 25(1), 79-80.

Hackmann, A., Clark, D.M. & McManus, F. (2000). Recurrent images and early memories in social phobia. *Behaviour Research and Therapy*, 38, 601-610.

Hackmann, A. & Holmes, E.A. (2004). Reflecting on imagery: a clinical perspective and overview of the special issue of *Memory* on mental imagery and memory in psychopathology. *Memory*, 12(4), 389-402.

Hackmann, A., Surawy, C. & Clark, D.M. (1998). Seeing yourself through others' eyes: a study of spontaneously occurring images in social phobia. *Behavioural and Cognitive Psychotherapy*, 26, 3-12.

Harris, I., Mulford, J., Solomon, M., van Gelder, J.M. & Young, J. (2005). Association between compensation status and outcome after surgery: a meta-analysis. *Journal of the American Medical Association*, 293(13), 1644-1652.

Hartvigsen, J., Christensen, K., Frederiksen, H. & Petersen, H.C. (2004). Genetic and environmental contributions to back pain in old age: a study of 2,108 Danish twins aged 70 and older. *Spine*, 29(8), 897-901.

Hayes, S., Strosahl, K. & Wilson, K. (2004). *Acceptance and commitment therapy: an experiential approach to behaviour change*. New York: Guildford Press.

Hestbaek, L., Iachine, I.A., Leboeuf-Yde, C., Kyvik, K.O. & Manniche, C. (2004). Heredity of low back pain in a young population: a classical twin study. *Twin Research and Human Genetics*, 7(1), 16-26.

Holmes, E.A., Crane, C., Fennell, M.J. & Williams, J.M. (2007). Imagery about suicide in depression - "Flash-forwards"? *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 423-434.

Holmes, E.A. & Mathews, A. (2005). Mental imagery and emotion: a special relationship? *Emotion*, 5(4), 489-497.

Holmes, E.A., Mathews, A., Dalgleish, T. & Mackintosh, B. (2006). Positive interpretation training: effects of mental imagery versus verbal training on positive mood. *Behaviour Therapy*, 37(3), 237-247.

Hudacek, K.D. (2007). A review of the effects of hypnosis on the immune system in breast cancer patients: a brief communication. *International Journal of Clinical and Experimental Hypnosis*, 55(4), 411-425.

Hunt, M., Bylsma, L., Brock, J., Fenton, M., Goldberg, A., Miller, R. *et al.* (2006). The role of imagery in the maintenance and treatment of snake fear. *Journal of Behavior Therapy and Experimental Psychiatry*, 37(4), 283-298.

Hunt, M. & Fenton, M. (2007). Imagery rescripting versus in vivo exposure in the treatment of snake fear. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 329-344.

Ilacqua, G.E. (1994). Migraine headaches: Coping efficacy of guided imagery training. *Headache*, 34(2), 99-102.

Johnson, M. (2003). The vulnerability status of neuroticism: over-reporting or genuine complaints? *Personality and Individual Differences*, 35(4), 877-887.

Jones, G.E. & Johnson, H.J. (1978). Physiological responding during self-generated imagery of contextually complete stimuli. *Psychophysiology*, 15, 439-446.

Jones, G.E. & Johnson, H.J. (1980). Heart rate and somatic concomitants of mental imagery. *Psychophysiology*, 17, 339-347.

Keefe, F.J., Rumble, M.E., Scipio, C.D., Giordano, L.A. & Perri, L.M. (2004). Psychological aspects of persistent pain: current state of the science. *The Journal of Pain*, 5(4), 195-211.

Kosslyn, S.M., Ganis, G. & Thompson, W.L. (2001). Neural foundations of imagery. *Nature Reviews Neuroscience*, 2(9), 635-642.

Kosslyn, S. & Pomerantz, J. (1977). Imagery, propositions, and the form of internal representations. *Cognitive Psychology*, 9, 52-76.

Lewandowski, W.A. (2004). Patterning of pain and power with guided imagery. *Nursing Science Quarterly*, 17(3), 233-241.

Lewandowski, W., Good, M. & Draucker, C.B. (2005). Changes in the meaning of pain with the use of guided imagery. *Pain Management Nursing*, 6(2), 58-67.

