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**THE IMPACT OF LOCUS OF CONTROL AND
CONTROL ON PERFORMANCE DURING
PAINFUL STIMULATION:
AN EXPERIMENTAL INVESTIGATION**

**A dissertation in partial fulfillment of the requirements
for the degree of Masters of Arts in Psychology
at Massey University**

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1999

ABSTRACT

Pain interrupts cognitive processing, is hard to ignore and demands priority attention (Crombez, Baeyens & Eelen, 1994). Focusing on the effect of pain on attention, the primary task paradigm was used to investigate the effect pain had on the task performance of 59 psychology undergraduate students assessed for their locus of control (LOC) beliefs using Rotter's (1964) LOC Scale. In a mixed experimental design, participants were required to discriminate between 250 and 750 MHz tones while being exposed to the experimental pain stimulus potassium iontophoresis, a control stimulus of an old man's face and tone only baseline trials. A control manipulation gave all participants both control and no control over the presentation of three levels of pain; high, medium and low pain. The results show that pain interfered with the accuracy of tone discriminations but not reaction times (RT). Additionally, the interference effect from painful stimulation was greater at 250 ms after the onset of the tone compared to the 750 ms onset. A signalling/warning effect is discussed as an explanation for this finding. The external LOC group performed worse when they had control over pain compared to no control. The internal LOC group showed less task degradation overall during the pain condition compared to the external group. These results are discussed in relation with current theories of attention, the effects of control and LOC beliefs.

ACKNOWLEDGEMENTS

I would like to express my thanks and appreciation to my supervisor Malcolm Johnson for his time that he put into the supervision of this thesis. I also appreciated his remarkable patience when explaining statistics to me and for the months spent adapting the primary task used in this study.

Thanks must also go to Steve Humphries who did all of the computer programming for this experimental research and who always came to this project with the best attitude possible. Thanks Steve for your time and patience when dealing with someone that could use Windows and not DOS.

Additionally I must extend a huge thank you to Mike Hughes and Malcolm Loudon of the School of Psychology workshop for the time that they spent fixing things when they broke, showing me “how to”, and being a huge source of entertainment during this thesis. Their workmanship is second to none and could not have done this without their help.

I have to thank my experimental guinea pig Duncan Babbage from the School of Psychology at Massey University for the number of times that he gave me his arm to test my pain machine and also to Angela McNaught for her precious time reviewing this work. Thanks to my friends and family who supported me throughout this thesis.

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CHAPTER ONE

INTRODUCTION

Pain performs a number of important functions. Firstly, pain acts as a signal to withdraw from a situation that is causing harm. Secondly, pain has a preventative role, it protects against further injury by warning us that continued use of an injured limb may cause more damage. Finally, pain acts as a mechanism for recovery and protection of the injured tissue by forcing rest and restrictions on the use of damaged tissue (Fields, 1987; Price, 1988). In order for pain to function in these ways, pain must be perceived, noxious, and have the ability to demand attention and interrupt other ongoing behaviour (Crombez, Eccleston, Baeyens & Eelen, 1996).

Recent research suggests that pain not only has physiological characteristics, but also includes emotional and psychological components. Physiological aspects include pain intensity, duration and location, whereas psychological aspects integrate personality characteristics and reactions that may influence the experience of pain (Melzack & Wall, 1982). Common psychological reactions to pain include anxiety, depression, feelings of hopelessness and lost control, attention difficulties and negative cognitions (Genius, 1995; McCaul & Malott, 1984). Therefore the experience of pain is an interplay of both physiological and psychological factors. From a psychological perspective this has important implications for the management of pain.

Individuals that suffer from pain form a significant proportion of the population and also require a significant portion of health care resources. American studies have found that in any given year approximately 80% of the adult population will experience lower back pain and that 30% of this number will seek treatment for this problem (Bonica & Ng, 1980). Pain problems directly account for over 700 million lost working days annually in the USA, at a cost of US\$60 billion, or 10%

of the national budget (Meinhart & McCaffery, 1993). In 1995, in New Zealand, the Accident Compensation Corporation (ACC) paid claimants \$367 million for back pain injuries, which is 30% of the total ACC budget (McNaughton, 1996). In New Zealand there are nearly three million analgesic prescriptions made out for a variety of pain complaints every year by doctors (Humphries, 1995).

The current study was primarily concerned with the psychological reactions to pain. It examined the effect of beliefs about internal and external attributions of control and control over pain on performance of a task during painful stimulation. Before presenting the study itself it is important to provide detailed background information on the physiology and psychology of pain as this acted as a starting point for the research itself. For this reason, the rest of chapter one discusses a definition and related theories of pain, with specific focus on the gate control theory. The second chapter briefly discusses the physiology of pain and then concentrates in more detail on the relationship between pain and psychological functioning. This is followed in chapter three by attention/distraction strategies that are used widely to alleviate pain. This chapter also introduces a method for investigating the effectiveness of attention strategies. Finally chapter four discusses two psychological aspects of control, locus of control beliefs and actual control, which have been reported to influence the successful use of attention strategies to alleviate pain.

PAIN

The International Association for the Study of Pain Task Force on Taxonomy (1994) (IASP) defines pain as, “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (Wells & Wolf, 1991, p 523).. This definition is used as it recognises three important qualities of pain: (a) pain has unique sensory and perceptual characteristics; (b) there is no categorical correspondence between pain tissue and damage and (c), pain is an unpleasant emotional experience (Fernandez & Turk, 1992). Furthermore, pain is recognised as a personal and private experience and it appears individuals respond differently to pain. For some, chronic pain has little interference with daily activities, while for others pain may become intolerable. There is considerable variation amongst those who suffer from pain, particularly in cognitions and pain-related behaviours. According to research these variations are associated with how individuals cope with their pain, whether an individual considers their pain debilitating or manageable and/or the extent to which they perceive that they are in control of their pain (Melzack, 1973). Despite a recent increase in the amount of research that has aimed at investigating possible factors that may account for some of this variability, pain still remains a misunderstood health issue.

The Classification of Pain

As already mentioned, there are considerable differences in the experience of pain in relation to chronicity, disabling effects and management. In clinical settings these differences are used to classify pain as either acute or chronic. Pain usually has a well-defined cause and a characteristic time course in which pain disappears after healing has occurred (Jenson, Turner, Romano & Karoly, 1991). Acute pain occurs after a person has escaped the immediate danger of the situation, and is defined as “the phase in which behaviour related to recovery begins” (Price, 1988, p. 12). Pain is considered acute during the transitional period once the individual has adapted to the cause of the pain and is preparing for recovery, either by seeking treatment or other interventions, such as forced rest. Intense discomfort,

distress, tissue damage and arousal of the central nervous system usually accompany this type of pain. Overall, acute pain is generally well understood and easily managed by health practitioners (Price, 1988; Sternbach, 1974; 1987).

By contrast, chronic pain has been described as pain that persists for a period of at least six months, being either recurrent or causing continual discomfort (Fuerstein, Papciak & Hoon, 1987). Turk, Meichenbaum and Genest (1983) have identified three types of chronic pain, the first of which is chronic periodic pain, where the individual experiences repeated bouts of acute pain intermittently, for example with migraine headaches. The second is chronic intractable benign pain, where the pain is present most of the time with varying intensity but is not associated with a disease process, for example in lower back pain. Finally, chronic progressive pain is similar to chronic intractable benign pain however it is often associated with malignancies. The persistence of chronic pain beyond normal healing time serves little biological function and is less well understood and therefore more difficult to manage (Novey, Nelson, Francis & Turk, 1995; Price, 1988).

Common complaints for individuals with chronic pain include sleep disturbance, high levels of distress and disability (Jensen, Turner, Romano & Karoly, 1991), loss of appetite, social withdrawal, depression (Turk, Okifuji & Scharff, 1995), and problems with concentration and feelings of exhaustion (Crombez, Eccleston, Baeyens & Eelen, 1997). Chronic pain patients may become isolated socially and less mobile, fearing movement away from home because of their pain. This fear behaviour may hinder recovery in a number of ways. Firstly, it may lead to a decrease in physical activity which is known to be detrimental to various physiological systems including the musculoskeletal system. Bortz (1984) reported that bed rest results in a substantial loss of calcium and a significant reduction in muscle strength. Therefore avoidance of movement due to pain may lead to further development of pathology thus increasing the pain experience.

Secondly, Ishizaki et al., (1994) and Watson and Pennebaker (1982) have argued that the loss of external stimulation along with negative affect may increase the attention to internal sensations and increase somatic complaining. Additionally, for those individuals that have chronic pain, the vigilance to noxious sensations often becomes a significant part of their attentional focus. Continual attention to chronic pain is counter-productive both because escape from this kind of pain is rarely obtainable and attention often results in a disabling effect on the sufferer (Eccleston, 1994). Many of these consequences of chronic pain can have a substantial impact on family relationships. Often the individual with chronic pain is unable to return to work or significantly add to the daily running of the household. This change may lead to financial pressure which can destabilise relationships between partners both emotionally and sexually.

Theories of Pain

Pain and its causes have been speculated about for thousands of years. The early stoic philosophers thought that humans could control pain by the process of “rational repudiation” (Beecher, 1956, p. 234). Likewise, Aristotle, Descartes and Spinoza claimed that pain could be mastered through the “permeation of reason” (Turk et al., 1983, p. 85). More recently, three prominent theories of pain, specificity theory, pattern theory and the gate control theory, provide evidence of the continual development of pain theories. Specificity theory developed from the writings of Descartes (1664), von Frey (1895) and Muller (1942) and examined the interaction of sensory pathways. They proposed that there was a direct pathway from the site of injury to the brain. This specificity theory suggested that there was a specific modality, like hearing or vision, which was responsible for the pain response (Price, 1988). However, advances in pain research have discovered differences in pain quality and intensity, suggesting that there are differences in the sensory stimuli and therefore not supporting the specific modality idea. Turk et al., (1983) note that research during the era of specificity theory considered other factors such as thought processing and personality as mere reactions to pain rather than important issues themselves. Although

specificity theory did not stand the test of time it did provide a solid grounding for future research on the mechanics of pain.

Pattern theory advanced from specificity theory and attempted to deal with some of the limitations of the original theory. Pattern theory developed as a result of the fact that cutaneous receptors lacked the ability to be specifically pain receptors (Price, 1988). This theory maintains that the nerve impulse pattern responsible for pain is produced by intense stimulation of the “non-specific receptors since there were no specific fibers or no specific endings” (Melzack & Wall, 1965, p. 971). This suggests that there is little variation between the receptors in the skin and thus there is little variation in response from the receptors (Price, 1988). It was thought that pain was produced by spatial-temporal patterns of neuronal impulses which were then coded by the central nervous system and resulted in the experience of pain (Turk et al., 1983).

The pattern and specificity theories have been criticised on three accounts. Firstly, Beecher (1956) argues that sensory models fail to explain variations in distress responses by individuals who have similar medical conditions and injuries, yet are in different situations. Secondly, Weisenburg (1977) argues against the use of sensory models citing the limited success of surgical and other interventions based on this approach. Thirdly, sensory models do not account for phantom limb pain, a well-documented finding, nor the low correspondence between physical stimulation and pain reports (Melzack, 1971) (for an extended discussion of these criticisms see Weisenburg, 1977).

In an attempt to accommodate these criticisms Melzack and Wall (1965) proposed the gate control theory. They suggest that the transmission of nerve impulses from afferent fibers to spinal cord transmission (T) cells is modulated by a gating mechanism in the dorsal horns. In addition, they suggested that nociceptive transmission could be “inhibited and facilitated by a variety of central neural factors, including those originating locally and those originating from descending control systems in the brain” (Price, 1988, p. 216). The spinal gating mechanism

was originally thought to be pre-synaptic and affected by the amount of activity in large-diameter and small diameter fibers; activity in the large fibers closes the gate, while activity in the small fibers opens the gate (Humphries, Long & Johnson, 1996). The gate control theory suggests that the transmission of peripheral nociceptive inputs can be modulated by non-nociceptive inputs. In other words, psychological factors may play an integral part in pain processing (Fields, 1987; Humphries et al., 1996; Price, 1988).

Criticisms of the gate control theory centre around two issues. Firstly, physiological studies have reported that at least part of the inhibitory effect produced in spinal pain transmission neurons is post synaptic (Hongoi, Jankowska & Lunberg, 1968). Furthermore, Fields (1987) argues that presynaptic inhibition of unmyelinated fibers has not been established experimentally. The second criticism raises the issue of the gate control theory's failure to recognise that the sensory, cognitive, affective and behavioural aspects of pain are not stable or static, but dynamic events (Aldrich, Eccleston & Crombez, in press).

Summary

Whilst the specificity and pattern theories of pain have been surpassed, the gate control theory's general principles, specifically the role of descending control, have held up despite criticisms. This theory is able to account for puzzling and apparently paradoxical clinical findings, particularly phantom limb pain and through the mechanisms of descending control it allows for psychological factors to be involved in the experience and control of pain. From a psychological perspective, this suggests that psychology and has much to offer individuals in pain, and also has the potential to expand our current understanding of the nature of pain.

CHAPTER TWO

FACTORS EFFECTING PAIN

There are many reasons why some individuals feel pain differently than others. Mobily, Herr and Kelley (1993) have argued that pain is a multidimensional experience interrelating three dimensions: “(a) the influence of psychological traits, (b) determination by physiological factors, and (c), a dependence on the interaction between physiological and psychological determinants” (p. 538). In support of this, the cognitive-behavioural model endorses the view that affective, behavioural, cognitive, and sensory-physical facets are important when attempting to understand the experience of chronic pain patients (Novy, Nelson, Francis & Turk, 1995).

As mentioned in chapter one, gate control theory has provided a framework to investigate the influence of physical factors and an individual’s psychological functioning, culture, environment and social interactions on pain. This chapter briefly discusses some of the physiological factors that influence the pain experience, and then examines cultural, environmental, social, and psychological factors which affect the experience of pain.

Physiological Factors Affecting Pain

In pain research there is a common finding that responses to a given stimulus cannot be predicted with any certainty. Fields (1987) found that some individuals report excruciating pain when exposed to innocuous stimuli, while others with severe injuries deny any significant pain. Recent research examining this fact suggests that there are a number of potential reasons for the variation in the experience and reporting of pain. Fields (1987) and Price (1988) report that injury to the pain transmission system, variations in the activity of the modulatory system, and abnormal neural activity account for some of the differences in pain experience. In support of this Devor (1994) found that variability in the

experience of pain is linked to both peripheral and central nervous system (CNS) factors. For example, pain thresholds to mechanical stimulation can be significantly reduced in an area of inflammation by the sensitisation of primary afferents.

Factors such as arousal, attention and emotional distress that involve CNS activity can also profoundly alter responses to painful stimuli. For example, Beecher, (1946) found that some soldiers wounded in battle do not feel or report any pain initially, while others present in agonising pain.

In experimental and clinical research one of the most consistent findings is the difference in pain reporting between men and women (Symes, 1999). Whilst our knowledge about the relationship between gender and pain is limited and of recent origin (Isenburg, 1998; Roehr, 1998), women have been shown to have lower cutaneous thresholds for pain (Bonica, 1974), and men have been shown to have higher tolerance levels for cold pressor, electric shock, and focal pressure pain (Otto & Dougher, 1985). Further research which investigates why men and women experience pain is required to help understand what factors influence the experience of pain.

Psychological Factors Affecting Pain

Chapter one referred to research that suggests that the pain experience includes both nociceptive stimulation and the psychological reactions that such stimulation causes (Baron & Logan, 1993). More precisely, psychological factors are proposed to determine and influence an individual's reaction to painful stimulation. Researchers have recognised that psychological factors are responsible for the externalising behaviours associated with the experience of acute and persistent chronic pain (Baron & Logan, 1993; Otto & Dougher, 1985; Rokke, Al Absi, Lall & Oswald, 1991). Psychological reactions to pain include alterations in mood (Doan, & Wadden, 1989), overt behaviours and cognitive processing (Helman, 1994).

A number of researchers have emphasised the importance of cognitive processing and appraisals in influencing of the pain-psychological reaction relationship (Izard, 1979). Pain on its own is thought to be a necessary but not a sufficient condition to produce the above mentioned psychological reactions. Instead, a change in an individual's cognitive processing influences how they perceive pain to have impacted on their lives (Kerns & Haythornwaite, 1988; Turk, Rosenburg & Kerns, 1984).

Some of the most common alterations in mood as a consequence of pain include depression, frustration, panic, anxiety (Sullivan & D'Eon, 1992) and hopelessness and confusion (Calvert-Boyanowsky & Leventhal, 1975; Rokke et al., 1991; Turk et al., 1995). Research suggests that approximately 50% of the chronic pain population suffer from significant levels of depression (Romano & Turner, 1985) and a similar number from anxiety (Davies, Combie, Macrae & Rogers, 1992).

When pain is prolonged, these alterations in mood often increasingly intrude on everyday cognitions and manifest as problems with concentration and excessive worry (Aldrich et al., in press). High levels of worry and concern have also been associated with the extent of pain-related disability seen in sufferers (McCracken & Gross, 1995). Supporting evidence exists that catastrophising styles of thinking about pain can account for variations in pain sensitivity, tolerance and task performance (Spanos, Radtke-Bodorik, Ferguson & Jones, 1979; Turk et al., 1983). For example, Heyneman, Fremouw, Gano, Kirkland and Heiden (1990) reported results suggesting that catastrophisers are impaired in their ability to use distraction coping strategies. It is thought that the threat of pain is amplified in individuals with high levels of catastrophic thinking.

A considerable amount of research has been directed towards identifying cognitive factors that contribute to pain and disability. Gatchel and Turk (1994) suggest that individuals' cognitions about the consequences of an event and their ability to deal with this event will affect functioning in two ways: they may have either a direct influence on mood, or an indirect one through their impact on

coping efforts. Clinical studies have identified patients' beliefs, attitudes, and expectancies about pain, their coping resources, and the health care system, as influencing their reports of pain and levels of disability (Tota-Faucette, Gill, Williams & Goli, 1993) (for an extended review see Flor & Turk, 1988). In addition, cognitive beliefs are thought to influence an individual's acceptance of pain, treatment adherence as well as perceptions of chronicity. Other researchers have proposed that negative thoughts about pain can lead to maladaptive functioning, an increase in pain, suffering and disability (Alfleck, Tennen, Pfeiffer & Filfield, 1987; Gatchel & Turk, 1994; Jenson & Kaorly, 1991; Spinhoven, Ter Kuile, Lissen & Gazendam, 1989). Researchers are attempting to currently explore this relationship further to understand which cognitive factors have the most influence on pain.

In addition to psychological characteristics, how an individual reacts to pain is also thought to involve a combination of cultural (Helman, 1994; Lipton & Marbach, 1984; Wolff & Langley, 1968), environmental, and social components (Keefe & Williams, 1989). Also, an individual's expectancies based on previous experiences with illness have been shown to influence pain behaviours (Kanfer & Seidner, 1973). Helman (1994) found that cultural factors influence how health professionals interact with pain patients, the level of pain expressed by patients and also, in most situations, what kind of treatment or interventions are sought. Additionally, research suggests that the expectations of individuals suffering from pain, the likely response to their pain from others and the social costs and benefits of revealing their pain play important roles. For example, Block, Kremer and Gaylor (1980) demonstrated that pain patients reported differential levels of pain depending upon whether they knew that they were being watched by their spouses or by a researcher.

Summary

Research suggests that the experience of pain is dependent upon both physiological and psychological factors. In particular, negative cognitive activity (thoughts, beliefs, and expectations) is associated with increases in pain,

disability, anxiety and depression (Turk et al., 1984). The severity of emotional distress has been related to treatment outcome, and different personality types appear to be important predictors of pain behaviours, especially disability. An individual's culture and environment are also important factors that affect how pain is experienced. Additional research is required to understand the interaction between physiological and psychological components in the experience of pain.

CHAPTER THREE

STRATEGIES TO INFLUENCE THE EXPERIENCE OF PAIN

A number of cognitive and behavioural strategies appear to be effective in alleviating the effects of pain (Fernandez & Turk, 1989; McCaul & Malott, 1984). Cognitive strategies are techniques that moderate and influence pain through an individual's thoughts and beliefs, using techniques such as attention diversion, imagery, and self-statements. Although attention based cognitive strategies are often reported as simple and effective methods of coping with pain, the parameters that govern their effectiveness are unclear. However, behavioural strategies clearly modify an individual's behaviour by manipulating stimulus conditions and overt behaviour (Fernandez & Turk, 1989; Mobily et al., 1993). Examples of behavioural strategies include the use of relaxation and biofeedback.

Although there are many strategies for pain management, this chapter focuses on three core cognitive-behavioural strategies which divert attention away from pain. These strategies are relaxation training, the use of imagery, and distraction techniques. The effect these strategies have on pain is discussed and in the concluding section an approach to investigating the assumptions of attention diversion strategies is discussed.

Relaxation

Relaxation is frequently used in pain treatment as it is effective in reducing common symptoms of pain including anxiety, tension and muscle contraction (Ahles, Blanchard & Leventhal, 1983; Jessup & Gallegos, 1994; Linton & Gotestam, 1983; Price, 1988). Relaxation is a systematic approach to teaching awareness and control of physiological responses to pain (Arena & Blanchard, 1986; cited in Gatchel & Turk, 1989) and has been defined as an "integrated physiological response characterised by generalised decreases in the sympathetic nervous system and metabolic activity" (Jessup & Gallegos 1994). Relaxation

strategies diminish the sensation of pain by allowing the patient to control the intensity of their reactions (Edgar & Smith-Hanrahan, 1992; Wisniewski, Genshaft, Mulick, Coury & Hammer, 1988). They influence cerebral cortex functioning, especially the sympathetic system and focus on reducing anxiety and skeletal tension (Smith, Airey & Salmond, 1990; Talbot et al., 1991).

Clinical research suggests that relaxation strategies are successful in alleviating pain. For example, in a four-year follow-up of 225 chronic pain patients treated using relaxation training, Kabat-Zinn, Lipworth, Burney, and Sellers (1987) found that 60 to 72% of patients reported moderate improvement in their pain status despite the fact that their pain rating index tended to return to pre-intervention levels. Furthermore, a review of the literature on muscle contraction headache has shown that relaxation is the most effective treatment available (Jessup & Gallegoes, 1994).

However, variables such as perceived control and personality differences have been shown to influence the success of relaxation strategies (Chapman & Turner, 1986; Litt, 1988). While research has shown that relaxation is an effective strategy for alleviating pain, the mechanisms by which it operates, and factors which may influence the success of relaxation techniques need to be further explored (Harkapaa, Jarvikoski, Mellin, Hurri & Lumoa, 1991; Toomey, Gover & Jones, 1983).

Cognitive Behavioural Strategies for Alleviating Pain

A number of strategies have been found to be effective in alleviating pain and pain-related distress. For example, self-statements, involving the repetition of positive coping phrases, are designed to alter individuals beliefs and to enable individuals to strengthen their ability to withstand pain (Heyneman et al., 1990). Strategies that involve the manipulation of attention are designed specifically to remove the focus from the pain and place it on alternative tasks, for example, listening to music or someone's voice, or engaging in an attention-demanding motor task. Other strategies involve the use of images which enable an individual

to refocus their attention to more pleasant sensations or emotional feelings. All of these strategies have in common the manipulation of attention to alleviate pain.

A meta-analysis carried out by Fernandez and Turk (1989) found that in 85% of studies cognitive-behavioural strategies had a positive effect in enhancing pain tolerance and threshold levels when compared to no treatment controls. Their findings advance on Tan's (1982) review which found in 50% of cases, cognitive strategies were effective over control and no treatment groups. McCaul and Malott (1984) also support these reviews with their findings suggesting that distraction strategies were more effective than control strategies for moderating pain, and that pleasant imagery was more effective than no treatment conditions.

Imagery

Imagery, unsurprisingly, employs the imagination and creative abilities to control pain, usually through the development of sensory images including visual and auditory sensations. Imagery is thought to disrupt the pain-anxiety-tension cycle and enhance perceived self-efficacy by decreasing the intensity and unpleasantness of the pain sensation (Keefe, Wilkins, Cook, Crisson & Muhalbaier, 1986; McCaffery & Beebe, 1989). Two kinds of imagery are used in pain settings. The first, incompatible or irrelevant imagery, involves imagining sensory images that are not associated with the pain, favouring pleasant scenes or sounds (Price, 1988). Transformative imagery, the second, is the reinterpretation of the pain from the noxious stimulus it presents as, to less noxious sensations such as numbness (Fernandez, 1986).

McCaul and Malott (1984) reviewed experimental pain studies that used mainly incompatible imagery and found mixed results for the effectiveness of imagery in alleviating pain. Subsequent research has produced mixed results with some in support of the effectiveness of imagery (Pearson, 1987) and others doubting its effectiveness (Douglas, 1994). A potential explanation for this variation may be individual differences. Weisenburg (1994) suggests that some individuals are better at forming images that are capable of eliciting a powerful enough effect to

elicit pain relief. Therefore the efficacy of using imagery to alleviate pain depends in many respects, on the individual's imagination.