Linehan, M. (1993). *Skills training manual for treating borderline personality disorder*. New York: Guildford Press.

Mannix, L.K., Chandurkar, R.S., Rybicki, L.A., Tusek, D.L. & Solomon, G.D. (1999). Effect of guided imagery on quality of life for patients with chronic tension-type headache. *Headache: The Journal of Head and Face Pain*, 39(5), 326-334.

Marks, D.F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology*, 64(1), 17-24.

Mast, F.W., Ganis, G., Christie, S. & Kosslyn, S.M. (2003). Four types of visual mental imagery processing in upright and tilted observers. *Cognitive Brain Research*, 17(2), 238-247.

McAvinue, L. & Robertson, I. (2006). Measuring visual imagery ability: a review. *Imagination, Cognition and Personality*, 26(3), 191-211.

McCracken, L.M. (1998). Learning to live with the pain: acceptance of pain predicts adjustment in persons with chronic pain. *Pain*, 74(1), 21-27.

McCracken, L.M., Zayfert, C. & Cross, R.T. (1992). The pain anxiety symptoms scale: development and validation of a scale to measure fear of pain. *Pain*, 50, 67-73.

Melzack, R. (1975). The McGill Pain Questionnaire: major properties and scoring methods. *Pain*, 1(3), 277-299.

Melzack, R. (1987). The short form McGill Pain Questionnaire. *Pain*, 30, 191-197.

Melzack, R. (1992). Phantom limbs. *Scientific American*, 266(4), 120-126.

Melzack, R. & Wall, P.D. (1965). Pain mechanisms: a new theory. *Science*, 150(699), 971-979.

Morley, S., Eccleston, C. & Williams, A. (1999). Systematic review and meta-analysis of randomised controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache. *Pain*, 80, 1-13.

Morrison, A.P. (2004). The use of imagery in cognitive therapy for psychosis: a case example. *Memory*, 12(4), 517-524.

Morrison, A.P., Beck, A.T., Glentworth, D., Dunn, H., Reid, G.S. & Larkin, W. *et al.* (2002). Imagery and psychotic symptoms: a preliminary investigation. *Behaviour Research and Therapy*, 40(9), 1053-1062.

NHS Quality Improvement Scotland (2006). *Management of chronic pain in adults: best practice statement*. Edinburgh: NHS Quality Improvement Scotland.

NICE. (2005). *Post-traumatic stress disorder: The management of PTSD in adults and children in primary and secondary care: National Clinical Practice Guideline Number 26*. Trowbridge: Royal College of Psychiatrists & British Psychological Society.

Osman, O., Cooper, M., Hackmann, A. & Veale, D. (2004). Spontaneously occurring images and early memories in people with body dysmorphic disorder. *Memory*, 12(4), 428-436.

Patel, T., Brewin, C.R., Wheatley, J., Wells, A., Fisher, P. & Myers, S. (2007). Intrusive images and memories in major depression. *Behaviour Research and Therapy*, 45, 2573-2580.

Pinker, S. (1997). *How the mind works*. London: Penguin.

Pincus, D., Wachsmuth-Schlafer, T., Sheikh, A.A. & Ezaz-Nikpay (2004a). Transforming the pain terrain: Theory and practice in the use of mental imagery for the treatment of pain. In A.A. Sheikh (Ed.) *Healing images: The role of imagination in health*. New York: Baywood.

Pincus, D. (2006). Dynamical systems theory and pain imagery: Bridging the gap between research and practice. *Journal of Mental Imagery*, 30(1-2), 93-112.