Distraction

Distraction is defined as “directing one’s attention away from the sensations or emotional reactions caused by a noxious stimulus“ (McCaul & Malott, 1984, p. 157). It seems that strategies which require an individual to attend to something other than pain, have the ability to reduce pain-related distress and alleviate the pain experience (McCaul & Malott, 1984). Therefore the use of distraction strategies to alleviate pain is based on the assumption that distraction will reduce pain by interrupting the information processing of noxious stimuli (Petrie, 1991). It is thought that distraction strategies compete for limited attentional resources by redirecting a person’s attention from a noxious stimulus to other images or tasks (McCaul & Haugtvedt, 1982). Thus distraction strategies must compete with the ability of the pain to demand attention and priority processing by forcing the conscious reallocation of short-term memory to the new task. McCaul and Mallot (1984) highlight a number of theoretical assumptions that form the basis for predictions regarding the effectiveness of distraction strategies in pain relief. These assumptions are:

1. “attentional capacity is limited;
2. cognitions are important in determining the pain experience;
3. pain perception is a controlled, rather than an automatic process, and
4. the distraction task is also controlled rather than automatic.” (p, 519).

The effectiveness of distraction strategies depends on a number of principles according to McCaul and Malott (1984), who came to this conclusion based on experimental pain studies. Firstly, they argue that the more difficult a distraction task is the more it is likely to reduce the experience of pain. In other words, the more attention-demanding a distraction strategy is the more it will reduce the distress associated with painful stimulation. Secondly, they also suggest that distraction is more effective for milder levels of pain compared to more intense

levels and there is a point where pain intensity can compromise the utility of the distracter task by overriding the individual's ability to attend to the distracter.

The majority of research investigating distraction strategies has found that on average distraction works better than control and no instruction strategies (Ahles et al., 1983; Corah, Gale & Illig, 1978; Dubreuil, Endler & Spanos, 1988; Farthing, Venturino & Brown, 1984; McCaul & Malott, 1984; McCaul, Monson & Maki, 1992). For example, of eight cold pressor studies comparing distraction strategies versus no instruction, threshold and tolerance levels consistently increased with a variety of distraction tasks. With pain stimuli other than cold pressor the findings are further supported with Fernandez & Turk (1989) reporting that in 85% of studies they reviewed, distraction strategies were more effective than non instruction conditions.

However, a recent editorial by Leventhal (1992) argues that distraction appears to be an insufficient analgesic technique by itself. He suggests that the effectiveness of distraction strategies may be dependent on mood or the individuals evaluation of the strategy's ability. Research has found that there are significant differences between people in their successful use of strategies to alleviate pain (Harkapaa et al., 1991; Leventhal, 1992). Further research that takes into consideration individual cognitive differences may provide more insight into the effectiveness of distraction tasks to alleviate pain.

THE PRIMARY TASK PARADIGM AND DISTRACTION

Attention-diversion strategies operate on the assumption that a task has the ability to demand attention from the processing of noxious stimuli by competing for limited attentional resources. However, Crombez, Baeyens and Eelen (1994) and Crombez, Eccleston, Baeyens and Eelen (1996) contend that research has failed to investigate the difficulty in attending to a task while experiencing pain. In other words, research has not investigated the disruptive effect pain has on the ability to perform another task. Much research has shown how distraction tasks affect pain. However, very little has looked at how pain affects task performance.

Earlier research by Walker (1971) examined the impact of pain on the ability to perform a primary task and found that pain significantly interfered with performance. Following from this research, Eccleston (1994; 1995) developed the primary task paradigm to investigate and measure the attentional cost of pain. In this paradigm, participants are asked to ignore pain in order to effectively perform a primary task. The degradation in task performance, in terms of speed and accuracy, is taken as an index of attentional interference due to pain.

Eccleston (1994) and Crombez et al., (1994) proposed three arguments why research should investigate how pain interferes with the ability to perform another task. Firstly, they argue that in order to improve the ecological validity and reliability of distraction theory it needs to take into account that concentration and attention are impaired during pain. For example, Jamison, Sbrocco and Paris (1988) have reported that one significant characteristic of chronic pain patients is associated problems with concentration and attention. Also, psychological factors and negative cognitions (e.g., depression, worry, catastrophising) interfere with the performance of strategies by altering the response styles of individuals. To Crombez et al., (1994) and Eccleston (1994) this implies that the use of cognitive-behavioural strategies to alleviate pain may be affected by an inability to concentrate on the strategy designed to assist with pain management.

Secondly, the interference of pain on the ability to perform the distraction task can be a behavioural measure of the attentional demands of pain. This allows for the investigation of how difficult it is to redirect attention away from pain to a new task and therefore questions the use of distraction based strategies to alleviate pain. Also, investigating pain and task performance allows the investigation of personality variables to be examined which may account for the failure of these techniques to work effectively. Thirdly, it offers a centralised point from which the cognitive processing of pain information can be investigated.

Eccleston (1994; 1995), Crombez et al., (1994) and Crombez et al., (1997) have used the primary task paradigm with both chronic pain patients and healthy controls. Participants experiencing high levels of pain have been found to perform worse on primary tasks relative to patients in low pain and control participants. However, Crombez et al., (1994) report that degradation of performance is selective, with attentional interference occurring only during painful stimulation, and not in control conditions. To investigate the immediate attentional demands of pain, Crombez et al., (1994) presented a tone discrimination task at three different times- at the onset of pain, during pain, and immediately after offset of pain. Results suggest that degradation in task performance occurred at the onset of pain but not during painful stimulation or after pain offset. Subsequently, research has found that interference is more pronounced at the beginning of painful stimulation than at the end (Crombez et al., 1997)

The primary task paradigm has offered a new method for investigating the relationship between pain and attention. However, the role of individual differences should not be underestimated. Eccleston, Crombez, Aldrich and Stannard (submitted) report that awareness of body information is an influential factor associated with attentional disruption and the successful use of distraction techniques. In a study of chronic pain patients, those with high pain intensity showed disruption of attention. It was argued that for those who are hypervigilant to body information, intense pain quickly and repeatedly accesses awareness and interrupts performance.

Summary

Research has attempted to investigate the ways that cognitive strategies help to alleviate the effects of pain. There is some evidence to suggest that relaxation, guided imagery and distraction are effective in relieving pain-related distress, increasing tolerance levels and increasing perceived control over pain. With respect to distraction, Eccleston (1994; 1995) and Crombez et al., (1994) and Crombez et al., (1996) suggest that changes should be made to the way the

interaction between pain and attentional resources is investigated. Using the primary task paradigm, they have shown that pain takes considerable effort to ignore and tends to demand priority processing and may therefore be less effective in some clinical populations.

CHAPTER FOUR

CONTROL AND PAIN

Perhaps one of the clearest findings in pain research is that there is considerable variability in both how individuals experience pain, and their ability to use strategies to alleviate their pain. These differing abilities and experiences have been put down to individual differences (Jensen et al., 1991), particularly, differences surrounding beliefs about control seem to be important. Two aspects of control are of particular interest to pain research. Firstly, beliefs about control, and secondly, actual control of pain. Beliefs about control refer to the cognitions a person has about their ability to influence the course of their pain; this is termed Locus of Control (LOC). Whereas, actual control is simply having some control over the course of pain.

Whilst a number of psychological characteristics have been shown to influence the expression of pain (e.g., depression, anxiety and worry), control is thought to determine the initiation of coping behaviours and the overall sense of wellbeing (Bandura, 1977). Therefore, this chapter explores control beliefs and the effect control strategies have on individuals' ability to use various distraction strategies to alleviate pain. Furthermore, this chapter in summary proposes some expected relationships between beliefs about control and control strategies.

CONTROL OF PAIN

Control is a key word in the treatment of pain and is one of the most extensively researched psychological factors. In relation to pain, control refers to an individual having a physical or psychological mechanism available to use to control their pain (Litt, 1988). Examples of control mechanism include patient controlled analgesia (PCA) or cognitive-behavioural strategies such as relaxation training or the use of distraction techniques, as mentioned in chapter three.

Control is typically characterised by the study of an individual's behaviour under conditions of high response conflict. Research paradigms on self-control have investigated the effectiveness of controlling responses in increasing the capacity of the individual to tolerate unpleasant consequences. Self-control is of particular interest in understanding health related behaviour, especially the adoption of desirable behaviours or adherence to recommended treatment plans (Baron & Logan, 1993). In self-control, the individual must generate cognitive coping responses in order to maintain goal-directed behaviour within a context of aversive environmental stimulation (Kanfer & Karoly, 1972). The self-generated cognitions may take the form of self-instruction, imagery, or specific distraction (Kerr, 1986; Meichenbaum, 1985), while the environmental demands may be either external factors such as situational cues for unwanted behaviour, or internal factors such as increased physiological arousal, tension, or pain.

The utility of coping techniques derived from this concept of self-control is demonstrated in findings that when an individual can exert control over some noxious event, they adjust more successfully (Averil 1973; Burger & Cooper, 1970; Crisson & Keefe, 1988). Numerous studies have shown that giving participants some degree of control over pain stimulation can result in lower stress responses and increased pain tolerance. Langer (1974), and Taylor, Lichtman and Wood (1984) reported that control procedures lowered anxiety, panic, and confusion, which rendered nociceptive stimuli less aversive. In contrast, Bowers (1969) reported that a lack of control resulted in an increase in the reporting of pain and an increase in levels of anxiety. Also, Straub, Tursky & Schawartz (1971) and Burger (1992) have found that when participants did not have control, they experienced increased anxiety and lower pain tolerance.

These results, while encouraging, are unfortunately not representative of the whole control-pain literature (Biederman & Schefft, 1994). For example, after extensive review, Thompson (1981) concluded that while various forms of control increased pain tolerance, reduced anticipation anxiety, reduced anticipatory physiological responding and minimised task interference effects, the results

regarding the impact of control on reported pain and distress were often contradictory and underdeveloped. He cites particularly the literature on dental stress in which control manipulations have shown to have some mild effects on skin conductance, but have failed to show any overall significant reduction in pain (e.g., Corah, Bissel & Illig, 1978; Corah, Gale & Illig, 1979). However it is still unclear if the results are as mixed in the general pain area.

Researchers have found it perplexing that there is no clear support for the prediction that control should consistently alleviate the effects of pain. Baron and Logan (1993) and Weinsenberg, Wolf, Mittwoch and Mikulincer (1990) have suggested that part of the problem may lie with early research failing to acknowledge the important role of individual differences in preferred coping styles. Research which has investigated differences in coping styles has found that when individuals adopt a coping strategy that is in contradiction to their beliefs about control, this can lead to an increase in distress (Burger, 1989; Miller, 1987; Walleston & Walleston, 1982; cited in Sanders & Suls, 1990).

LOCUS OF CONTROL

The LOC construct, first introduced by Rotter (1964), describes two attribution styles and their relationship to behaviour, especially the contribution of reinforcement to learning. Rotter (1972) suggests that there is considerable variability in how individuals interpret different situations and the role that personality plays in the outcome of events. While some individuals may consider an event as personally rewarding, others may perceive events as less rewarding or less reinforcing. He further suggests that this reaction is conditional upon the “degree to which the individual believes that the reward follows from, or is contingent upon, their own actions or attributes, versus the degree to which they feel that reward is controlled by external forces outside of their control” (Rotter, 1972, p. 171). This perceived causal relationship is generally thought of as a sliding scale of possibility. When an individual believes that reinforcement follows an action of their own, but it is not a direct result of their efforts, then it is often considered to be as a result of luck, chance or fate. Rotter suggested that

this type of interpretation of events indicated a belief in *external* control. If individuals perceive that the event is contingent upon their own behaviour or their own relatively permanent characteristics, Rotter then proposed this as a belief in *internal* control.

The LOC construct has been applied to a wide range of health issues with findings indicating that beliefs about internal control relate to indices of adaptive psychological functioning (Affleck, Tennen, Pheiffer & Fifield, 1987; Keefe et al., 1987). An internal LOC has been shown to be linked to knowledge about disease (Seeman & Evans, 1962; Walleston, Walleston, Kaplan & Maides, 1976), ability to stop smoking (Coan, 1973; James, Woodruff & Wermer, 1965), ability to lose weight (Balch & Ross, 1975; Walleston et al., 1976) and the ability to follow medical regimes (Lewis, Morisky & Flynn, 1978).

When applying the LOC construct to pain, it is thought that patients with an internal LOC believe their own efforts will produce a reduction in pain and lead to better adjustment (Buckelew et al., 1990; Calhoun, Cheney & Dawes, 1974). Consequently, these individuals have been shown to use more cognitive self-management strategies to reduce the distress associated with persistent pain. On the other hand, individuals with an external LOC believe that nothing they do matters, and that luck, fate and chance are in control of their pain and associated psychological distress (Crisson & Keefe, 1988). Research investigating external LOC suggests that external LOC patients believe regular visits to the doctor and taking prescription medication are the best ways to manage chronic pain. Also, external LOC individuals with chronic pain utilise ineffective coping strategies such as praying and hoping (Buckelew et al., 1990; Crisson & Keefe, 1988).

Further research has focused on an individual's belief system, specifically the role that pain sufferers believe they play in their illness (Harakapaa et al., 1991). Of particular interest is the effect an individual's beliefs about control have on their success when undergoing treatment for chronic pain. An increasing number of researchers support the idea that an individual's locus of control can account for

differences in the success or failure of pain alleviating strategies (Buckelew et al., 1990; Efran, Chorney, Ascher & Lukens, 1989; Harkapaa et al., 1991; Martelli, Auerbach, Alexander & Mercuri, 1987). Furthermore, it is suggested that LOC may make some individuals more suitable to self-directed pain control strategies, such as distraction. Several researchers support the possibility of increased potential benefits from matching treatments to individual's control beliefs (Atkins, Hollandsworth & O'Connell, 1982; Altmaier, Ross, Leary & Thornbrough, 1982).

Summary

The literature on LOC and control has a number of similarities. Both have shown that individuals perform better on average in both experimental and clinical settings when they believe that they are in control of their pain. Conversely, when an individual does not believe they have control, research has reported increases in emotional distress, poor functioning and negative cognitions. Overall, an internal LOC has been associated with better performance on control strategies and less psychological distress following painful stimulation. However, an external LOC has been associated with poor performance and the use of unsuccessful coping strategies (e.g., Buckelew et al., 1990; Crisson & Keefe, 1988).

A number of researcher have also suggested that when a person is placed into a situation that is in conflict with their beliefs regarding control that higher levels of emotional distress results (e.g., Harkapaa et al., 1991; Buckelew et al., 1990). These findings have specific implications for the use of attention-diversion strategies to alleviate pain as it is evident that significant differences exist between an individual and their ability to use these strategies. This is of specific interest and will be considered in the current study.

CHAPTER FIVE

THE PROPOSED RESEARCH

Much pain research has focused on the role of various cognitive-behavioural strategies to alleviate the effects of pain. Within this research some have focused on how distraction strategies work to influence the consequences of pain. Overall, the findings suggest that distraction strategies are able to increase pain tolerance and threshold levels, as well as decrease pain-related distress and increase perceptions of control when compared to no intervention control strategies (Fernandez & Turk, 1989; McCaul & Malott, 1984; McCaffery & Beebe, 1989).

However, Crombez et al., (1994), Crombez et al., (1996) and Eccleston (1994; 1995) argue that pain takes considerable effort to ignore, is distracting and demands priority processing. Using the primary task paradigm, they have shown the difficulty involved with performing other tasks when experiencing painful stimulation. They believe that studying the interruptive nature of pain on the performance of other tasks has ecological validity as pain patients have difficulties with concentration and attention. Strategies which are designed to make patients concentrate on tasks other than pain may therefore be extremely difficult to perform.

Following on from this theme that pain interrupts and is hard to ignore, a large body of research has shown that control and LOC are important factors that influence how pain affects individuals, especially the successful use of coping strategies (Buckelew et al., 1990). Overall, a person with an internal LOC has been shown to perform better in aversive situations compared to external LOC individuals as they appear to engage in more self control strategies (Litt, 1980). External LOC on the other hand, are thought to rely on ineffectual coping strategies such as prayer and hope. Internal LOC individuals when using a coping strategy which matches their beliefs of control have been reported to perform

better when compared to a coping strategy which is in conflict with their beliefs. This relationship also applies to those with an external LOC.

The primary task paradigm offers a method to examine differences in responding between internal and external LOC individuals as well as investigating the effect of control over pain. Control over the pain within the context of this primary task paradigm would be expected to reduce the unpredictability of pain, resulting in better performance. In contrast, having no control over the pain, being unpredictable pain, would be expected to cause a significant decrease in performance on the primary task.

Therefore, the proposed research aims to investigate the attentional interference of pain on an individual's ability to perform a task using the primary task paradigm. The second aim of the proposed research is to investigate the effect beliefs about control and actual pain control have on task performance.

THE CURRENT STUDY

Participants in this study were allocated to two groups based on their LOC scores. Participants were required to perform a primary auditory task which required them to discriminate between two tones which occurred from time to time during painful stimulation or during the presentation of a control visual stimulus. Degradation in the ability to perform the discrimination task was measured using reaction time (RT) and number of errors. To allow participants to have some control of the pain during part of this study, the pain stimulus was presented at three levels and participants choose the order that they received them. The predictions for the current study are outlined in the hypothesis below.

The Specific Hypothesis To Be Tested Are:

- Participants will show greater task degradation during painful stimulation compared to the baseline condition
- Participants will perform better during the control over pain condition compared to the no control over pain condition;

- Those participants with an internal LOC will makes less errors and perform better in the pain condition compared to those with an external LOC;
- Internal LOC participants will perform better in the control condition and externals LOC participants will perform better in the no control condition during both the pain; and
- Male participants will have a higher pain tolerance level than females.

CHAPTER SIX

METHOD

Participants

The participants were 59 volunteers from the School of Psychology at Massey University. University students were selected as participants for a number of reasons. Firstly, prior LOC research has used university students, therefore allowing some commonality in sample characteristics. Secondly, the normative data for the LOC scale has been obtained from psychology students which allows more valid score comparisons. Thirdly, psychology students allowed for ease of access to participants.

The researcher sought participants by presenting a short seminar outlining the proposed research at undergraduate psychology lectures. Those that indicated their interest were given an Information Sheet (Appendix A) that outlined the nature of the experiment, the requirements of the study, and the time commitment necessary. At this stage participants were required to complete the LOC questionnaire (Appendix B), medical checklist (Appendix C) and return the completed forms to the researcher. Prior to the start of the experimental sessions a consent form was required to be signed by each participant (Appendix D).

Participants were selected on basis of their scores on Rotter's LOC scale, and their current health status. Over 130 people responded to the research questionnaire, however, only 60 people were selected due to funding restrictions. Nine potential participants were excluded from participation on medical grounds. The first 60 people to meet the median split criteria were used in this study. The use of a median split on the LOC scale is standard practice in this type of study (Pickett & Clum, 1982). In the present study the median score on Rotters LOC scale was 10 (possible range of 0 - 21). Participants were allocated to the internal LOC group

if their score was 10 and below, and to the external group if their score was 11 and over.

Each participant was paid \$10.00 after completing the experimental portion of the study. However, this payment was not contingent on the completion of the experimental phase of the study. A total of 35 females and 25 males completed the experimental sessions, however one female participant's data was not analysed due to external noise interference present during the experimental session. The age range for the participants was 18 to 55 years and can be seen in Table 1.

Table 1

Age Distribution for Participants

Age	Number of Participants
18 and under	2
19-25	41
26-30	5
31-35	3
36-40	3
41-45	3
46+	2
Total	59

Setting

The experimental sessions were conducted in a laboratory at Massey University School of Psychology. The experimental room contained a large "L" shaped workstation, two computers and the pain generator apparatus. A stainless steel sink was used to prepare participants for the pain stimulus (see iontophoretic

preparation procedure). Participants were seated at a table one metre away from the computer screen which presented the visual distracter.

Apparatus

One IBM PC computer ran the experimental pain stimulus, the tone discrimination task and recorded the participants' response times (in milliseconds) as well as the number of errors made. A second IBM computer controlled the presentation of the control distracter, a photograph of an old man's face (Appendix E).

Pain Stimulus

The pain stimulus for this study was potassium iontophoresis which is the process of ion transfer through the skin when an electrical current is applied to a solution containing ionised species (Tyle, 1988). The level of felt stimulation depends upon the amount of current applied and the duration of the stimulation (Benjamin & Helvey, 1963; Humphries, Johnson & Long, 1996; Voudouris, Peck & Colman, 1985). The pain stimulation is often felt as a tingling sensation at lower levels and a burning prickling sensation at higher levels. Previous studies that have used potassium iontophoresis have suggested that it possesses many of the ideal characteristics of a pain stimulus (Benjamin & Harvey., 1963; Breakwell, 1992; Humphries, 1995).

Iontophoretic Pain Generator

An iontophoretic pain generator, designed at the Massey University School of Psychology, administered the pain stimulus for this study. This generator consisted of a constant-current power source, which delivered a selected range of current between 0 mA and a maximum of 25 mA. The set up of the iontophoresis pain generator equipment was identical to that used in previous studies conducted by Humphries et al., (1994), Breakwell (1994) and Douglas (1994). The iontophoretic generator had two electrodes that were placed onto the participant's non-dominant arm and strapped in place using two rubber adjustable straps. A cathode consisting of a silver plate (approximately 4cm x 13cm) covered with

several layers of saline saturated medical gauze was placed against the palmar surface of the participant's arm. An anode consisting of a silver plate suspended in a plastic bowl with no base was placed against the volar surface of the participant's arm. The participant's skin acted as a base for the bowl. Inside the bowl was placed the potassium chloride gel that had to be in direct contact with the participant's skin (Figure 1). Once the bowl was filled with a potassium chloride solution (3% weight/weight), there was a surface area of 12.5 cm² of solution in direct contact with the participant's arm. To prevent leakage of the potassium solution half a gram of agar was added to every 100mls of potassium chloride solution.

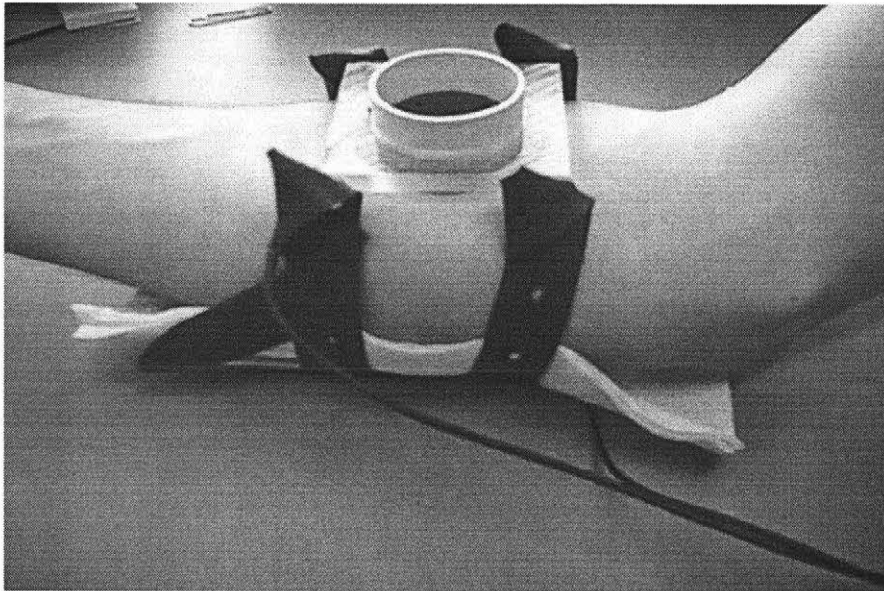


Figure 1.
Iontophoretic Pain Generator Apparatus.

Response Device

The response device was a moulded plastic attachment with two buttons labelled "H" (for high) and "L" (for low). A velcro adjustable strap enabled this device to be attached to the participants index and second finger and adjusted according to finger size.

Participant's responded to the auditory discrimination task using their dominant hand while experiencing pain on their non-dominant arm. As the participant's needed to respond quickly to the tone discrimination task, it was decided that the pain and the response keys should not be attached to the same hand. Additionally, the pain apparatus required each participant to hold their hand flat during the experimental trials to prevent the potassium gel from leaking (see Figure 1).

Emergency Cut-off Switch

A small device was positioned on the table beside each participant's dominant hand that was designed to terminate the experiment at any stage if the participant did not wish to continue. Participants were told that this device would immediately stop the pain sensation. However, no participant used this device during this study.