- Pincus, T., Williams, A.C., Vogel, S. & Field, A. (2004b). The development and testing of the depression, anxiety, and positive outlook scale (DAPOS). *Pain*, 109 (1-2), 181-188.
- Potter, L., Gillanders, D. & Morris, P. (in submission). It hurts: the relationship between mental imagery and functioning in chronic pain. *Clinical Journal of Pain*.
- Power, M. & Dalgleish, T. (1997). *Cognition and emotion: From order to disorder*. Hove: Psychology Press.
- Pylyshyn, Z. (1973). What the mind's eye tells the mind's brain: a critique of mental imagery. *Psychological Bulletin*, 80, 1-24.
- Rachman, S. (2007). Unwanted intrusive images in obsessive compulsive disorders. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 402-410.
- Raft, D., Smith, R.H. & Warren, N. (1986). Selection of imagery in the relief of chronic and acute clinical pain. *Journal of Psychosomatic Research*, 30(4), 481-488.
- Raselli, C. & Broderick, J.E. (2007). The association of depression and neuroticism with pain reports: a comparison of momentary and recalled pain assessment. *Journal of Psychosomatic Research*, 62(3), 313-320.
- Reisberg, D., Pearson, D.G. & Kosslyn, S.M. (2003). Intuitions and introspections about imagery: The role of imagery experience in shaping an investigator's theoretical views. *Applied Cognitive Psychology*, 17, 147-160.
- Richardson, A. (1969). *Mental imagery*. London: Routledge and Paul.
- Rist, J. (1972). *Epicurus: an introduction*. Cambridge: Cambridge University Press.
- Romano, J.M., Turner, J.A., Jensen, M.P., Friedman, L.S., Bulcroft, R.A., Hops, H. *et al.* (1995). Chronic pain patient-spouse behavioural interactions predict patient disability. *Pain*, 63(3), 353-360.

Rusch, M., Grunert, B., Mendelsohn, R. & Smucker, M. (2000). Imagery rescripting for recurrent, distressing images. *Cognitive and Behavioural Practice*, 7(2), 173-182.

Sachs-Ericsson, N., Kendall-Tackett, K. & Hernandez, A. (2007). Childhood abuse, chronic pain, and depression in the National Comorbidity Survey. *Child Abuse and Neglect*, 31(5), 531-547.

Scholz, J. & Woolf, C.J. (2002). Can we conquer pain? *Nature Neuroscience*, 5, 1062-1067.

Segal, Z. Williams, J. & Teasdale, J. (2001). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. New York: Guilford Press.

Sheikh, A.A., Kunzendorf, R.G. & Sheikh, K.S. (2004a). Healing images: Historical perspectives. In A.A. Sheikh (Ed.) (2004a). *Healing images: The role of imagination in health*. New York: Baywood.

Sheikh, A.A., Kunzendorf, R.G., Sheikh, K.S. & Baer, S.M. (2004b). Physiological consequences of imagery and related approaches. In A.A. Sheikh (Ed.) *Healing images: The role of imagination in health*. New York: Baywood.

Sloman, R. (1995). Relaxation and the relief of cancer pain. *Nursing Clinics of North America*, 30(4), 697-709.

Smith, B.H., Elliott, A.M., Chambers, W.A., Smith, W.C., Hannaford, P.C. & Penny, K. (2001). The impact of chronic pain in the community. *Family Practice*, 18(3), 292-299.

Smith, B., Macfarlane, G. & Torrance, N. (2007). Epidemiology of chronic pain, from the laboratory to the bus stop: time to add understanding of biological mechanisms to the study of risk factors in population-based-research? *Pain*, 127, 5-10.

Smucker, M., Pancu, C., Foa, E. & Niederee, J. (1995). Imagery rescripting: a new treatment for survivors of childhood sexual abuse suffering from post-traumatic stress. *Journal of Cognitive Psychotherapy*, 9, 3-17.

Snowden, R. (2006a). *Freud*. New York: McGraw-Hill.

Snowden, R. (2006b). *Jung*. New York: McGraw Hill.

Somerville, K., Cooper, M. & Hackmann, A. (2007). Spontaneous imagery in women with bulimia nervosa: An investigation into content, characteristics and links to childhood memories. *Journal of Behavior Therapy and Experimental Psychiatry*, 38, 435-446.

Speckens, A.E., Hackmann, A., Ehlers, A. & Cuthbert, B. (2007). Imagery special issue: intrusive images and memories of earlier adverse events in patients with obsessive compulsive disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 411-422.

Sullivan, M., Bishop, S. & Pivik, J. (1995). The pain catastrophising scale: development and validation. *Psychological Assessment*, 7, 524-532.