Primary Task

The primary task was based on that used by Crombez et al., (1994). A single tone of either 250 or 750 MHz was presented either 250 or 750 milliseconds ms after the onset of either a pain or visual distracter stimulus. Each tone was presented for a total of 200 ms with each pain and visual stimuli being presented for 2000 ms. There were inter-stimulus intervals of 2000, 2500 and 3000 ms to reduce familiarity of presentation. There were no more than three same tone presentations in succession and a pain and visual stimulus did not occur at the same time. Additionally, there were between three and five tone-only presentations before the pain or visual stimuli were presented.

There were six experimental sets, each containing 49 presentations of the primary auditory task. Each experimental set had approximately an even number of high and low tone presentations. A total of 230 tones were presented in the absence of any pain or visual stimuli, 24 tones were presented with pain and 24 with a visual stimulus. To account for the acquired familiarity of the presentation of a tone with the presentation of either a pain or visual stimulus, seven pain/visual stimuli were presented in the absence of a tone.

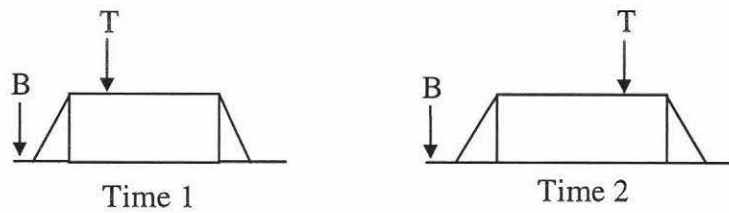


Figure 2.

Schematic representation of the experimental design.

The arrows indicate the moment of tone presentation. B arrows are baseline tones and T arrows are tones during experimental events. During Time 1 a tone was presented at 250 ms after pain/visual stimulus onset. During Time 2 a tone was presented at 750 ms after pain/visual stimulus onset. The pain took 250 ms to ramp up and down to the stimulus level.

Participants were required to indicate the frequency of the tone by responding as fast as possible using the response device. If the participant believed the tone to be a high tone the “H” was pressed or “L” for a low tone. Participants were given 20 practice tones to reduce the number of errors made in the experimental sessions.

Participants in the internal and external LOC groups were further assigned to an order condition. Half of the participants from each internal and external LOC groups were given control over the order of pain that they received first, while the other half of each group had no control first. A random procedure decided the order that participants received the control condition. A counter balance design was used to ensure that all participants were given all conditions.

DESIGN

Design of experiment

This study used a two group (internal LOC, external LOC) by three measures (reaction time, control, stimulus type) repeated measures design. A repeated measures design was used to reduce the impact of inter-subject variability that is

known to be associated with iontophoretically transferred potassium ions (Benjamin & Helvey, 1963).

ASSESSMENT

The constructs of interest in this study were pain, control manipulation, LOC and task degradation.

Pain Tolerance

Initial pain tolerance levels were established using a single staircase method. This method is a modified version of the double random staircase (Cornsweet, 1962; Gracely, 1988; cited in Dunbar, Gebhart & Bond 1988; Gracely, Lota, Walter & Dubner, 1988). The single staircase method involved 16 pain presentations. The participant's responded to painful stimuli using two keys, one labelled "too much pain" and the other "more pain" after the sound of a tone which signalled the end of the stimulus. Each successive pain stimulus increases proportionally in relation to the participant's responding until the participant indicates that he/she does not want to go any higher. When this occurs the next stimuli decreases proportionally until the participant indicates that they can take "more pain". Successive presentations of the pain stimuli change according to the response from the participant. The result is an oscillating level of pain intensity around an individual's average tolerance level for pain (Humphries, 1995). Pain tolerance was averaged using the final four pain levels that each participant indicated.

One potential disadvantage of using a modified staircase method is that participants can become aware of the procedure and manipulate their responding, by either anticipation or response preservation (Humphries, 1995). However, as this study is interested in the effects of pain on performance rather than changes in tolerance, this is considered to be less of a concern. This single staircase design was used in order to limit experimental exposure and to determine the pain tolerance levels to be administered during the experimental phase.

Control Manipulation

In order to have a control manipulation condition, the pain stimulus in this study was presented at three different levels. Each participant's three levels of pain were calculated using 60, 75 and 90 % of their tolerance level. The six experimental sets were divided into two groups. In group one, the no control condition, three sets had a mixed level of pain presentations and allowed for no control over the order of pain presentations. In group two, the control condition, the remaining three sets allowed participants to choose which order they would receive the three levels of pain. Participants received both control and no control sessions, totalling six sets.

Locus of Control

LOC was measured using Rotter's LOC scale (Rotter, 1964) (Appendix B). This scale was chosen as it assesses the general construct of LOC and is designed for healthy participants. Rotter's LOC scale has 29 paired choice items and is designed to force the participant to choose between two alternative views of events. The range of scores is between one and 21 with eight items being fillers only. A score in the range of 10 and under normally indicates an internal LOC, whereas a score between 10 and 21 is again normally considered to indicate an external LOC. The norms for this scale come from American studies using psychology students as participants; males mean = 8.15. (SD = 3.88), and for women, mean = 8.42, (SD = 4.06) (Rotter, Chance, Phares, 1972). The reliability and validity of the LOC scale has been established from a series of samples including elementary psychology students (.79) and university students (.65). LOC is considered to be stable over time (for further test statistics on reliability information see Rotter et al, 1972). The separation of participants into two groups allowed for differences in LOC orientation and pain responding to be investigated between groups.

Task Performance

Performance on the task requiring auditory discrimination was assessed using two methods: reaction times (RT) and the number of errors. RT was measured in ms

by a computer that calculated the time between the presentation of the tones and participant's response using the response device. RT was recorded for baseline, pain stimulation, and visual stimulation trials. The use of RT is in line with research by Crombez et al., (1994). The second method assessing performance refers to the number of errors made by participants in completing the primary auditory task requiring accurate discrimination between the two tones. Errors were defined as incorrect discriminations between high and low tones.

One of the disadvantages of using RT is the variance in response data. Experience with RT distributions has led several investigators to suggest that RT distributions are nearly always positively skewed with a unimodal shape (Bradley, 1982; Heathcote, Popeil & Mewhort, 1991). However, this method offered a behavioural measure of pain interference which has been shown to have more reliability than self-report measures (Crombez et al., 1994)

PROCEDURE

All experimental procedures were carried out by one male researcher in a laboratory room devoted to experimental pain research. The same protocol, as outlined below, was used for every participant.

Welcome and Questions

Participants were thanked for their participation and reminded that they did not have to complete the experimental session of the experiment if they chose not to. Any questions that they had about the experiment and the nature of the pain stimulus were answered. All participants were then offered the opportunity to take their payment and leave if they no longer wished to participate in the research. No participant chose this option. The experimental procedure was outlined and participants informed that they would instructions at each stage of the experiment.

Introduction to the Pain Apparatus

Participants were shown how the apparatus would be used during the trials and familiarised with their tasks in the experimental session. During this stage of the experiment each participant was shown how to end the experiment using the emergency cut off switch.

Task Practice and Iontopheretic Preparation

Participants were introduced to the primary discrimination task and informed that they would be required to discriminate between two tones using the response device. The researcher explained that there were only two tones used in the experiment, a high tone and a low tone. Both tones were then presented to each participant and the experimenter identified each tone. Participants were then given 20 tones as a practice session and asked to try and respond as quickly as possible after the presentation of each tone. In this session were equal numbers of high and low tones presented, with an inter-stimulus interval of 2000 ms. The data for this practice session was not recorded. Another practice of 20 trials was given if the participant felt that they were having difficulty.

Prior to the application of the electrodes to the arm of each participant, the volar and dorsal surfaces of the participant's non-dominant arm were cleaned using Dettol liquid soap and an 80:20 solution of alcohol and acetone. The participant's arm was then towel dried. This process was performed to remove the skin resistance from the participant's arm as well as standardising skin resistance, this allowing for more consistent pain responding.

The pain apparatus was then attached to their cleaned non-dominant arm. The following instructions were then read to the participants after which they were asked if they understood what was about to take place:

I am now going to introduce you to the pain stimulus. What this involves is two pain ramps whereby the pain begins at zero and slowly increases in intensity. When you think that you have had enough pain, you have

reached your tolerance level, I would like you to push the button in front of you labelled "Tolerance". When you push this button labelled "Tolerance", the pain will ramp back to zero. Do you understand?

It was emphasised to participants that they should only take as much pain as they felt that they could handle at this precise point in time. Two ramps were used to allow the participants to become familiar with the pain sensation and reduce skin resistance. The researcher recorded each indicated tolerance level for later use in the more accurate measurement of tolerance as described below.

Pain Tolerance Procedure

Participants were given the following instructions at the beginning of this procedure.

I am now going to get a more accurate measure of your tolerance for pain. You are going to experience a number of pain stimulations and then after each stimulus, you will hear a tone. After each tone, I would like you to respond using the two keys in front of you marked "more pain" and "too much pain". If you think that you are able to take more pain then press "more pain", if you think that it was too much pain, press "too much pain". Please respond to each pain stimulus individually, and please wait for the tone to sound.

Prior to presenting the pain stimulus participants were again asked if they had any questions. All questions were answered except for those concerning the number of presentations participants were about to experience as it was felt that this information could lead to response manipulation. Thirty percent of the average pain tolerance level recorded during the two ramps in the above procedure for each participant was used as a starting pain stimulus level for the pain tolerance procedure. A total of 16 pain presentations were delivered to each participant and a computer recorded the participant's ratings and then calculated an overall tolerance value which the experimenter recorded.

Experimental Session

Participants were next involved in the experimental phase of the study. Instructions were given to participants informing them whether they had control or no control over the pain for the next three experimental sets. After each set, there was a break of approximately one minute, and after the completion of the third set there was an extended break of approximately 3 minutes to allow the participant to relax before the next three sets. Also this time allowed the researcher to prepare.

For the control condition (control over the order of the pain presentation) the participants were required to choose which order they preferred receiving the pain levels. When given control participants were read the following instructions:

In this part of the experiment, you have control over the level of pain that you are going to receive. There are three pain levels, high, medium and low. Each pain level is below your indicated tolerance level and you will not experience more pain than you have already today. You must include all three-pain levels, and you can have them in any order. Do you understand? Please make your decision now.

Each participant's responses were recorded by the researcher and this became the order of the control manipulation. Participants were then given the experimental trials in their chosen order. In the no control condition, participants were informed:

In this first half there are three trials. There is a mixture of three pain levels during these trials, high, medium and low. All three-pain levels are below your indicated tolerance level and you will not experience more pain than you have already today. You have no control over what pain level you are going to receive at any point. Do you understand?

Participants that had no control were given three experimental sets with a mixed pain level configuration. Participants were told that they had no control over the pain level that they were going to receive.

Debriefing and Payment

At the end of the experimental session the pain apparatus was removed from the participant and their arm cleaned using Dettol liquid soap. Participants were told that redness caused by the pressure of the cup on their arm would quickly dissipate. Participants were then paid \$10.00 for their time.

CHAPTER SEVEN

RESULTS

Planned comparisons were used to explore the hypothesis. It was felt that this method was the most appropriate given the large number of conditions and variables in this study. Using many conditions and variables can increase the number of trivial and spurious effects being found, and could unnecessarily complicate the results making interpretation difficult (Keppel, 1988).

At the outset of the analysis a number of manipulations took place to keep the data in line with other research. As previous research had found no significant difference in reaction times (RT) to the two tones used in this study, these RT were averaged (Crombez et al., 1994). Secondly, as time of the auditory stimulus presentation was not a variable of significant interest in this study, the two times, 250 and 750 ms, were combined together initially. Thirdly, RT more than three standard deviations away from the mean for the experimental sessions were excluded from the analysis (Tabachnick & Fidell, 1989). The removed data accounted for less than two percent of the overall data.

In line with the primary paradigm research, task degradation was measured using RT and percentages of errors made during the auditory discrimination task. The trial presented immediately prior to the pain/visual stimulus with the same tone was used as the baseline comparison measure. Throughout the analyses mean reaction times (RT) and percentage of errors made were used as the summary statistics.

Analysis

As one participant's data was earlier excluded from the analysis because of noise interference during the experiment, a total of 59 participants completed the experimental session. Due to ceiling effects (most people made no errors) mean

errors could not be calculated and therefore the data is presented as the percentage of people who made no errors. The statistical package SPSS/PC was used to analyse the data from this study.

Hypothesis One: Pain

The first hypothesis predicted that participants would show greater task degradation during painful stimulation compared to baseline trials. The overall mean RT and standard deviations for all of the pain and appropriate baseline trials can be seen in Table 2.

Table 2

Mean RT and Standard Deviations for Pain and Baseline Trials

	Mean	SD
Baseline	550.07	111.98
Pain	543.40	127.07

To investigate the difference in these mean RT a t-test was performed. The analysis resulted in a non-significant main effect for RT during pain ($t(1,58) = 1.086, p > .05$). The result indicates that there is no significant difference in RT between the pain and baseline (no pain) conditions. Analysis of the error data for the baseline condition found that 97% of participants made no errors. However for the pain condition 81% of participants made no errors. Error data was analysed using the Wilcoxon Signed Ranks Test. This measure was used by Crombez et al. (1994). The analysis found that there was a significant difference in the percentage of errors made during the pain condition compared to the baseline condition ($T(57) = -4.379, p < .001$).

Hypothesis Two: Control

The second hypothesis predicted that participants would show less task degradation when they had control over the pain compared to no control. The

overall means and standard deviations for control and no control over pain conditions can be seen in Table 3.

Table 3

Overall Means RT and Standard Deviations for Participants with Control and No Control Over Pain

	Pain	
	Mean	SD
Control	536.92	119.30
No Control	550.53	144.95

To compare the effect of control and no control on performance, a MANOVA was performed. The results suggested that there was no main effect for RT for control over pain ($F(1,58) = 1.784, p >.05$). This means that there was no significant difference in participants RT when they had control or no control over the pain. For the error data, in the control session during pain, 71% of participants made no errors, and during the no control condition, 81% of participants made no errors. Analysis of the error data found that there was a significant difference in the number of errors made for the no control and control condition during pain ($T(30) = 2.507, p < .05$).

Hypothesis Three: LOC and Performance

The third hypothesis predicted that participants with an internal LOC would perform better overall on the primary auditory task during pain compared to those with an external LOC. The RT means and standard deviations for LOC group with and without control of the pain condition is presented in Table 4.

Table 4

Mean RT and Standard Deviations for LOC Group With and Without Control

	Control		No Control	
	Mean	SD	Mean	SD
Internal	550.70	117.73	536.07	98.03
External	550.38	169.23	537.74	138.52

To investigate the differences between the means a MANOVA was performed. The results found a non significant difference in overall RT during pain between LOC groups over pain conditions ($F(1,57) = .009, p > .05$). This result suggests that there was no difference between groups and their RT to pain in either of the pain control conditions. The percentage of errors made for the pain conditions with and without control for both LOC group can be seen in Table 5.

Table 5

Percentage of Errors Made for LOC Group With and Without Control of Pain

	Pain	
	Internal	External
Control	79%	63%
No Control	72%	90%
Overall Mean	75.5%	76.5%

Table 5 shows that there was no significant difference in accurate discriminations for the tone task for either group during the pain condition compared. Analysis of this error data for the pain conditions found that there was no significant difference in performance for the internal group for the pain conditions (pain ($T(29) = -.329, p > .05$) for either control conditions. For the external LOC group there was a significant difference for the pain condition (pain ($T(30) = -2.507, p <$

.05). Therefore the third hypothesis was supported that internals would perform better over all during the pain condition

Hypothesis Four: LOC and Control

The fourth hypothesis predicted that participants with an internal LOC would perform better than those with an external LOC in the control condition and that external LOC participants would perform better in the no control condition. The overall mean RT and standard deviations for LOC group with and without control over pain can be seen in the above Table 4. This showed differences between both LOC groups and RT responding for both control and no control over pain. A MANOVA analysis revealed the interaction between LOC group and control condition was not significant ($F(1,57) = 1.758, p > .05$). This means that there was no difference in RT when participants had control or no control over the pain.

Table 5 shows the number of errors made during the control and no control conditions for both LOC groups. Analysis of the error data using the Wilcoxon Signed Ranks Test for hypothesis four found for the internal LOC group no significant difference in errors made for pain ($T(29) = -.329, p < .05$) between control over pain conditions. Overall, the hypothesis that the internals would perform better in the control condition was not supported. However, for the external LOC group, overall performance during the no control condition was significantly better compared to the control condition where the external LOC group showed significant task degradation ($T(30) = -2.507, p < .05$). Thus the finding supported hypothesis four for the external LOC group only.

Hypothesis Five: Condition

Hypothesis five predicted that RT would be significantly different between the pain, visual and baseline stimulus trials. Table 6 shows the means and standard deviations for pain, visual and baseline conditions.

Table 6

Overall Means and Standard Deviations for Baseline, Visual and Pain Conditions

	Mean	SD
Baseline	550.07	111.98
Visual	529.72	120.38
Pain	543.73	127.07

To investigate the differences between the means a MANOVA was completed. The results found a significant difference in RT between pain, visual and baseline trials ($F(2,57) = 6.109, p < .01$). Paired sample t-tests revealed that there was a significant difference for pain and visual stimuli ($t(58) = 2.548, p < .001$). There was a significant difference in reaction times ($t(58) = 3.364, p < .001$) for baseline and visual trials. The non-significant difference between pain and baseline trials was presented in hypothesis one and was therefore expected. The results indicate that RT time was longest for the baseline condition and then for the pain condition and significantly faster in the visual condition.

Hypothesis Six: Gender

The sixth hypothesis predicted that overall, males would have a higher tolerance to pain than females. The overall means and standard deviations can be seen in Table 7.

Table 7

Overall Means and Standard Deviations for Tolerance Levels for Males and Females

	Number	Mean	SD
Female	35	102.54	59.27
Male	24	125.63	76.65

In the current study, seven (12%) of the participants reached the maximum pain level during the measure of tolerance procedure (25 mA) and of this number six were males. To compare differences in tolerance to pain between males and females, a paired sample t-test was performed and approached significance, $t(58) = 1.303$, $p < .06$. Although this did not reach the lowest acceptable significance level (.05), in calculating the effect size there seems to be a moderate effect occurring between gender and tolerance level (ES (d) = .35) with males having a higher mean tolerance level than females.

Post Hoc Analyses

Two further analyses were carried out post-hoc. Firstly, this study used three pain levels 60, 75, and 90 percent of tolerance to allow for a control manipulation (for the participants pain levels were referred to as low medium and high pain respectively). Of interest in the post hoc analysis was the effect that the three pain levels had on RT. Table 8 shows the overall means and standard deviations for the three pain levels.

Table 8

Mean RT and Standard Deviations for Low, Medium and High Pain

Level	Mean	SD
60	539.80	137.80
75	553.38	120.40
90	517.78	124.60

The mean RT for the three levels of pain shown in Table 8 suggested that pain level may have influenced responding to the primary task. To investigate whether level of pain effected RT a MANOVA was performed. The results found a significant effect for pain level ($F(2,57) = 6.466, p < .001$). This indicates that there were significant effects for the three levels of pain on response times. To further investigate the effects of pain level, paired samples t-tests were performed. The results found that there was no significant difference in RT between low and medium pain levels ($t(58) = 1.067, p > .05$). However, there was a significant difference in RT between low and high pain level ($t(58) = 2.263, p < .05$) and high and medium pain ($t(58) = 3.393, p < .001$).

The second post hoc analysis investigated the effect that the timing of the primary task had on performance during painful stimulation. The rationale for this investigation was the potential for the two times to have influenced the RT to both the pain and the visual conditions. The current study presented the primary auditory task at 250 and 750 ms after the onset of pain or visual stimuli. Analysis of mean RT for Time one and Time 2 are presented in Table 9.

Table 9

Mean RT and Standard Deviations for Time One and Time Two for Pain and Visual Conditions

	Mean	SD
Time One	556.11	128.00
Time Two	537.07	133.89

The RT for Time one and Time two suggested that time may have influenced responding. To test to see if this was a significant difference a MANOVA was performed. The results found that there was a significant difference in RT for the time presentation of the primary task ($F(1,58) = 7.005, p < .01$). This suggests that overall participants responded faster for time two 750 ms compared to time one 250 ms for both the pain and visual conditions.

CHAPTER EIGHT

DISCUSSION

For the participants in this study pain had a significant effect on the number of errors they made during the primary auditory task but not on their RT to the painful stimulation. Those participants with an internal LOC were able to perform better overall in the experimental conditions compared to the external LOC group

Review of the Hypotheses and Findings

Hypothesis one predicted that pain would interfere with participants' performances on the primary auditory task by disrupting attention resulting in task degradation. This hypothesis was not supported by the RT data however it was supported by the error data. The rationale for this prediction was based on the primary task paradigm which suggests pain demands priority processing and interrupts other behaviours (Crombez et al., 1994). The results from the current study found that pain did not significantly increase RT between pain and baseline conditions as predicted. However, a significant decrease in the number of accurate tone discriminations for the pain condition indicates that pain caused overall task degradation. The results from this hypothesis were not expected for three reasons. Firstly, Crombez et al., (1994) upon whose research the current study is based, found significant increases in RT differences for the pain condition and reported that the percentage of individuals making errors in their studies were insignificant. Secondly, the primary auditory task was designed to be a simple discrimination task and was not expected to cause problems with responding. Thirdly, participants were given a practice session designed to reduce the number of errors made (see task practice and iontophoretic procedure). As mentioned previously, the effectiveness of attention diversion strategies relies on the reallocation of attention away from pain to more pleasant experiences of tasks. The findings from the current study support the proposal that pain demands

priority processing and is hard to ignore and has a detrimental effect on attention and processing of a new task.

The second hypothesis investigated the differences in task degradation when participants had control and then no control over the pain stimulus. This hypothesis was not supported by the RT data, however it was supported by the number of inaccurate discriminations of the tones as seen in the percentage of errors made. It was predicted that overall there would be significantly less task degradation during the control condition. This prediction was based on research which has reported that individuals perform better on average when they have control over aversive situations (e.g., Averil 1973; Crisson & Keefe, 1988). Control has been shown to increase pain tolerance and minimised task interference effects (e.g., Thompson, 1981). As highlighted earlier, a number of studies suggests that when an individuals can exert control over some noxious event, they adjust to the event more successfully (e.g., Averil 1973; Crisson & Keefe, 1988).

Analysis of the RT data found that there was no significant difference between control and no control over the pain. This finding was not originally expected, however as the results from hypothesis one revealed, RT were not effected by the pain condition. Analysis of the error data showed that there were significant differences in the accuracy of responding between groups during the control condition. The percentage of incorrect discriminations between tones decreased by ten percent from the control to no control condition. This result was surprising given the evidence from the literature which suggested performance was better when individuals were given control over the pain. Therefore the results of this analysis found that there were significant effects for control of pain between LOC groups but this was in a way not expected by the hypothesis.

The third hypothesis predicted that those participants with an internal LOC would perform better during pain compared to those with an external LOC. The hypothesis was not supported for the RT data, nor for the error data. The

rationale for the hypothesis comes from research investigating LOC and task performance. Overall, an internal LOC has been associated with better performance on control strategies and less psychological distress following noxious stimulation (e.g., Buckelew et al., 1990; Harkapaa et al., 1991). It has been theorised that those individuals with an internal LOC believe that they have at their disposal the ability to control their pain (Jenson et al, 1991). On the other hand, external LOC has been associated with the belief that individuals have little influence over pain. In this study, there was no significant difference in RT between the external and internal LOC group during the pain conditions.

The fourth hypothesis was derived from hypothesis two and three. It was predicted that participants with an internal LOC would perform better than external LOC participants in the control condition and that participants with an external LOC would perform better than internals in the no control condition. The hypothesis was not supported for the RT data, but again the error data showed that there were significant differences between LOC group, the number of errors made and the control condition. Research about control beliefs, have shown individuals with an internal LOC perform better when they are in control and that individuals with an external LOC have been shown to perform better when they believe that significant others are in control of their pain (e.g., Harkapaa et al., 1991).

RT analysis in this study found no significant differences between groups for control and no control. For the internal LOC group there was no significant difference in the number of errors made for either control condition. However in the control of pain condition there was a slight although not significant decrease in errors made. For the external LOC group, the average number of errors decreased significantly overall during the no control condition compared to performance during control. The hypothesis was therefore supported for the external LOC group but not for the internal LOC group. As mentioned, the study failed to find any significant difference for the internal LOC group for control. The results in this study were also similar to that reported by Bierderman and Schefft (1994) for the internal LOC group where they found that there was no significant difference

in either the control or no control condition. This finding requires further research to understand why control had no effect on performance for the internal LOC group

The fifth hypothesis predicted that there would be significant differences between pain, visual and baseline conditions. It was predicated that the visual condition would have less of a distraction effect compared to the pain condition and that pain would have more of a distraction effect than the baseline and visual condition. The results found that there were significant RT differences between the three conditions, yet these were not in the predicted order. The rationale for the prediction was based on the idea that pain has been shown to demand priority attention, is a noxious stimulus and therefore would interfere more than the non-noxious visual and baseline conditions. As expected, the visual stimulus had less of an aversive consequence on performance compared to pain and baseline conditions. The finding that the baseline condition had significantly longer RT compared to the pain condition was not expected. Similar studies by Eccleston (1994, 1995) and Crombez et al., (1994) and Crombez et al., (1997) reported that the pain condition significantly effected RT to the primary task. To try and investigate and understand this finding it was decided to further investigate this finding as a post hoc analysis.