Suter, M.R., Wen, Y.R., Decosterd, I. & Ji, R.R. (2007). Do glial cells control pain? *Neuron Glia Biology*, 3(3), 255-268.

Syrjala, K. & Abrams, J. (2002). Hypnosis and imagery in the treatment of pain. In D. Tusk & R. Gatchel (Eds.) *Psychological approaches to pain management: a practitioner's handbook* (2nd edn). London: Guildford Press.

Syrjala, K.L., Donaldson, G.W., Davis, M.W., Kippes, M.E. & Carr, J.E. (1995). Relaxation and imagery and cognitive-behavioural training reduce pain during cancer treatment: a controlled clinical trial. *Pain*, 63(2), 189-198.

Teasdale, J.D. & Barnard, P.J. (1993). *Affect, cognition, and change: Re-modelling depressive thought*. Hove: Lawrence Erlbaum.

Turner, J.A. & Tensen, M.P. (1993). Efficacy of cognitive therapy for chronic low back pain. *Pain*, 52(2), 169-177.

Turk, D.C., Rudy, T.E. & Salovey, P. (1985). The McGill Pain Questionnaire reconsidered: Confirming the factor structure and examining appropriate uses. *Pain*, 21, 385-397.

Tusek, D.L., Church, J.M., Strong, S.A., Grass, J.A. & Fazio, V.W. (1997). Guided imagery: a significant advance in the care of patients undergoing elective colorectal surgery. *Diseases of the Colon and Rectum*, 40(2), 172-178.

Verhaak, P.F., Kerssens, J.J., Dekker, J., Sorbi, M.J. & Bensing, J.M. (1998). Prevalence of chronic benign pain disorder among adults: a review of the literature. *Pain*, 77(3), 231-239.

Verhoeven, L., Kraaimaat, F., Duller, P., van de Kerkhof, P. & Evers, A. (2006). Cognitive, behavioral, and physiological reactivity to chronic itching: Analogies to chronic pain. *International Journal of Behavioral Medicine*, 13(3), 237-243.

Walsh, C.A., Jamieson, E., Macmillan, H. & Boyle, M. (2007). Child abuse and chronic pain in a community survey of women. *Journal of Interpersonal Violence*, 22(12), 1536-1554.

Ward, C. (1984). Thaipusam in Malaysia: a psycho-anthropological analysis of ritual trance, ceremonial possession and self-mortification practices. *Ethos*, 12(4), 307-334.

Watson, J.B. (1913). Psychology as the behaviorist views it. *Psychological Review*, 20, 158-177.

Watson, D., Clark, L.A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063-70.

Weydert, J.A., Shapiro, D.E., Acra, S.A., Monheim, C.J., Chambers, A.S. & Ball, T.M. (2006). Evaluation of guided imagery as treatment for recurrent abdominal pain in children: a randomised controlled trial. *BMC Paediatrics*, 6, 29.

Wheatley, J., Brewin, C.R., Patel, T., Hackmann, A., Wells, A., Fisher, P. *et al.* (2007). I'll believe it when I can see it: imagery rescripting of intrusive sensory memories in depression. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 371-385.

Wild, J., Hackmann, A. & Clark, D.M. (2007). When the present visits the past: updating traumatic memories in social phobia. *Journal of Behavior Therapy and Experimental Psychiatry*, 38(4), 386-401.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition*. Stanford: Stanford University Press.

Young, J., Klosko, J. & Weishaar, M. (2003). *Schema therapy: A practitioner's guide*. London: Guildford Press.

Appendices

- Appendix 1:** Letter of ethical approval
- Appendix 2:** Letter of invitation to participants
- Appendix 3:** Participant information sheet
- Appendix 4:** Chronic Pain Mental Imagery Questionnaire
- Appendix 5:** McGill Pain Questionnaire- Short Form
- Appendix 6:** Depression, Anxiety, and Positive Outlook Scale
- Appendix 7:** Spontaneous Use of Imagery Scale
- Appendix 8:** Thematic analysis of imagery descriptions
- Appendix 9:** Interview response option materials
- Appendix 10:** Interview schedule
- Appendix 11:** Verbal cognitions associated with mental image