Hypothesis six was interested in examining the difference in pain tolerance levels between males and females, more specifically that males would have a higher pain tolerance than females. The results for this hypothesis almost reached significance, with a trend suggesting that males had higher pain tolerances compared to females. Research has shown that overall males have higher cutaneous thresholds for pain tolerance to pain (e.g., Bonica, 1987, cited in Douglas, 1994) and men have higher tolerance levels for cold pressor, electric shock, and focal pressure pain (e.g., Otto & Dougher, 1987). With the sample sizes of 35 females and 24 males, this study had just 25% power to yield a statistically significant result. An increase in the number of participants would therefore be expected to produce a significant result. Furthermore, six males

reached the maximum stimulation level which may have influenced this finding by limiting the range of scores possible. Only one female participant reached the maximum tolerance level.

Review of Post-Hoc Analyses

The first post-hoc analysis investigated the effect that the three pain levels of high, medium and low pain had on performance. The post-hoc analysis was carried out to see if there was significant difference in RT for the three pain levels. The results found that RT was significantly longer during the medium pain condition compared to the high pain condition. Furthermore, the high pain condition was faster than the low pain condition. The results indicated that RT time decreased for highest level of pain compared to the lowest levels of pain. One possible explanation for this finding is that the high pain level (90% tolerance) made participants respond faster because it was the most painful. Participants may have thought that by responding faster that the pain may stop faster. This finding requires additional investigation to fully understand this result.

The second post-hoc analysis examined the effect of time on RT during painful stimulation. The primary task was presented at two times, 250 ms (Time One) and 750 ms (Time Two) after the onset of both the pain and visual conditions. Although time was not originally a variable of interest, it was proposed that these two times might have influenced and account for the lack of significant RT results. The rationale for this prediction was that hypothesis five found significantly longer RT for the baseline condition compared to the pain condition and faster RT for the visual condition compared to pain and the baseline conditions. According to previous research findings, the baseline condition should have shown the fastest RT as there was no interference factor. Additionally, nothing occurred prior to the presentation of the tone that should have caused a significant level of distraction. One possible explanation was the timing of the tone presentation. The pain and visual conditions were presented at either 250 ms or 750 ms before the onset of the primary task whereas there was no event occurring before or during the baseline condition other than the presentation

of the tone. Therefore, it was proposed that these stimuli (pain and visual) might have acted as a warning signal for participants that they had to respond. This warning may therefore account for the longer baseline condition and the shorter pain and visual conditions.

The results of the time analysis found that there was a significantly longer RT for Time One compared to Time Two for both the pain and the visual conditions. Overall the longer delay of Time Two before the presentation of the primary task resulted in a decrease in RT. This finding supports the idea that at Time Two participants may have had the benefit of a longer advanced warning signal than at Time One. The longer RT to pain compared to the visual at either time may therefore be explained by the noxious effect pain has on performance. In other words, the advantage of a warning signal from the pain stimulus was outweighed by its noxious effect.

The implications of this warning signal effect may be of significance as Crombez et al., (1994) were unable to explain why their Time Two (750 ms after onset) did not have an increased effect on RT. They proposed that pain interferes more over time, when the processing of pain is significantly more involved. Furthermore they suggest that the question remains as to why there is no larger disruption in cognitive processing during the later experiences of pain. This proposed warning effect is one possibility that may explain this finding.

Methodological Issues

In any experiment there are always a whole host of variables that can influence the outcome. This is especially pertinent for psychology research where individual differences can influence the results to a point that leaves them uninterpretable. Control of such variables is a priority but in some cases it is difficult to identify potential problems and remove them before they can have an effect. Furthermore, Dworkin and Chen (1982) have emphasised the limited generalisability of experimental findings to clinical settings which offer significantly different conditions.

One problem with experimental pain studies is that often the stimulus does not accurately portray clinical pain. The existing experimental pain research has used a variety of artificially produced pain stimuli in laboratory settings, including the cold pressor task, high intensity light (radiant heat dolorimetry), pressor pain (Forgione & Barber, 1971), and electrical shocks (Price & Tursky, 1975). Unfortunately, these methods have limitations and methodological inconsistencies. Potassium iontophoresis was used in the current study as it allowed for a significant range of intensity and more closely approximated clinical pain than electric shocks or cold pressor pain techniques. Furthermore, the ability of potassium iontophoresis to be applied repeatedly makes this an especially suitable pain stimulus for experiments using a repeated measures design such as the current study.

Pain Report and Gender

The measurement of pain has caused a number of conceptual problems in the past including what tolerance actually measures (Price, 1988). Pain tolerance is considered a subjective experience and is influenced by psychological or evaluative/emotional circumstances (Chen et al., 1989). There are three potential problems with the use of tolerance as a measure of pain in the current study. Firstly, a significant portion of the participants asked prior to the experimental session if males had a higher pain tolerance than females. It is possible that this may have influenced subsequent tolerance measurements for both males and females as expectancies may have influenced the amount of pain that they wished to take.

Secondly, a number of participants who volunteered and met the experimental requirements of the study knew the researcher prior to participation. A participant's desire to perform according to their perception of what is expected of them constitutes worthy consideration (Price, 1988). It is possible that this socially desirable responding was played out also in their tolerance levels. As mentioned previously, more males reached maximum tolerance level compared to

females. As the researcher in this study was a male and known to participants this may have increased their desire to take more pain.

Finally, participants in the current study were paid for their to complete the current study. Price (1988) suggests that payment can lead to “expected” behaviours. However this was considered to be less of a concern in the current study as participants were offered their money at the beginning of the experimental session with the opportunity to take their money and withdraw from the research.

Slow Finger Responding

The current study was effected by a number of methodological problems and mistakes. In retrospect, the choice of response device for this study was not the best for measuring reaction time. It was not till after the completion of the current study that it was realised the response device was flawed in two key areas. Firstly, the response device required the participants to respond using their thumb which research has shown to be the least desirable finger for measuring reaction time (Reeve & Proctor, 1988).

Secondly, single finger responding can cause muscle fatigue that can result in slow responding over time (Andreasen, 1995). In a series of four experiments, Reeve and Proctor found consistent differences in RT for different fingers for both hands, with index fingers being significantly slower than middle fingers in a RT task. In the current study, the middle two fingers on the dominant hand should have been used to respond to the primary task. One consolation however is that the use of the thumb was across all conditions and used by all participants. Also, the use of the response device included the instruction for participants to keep their thumb in the middle of the two keys at all times, therefore controlling for some distance between the two buttons. Finally, continual breaks between experimental sets were used to allow participants to rest, which may have reduced potential fatigue effect.

Control

The current study used a control manipulation to investigate whether control over pain effected performance on the primary auditory task during painful stimulation. In retrospect, this manipulation was overall a relatively weak manipulation. However, a number of other options were rejected because they bordered on posing additional variables in the results such as, threat effects, anticipatory anxiety and cued responses. One potential option discussed during the development of this control manipulation was allowing participants to discontinue pain by responding faster to the primary auditory task. However, there were a number of problems with this method. Firstly, to avoid sudden painful over stimulation, potassium iontophoresis needs to be ramped off and on slowly over a period of no less than 250 ms. Therefore, fast responding would still have a delayed effect. Secondly, responding in this way may have decreased the accuracy of performing the primary task and not be investigating task performance. Additional investigation into control mechanism and strategies using potassium iontophoresis is needed.

Further Research

The finding that pain did not significantly increase RT when compared to the baseline condition suggests that further research is required to determine why this occurred in the current study and not in studies by Crombez et al., (1994) and Eccleston (1994; 1995). Additionally, the significant difference in RT when the primary task was presented at Time One compared to Time Two is a result that has not been previously answered in pain research using the primary task paradigm. The potential warning signal produced by the onset of either the pain or visual stimuli prior to the presentation of the auditory task may account for this finding with participants being able to prepare a response in advance. Further research is needed to investigate whether this warning effect can account for this finding.

The finding that there was no significant difference in responding for the internal LOC group for either control or no control over the pain stimulus is interesting.

While a number of studies have found similar results as this study (see Bierderman & Schefft 1994), further research that investigates the coping strategies used by those with internal LOC may lead to more understanding about the different ways pain is processed by some individuals.

Research Summary

The current study set out to determine whether pain interfered with participants ability to perform a primary auditory task and whether LOC and control over pain could account for the difference in successful performance. The results showed that pain did interfere with participants performance on the primary task when compared to the visual task only. The finding that the baseline condition was longer has been suggested to be as a consequence of the pain and visual stimuli acting as a warning signal and allowing participants time to prepare. Also, the study found that external LOC participants performed better when they did not have control over their pain and that the internal LOC did not significantly perform any differently between control conditions. The results also suggested a trend for pain tolerance with males having a higher tolerance compared to women.

Outcomes have been discussed in relation to the influence of LOC beliefs on the effectiveness of control strategies for reducing the noxious experience of pain. Furthermore, methodological issues including the pain stimulus used, the timing of the primary auditory task, the influence of gender and pain reporting, and methodological problems made in the method have also been considered.

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APPENDICES

Appendix A. Information Sheet.

The Impact of Locus of Control and Controllability on Performance During Painful Stimulation

My name is Matthew Manderson. I am a psychology Masters student interested in how pain works and the factors that affect how pain is perceived and controlled by different individuals. My supervisor for this research is Malcolm Johnson, a lecturer and researcher in the School of Psychology.

I am seeking participants for a study that measures the effects of a simple task on the way pain is perceived.

In this study, if you decide to participate, you will be asked to complete a Medical checklist which asks personal questions about your health status. This information will be kept confidential until one year after the study, and then will be destroyed. The information from the Medical Checklist is used for the purpose of subject selection for the study. If you have any doubts about your health you are not suitable for this study. You will also be asked to sign a Consent Form. The Consent Form is not a contract that in any way binds you to the completion of the experiment. You have the right to withdraw from the study at any point in time during the study. Participation is independent of any papers in which you are enrolled, and will not effect the assessment procedure associated with your course of study.

You will be required to complete a short pen and paper questionnaire and a 30-minute experimental session. In the session, you will be given an experimental pain stimulus, known as potassium iontophoresis. The nature of the pain stimulus is the application of potassium ions to the skin on the dominant arm. This type of

pain stimulus does not produce any tissue damage. The pain felt is typically described as a prickling or burning sensation. You will be administered pain of increasing intensity until you indicate your pain tolerance. During the main part of the experiment, the pain will change in intensity, but will remain below your tolerance level. The electrodes through which the current is administered will measure the electrical activity of your skin, as a measure of your pain perception.

While the pain continues you will be asked to perform a simple discrimination attention task, and your performance on this task is recorded. You will have the chance to practice this task before the experiment begins.

Remuneration for participation in this study.

Participants will be reimbursed for their time. This payment is not contingent on the completion of the experimental portion of this research. You will be paid whether you complete the experimental portion or not. If you choose to participate you will receive \$10.00 to compensate you for your costs involved in participation.

There have been other studies conducted in the university using the same pain stimulation that will be used in this study.

If you agree to take part in this study you have the following rights;

- 1) To refuse to answer any particular question we might ask
- 2) To be given time to consider and discuss participation with others if desired
- 3) To withdraw from the study at any point in time, without repercussion
- 4) To ask questions as they occur to you during participation
- 5) To provide information on the understanding that it will remain confidential to the researchers. All information will be stored confidentially, in coded form on a database that only researcher have access to. It will not be possible to identify you in any reports prepared for this study
- 6) To given access to your personal data

7) To have the opportunity to discuss the experiment immediately after participation

At the conclusion of the study you will be sent a full explanation of the experiment along with a summary of the findings in you choose.

If you wish to talk to someone about any aspect of this study you can contact

Malcolm Johnson (supervisor): School of Psychology, Massey University
Ph. 350 4130

Matthew Manderson (researcher) School of Psychology, Massey University

Appendix B. Locus of Control Scale

This is a questionnaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you are concerned. Please write the letter of your choice for each pair in the box provided.

1. a. Children get into trouble because their parents punish them too much.
 b. The trouble with most children nowadays is that their parents are too easy with them.

2. a. Many of the unhappy things in people's lives are partly due to bad luck.
 b. People's misfortunes result from the mistakes that they make

3. a. One of the reasons that we have war is because people don't take enough interest in politics.
 b. There will always be wars, no matter how hard people try to prevent them

4. a. In the long run people get the respect that they deserve in this world.
 b. Unfortunately, an individual's worth often passes unrecognised no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.
 b. Most students don't realise the extent to which their grades are influenced by accidental incidents.

6. a. Without the right breaks one cannot be an effective leader.
 b. Capable people who fail to become leaders have not taken advantage of their opportunities

7.
 - a. No matter how hard you try some people just don't like you
 - b. People who can't get others to like them just don't understand how to get along with others

8.
 - a. Heredity plays a major role in determining one's personality .
 - b. It is one's experiences in life that determine the what they are like

9.
 - a. I have often found that what will happen will happen.
 - b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10.
 - a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.
 - b. Many times exam questions tend to be so unrelated to course work that often studying is really useless.

11.
 - a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
 - b. Getting a good job depends mainly on being in the right place at the right time.

12.
 - a. The average citizen can have an influence in government decisions.
 - b. This world is run by the few people in power, and there is not much that the little guy can do about it.

13.
 - a. When I make plans, I am almost certain that I can make them work.
 - b. It is not always wise to plan to far ahead because many things turn out to be a matter of good and bad fortune anyhow.

14.
 - a. There are certain people who are just no good.
 - b. There is some good in everybody.

15.
 - a. In my case getting what I want has little or nothing to do with luck.
 - b. Many times we might just as well decide what to do by flipping as coin.

16.
 - a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
 - b. Getting people to do the right thing depends on ability, luck has little or nothing to do with it.

17.
 - a. As far as world affairs are concerned, most of us are victims of forces that we can neither understand, nor control.
 - b. By taking an active part in political and social affairs the people can control world events.

18.
 - a. Most people do not realise the extent that their lives are controlled by accidental happenings.
 - b. There is really no such thing as "luck".

19.
 - a. One should always be willing to a over the things politicians do in office.
 - b. It is usually better to cover up one's mistakes.

20.
 - a. It is hard to know whether or not a person really likes you.
 - b. How many friends you have depends upon how nice a person you are.

21.
 - a. In the long run the bad things that happen to us are balanced out by the good one's.
 - b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22.
 - a. With enough effort we can wipe out political corruption.
 - b. It is difficult for people to have much control over the things politicians do in office.

23. a. Sometimes I can't understand how teachers arrive at the grades they give.
b. There is a direct connection between how I study and the grades I get.
24. a. A good leader expects people to decide for themselves what they should do.
b. A good leader makes it clear to everybody what their jobs are.
25. a. Many times I feel that I have little influence over the things that happen to me.
b. It is impossible for me to believe that chance or luck plays an important role in my life.
26. a. People are lonely because they don't try to be friendly.
b. There's not much use in trying too hard to please people, if they don't like you, they don't like you.
27. a. There is too much emphasis on athletics in high school.
b. Team sports are an excellent way to build character.
28. a. What happens to me is my own doing
b. Sometimes I feel that I don't have enough control over the direction that my life is taking
29. a. Most of the time I can't understand why politicians behave the way that they do.
b. In the long run people are responsible for bad government on a nation as well as on a local level.

Appendix C. Consent Form

The Impact of Locus of Control and Controllability on Performance During Painful Stimulation

I have read the Information sheet and have had the details of this study explained to me. My questions have been answered to my satisfaction and I understand that I may ask further questions at any time.

I understand that I have the right to withdraw from the study at any time and may decline to answer any particular questions.

I understand that the information that I provide will be used for this project and publications arising from this research project.

I agree to participate in this study under the conditions set out in the Information sheet.

Signed.....

Name.....

Date.....

Contact phone number. ()

Appendix D. Medical Checklist

The Impact of Locus of Control and Controllability on Performance During Painful Stimulation.

Medical Checklist

Participant Name: _____

Please answer the following questions about your health:

have you any form of epilepsy? Yes/No

Do you have any known heart or circulatory condition? Yes/No

In the last 6 months have you suffered from any painful injury or condition that you think may influence your ability to feel pain? Yes/No

Is it possible that you are pregnant? Yes/No

Do you have diabetes? Yes/No

If you have answered yes to any of the above questions you are not suitable for this study:

Are you currently on any type of medication? Yes/No

Have you ever had an allergic reaction to any medication? Yes/No

Are you in good health? Yes/No

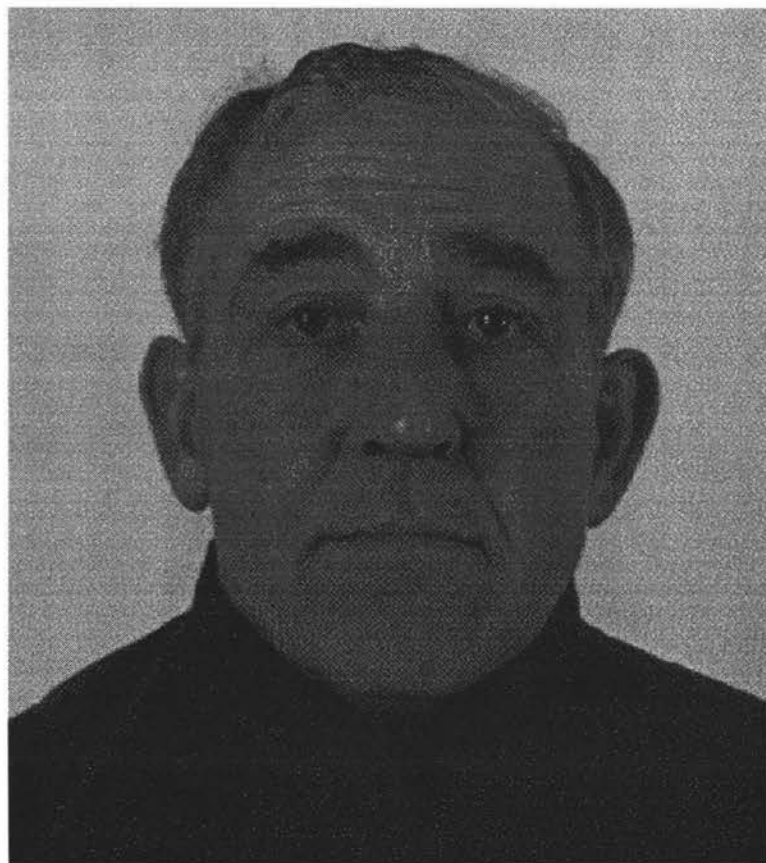
Do you suffer from any skin disorders? Yes/No

If you have any doubts about your health you should not participate in this study.

Researchers Signature..... Date:.....

Supervisors signature..... Date:.....

Appendix E Control visual distracter stimulus of an old man's face



Appendix F. Results of Study Sent to Participants

Dear

During August of 1998 you were involved in a pain study conducted by Matthew Manderson and Malcolm Johnson at the School of Psychology Massey University. The purpose of this experiment was twofold. Firstly, to investigate the affect painful stimulation had on peoples attention when performing a simple discrimination tone task, and secondly, to investigate the affect that beliefs about control and control over pain had on peoples responding. The researchers would like to thank you most sincerely again for your participation. Your time was greatly appreciated! The research has now been completed, and a brief summary of the key results provided for your interest. Full results are available from the Massey University Library.

Summary and Key Results

The questionnaire that you completed was the Locus of Control Scale, which measures people's beliefs about control over events in their lives. There are two attributions of control. A belief in external control whereby a person believes in luck, chance and significant others as being responsible for events that influence their lives, and the second, a belief in internal control, whereby a person beliefs that they are directly responsible for their behaviour and environment. In the study, people with an internal locus of control performed the tone task better when receiving pain compared to those with an external locus of control.

You will remember that during the experiment you were told that you either had no control or control over the level of pain that you were going to receive. Of interest was whether control over pain influenced peoples responding compared to no control. The results found that when people with an external locus of control had no control over the pain that they responded with less errors when compared to when they had control.

The most popular questioned asked during this study was whether men tolerated pain more than women did. A trend was found that suggested that males had overall higher pain tolerances in this study than women.

We hope that the results of this study are of some interest to you. Once again, the researchers would like to thank you for your participation in our study.

Yours Sincerely,

Matthew Manderson
(Researcher, Postgraduate Student)

Malcolm Johnson
(Supervisor)

Appendix G. Format for the six experimental sessions

This appendix presents the six experimental sets format. Trial numbers, frequency (MHz) of tone (no tone = 0, low = 1, high = 2), Visual = 1, Pain trial = 2, Time onset, Time One = 1, Time 2 = 2, and Pain level 1 = low, 2 = medium, 3 = high.

Experiment One. No Control format

Trial Num	Tone H/L	Stim Type	Time	Pain Level
1	2	0	1	0
2	1	0	1	0
3	1	2	1	2
4	2	0	1	0
5	2	0	1	0
6	1	0	1	0
7	2	0	1	0
8	2	2	2	2
9	1	0	1	0
10	1	0	1	0
11	2	0	1	0
12	1	1	1	0
13	1	0	1	0
14	2	0	1	0
15	1	0	1	0
16	1	0	1	0
17	1	2	1	1
18	2	0	1	0
19	2	0	1	0
20	1	0	1	0
21	2	1	1	0
22	2	0	1	0
23	1	0	1	0
24	2	0	1	0
25	1	0	1	0
26	2	2	1	3
27	1	0	1	0
28	1	0	1	0
29	2	0	1	0
30	2	0	1	0
31	2	1	2	0
32	1	0	1	0
33	2	0	1	0
34	1	0	1	0
35	2	0	1	0
36	1	0	1	0
37	2	2	2	3

38	1	0	1	0
39	1	0	1	0
40	2	0	1	0
41	2	0	1	0
42	0	2	1	1
43	1	0	1	0
44	2	0	1	0
45	2	0	1	0
46	1	2	1	3
47	2	0	1	0
48	1	0	1	0
49	1	0	1	0

Experiment Two. No control

Trial Num	Tone H/L	Stim	Time	Pain Level
1	1	0	1	0
2	2	0	1	0
3	1	1	2	0
4	1	0	1	0
5	2	0	1	0
6	2	0	1	0
7	1	0	1	0
8	2	1	1	0
9	1	0	1	0
10	2	0	1	0
11	2	0	1	0
12	0	1	1	0
13	1	0	1	0
14	1	0	1	0
15	2	0	1	0
16	1	0	1	0
17	1	2	1	2
18	1	0	1	0
19	2	0	1	0
20	1	0	1	0
21	2	1	1	0
22	0	0	1	0
23	1	0	1	0
24	1	0	1	0
25	2	1	2	0
26	1	0	1	0
27	1	0	1	0
28	2	0	1	0
29	2	0	1	0
30	0	2	1	3
31	1	0	1	0
32	2	0	1	0
33	1	0	1	0
34	1	0	1	0
35	2	0	1	0
36	1	2	2	1

37	2	0	1	0
38	1	0	1	0
39	1	0	1	0
40	0	1	1	0
41	2	0	1	0
42	2	0	1	0
43	1	0	1	0
44	2	0	1	0
45	1	1	1	0
46	2	0	1	0
47	1	0	1	0
48	1	0	1	0
49	2	0	1	0

Experiment Three. No Control

Trial Num	Tone H/L	Stim	Time	Pain Level
1	2	0	1	0
2	2	0	1	0
3	1	2	2	2
4	1	0	1	0
5	1	0	1	0
6	2	0	1	0
7	0	2	1	3
8	1	0	1	0
9	2	0	1	0
10	1	2	2	1
11	1	0	1	0
12	1	0	1	0
13	2	0	1	0
14	1	2	1	3
15	2	0	1	0
16	1	0	1	0
17	2	0	1	0
18	1	0	1	0
19	2	2	1	1
20	2	0	1	0
21	1	0	1	0
22	1	0	1	0
23	2	0	1	0
24	2	1	2	0
25	1	0	1	0
26	1	0	1	0
27	2	0	1	0
28	0	1	1	0
29	2	0	1	0
30	1	0	1	0
31	2	0	1	0

32	2	2	1	0
33	2	0	2	1
34	1	0	1	0
35	1	0	1	0
36	0	1	1	0
37	2	0	1	0
38	1	0	1	0
39	2	0	1	0
40	1	2	2	3
41	2	0	1	0
42	2	0	1	0
43	1	0	1	0
44	2	0	1	0
45	1	1	1	0
46	1	0	1	0
47	2	0	1	0
48	2	0	1	0
49	2	1	2	0

Experiment Control Trial 90 Percent Tolerance

Trial Num	Tone H/L	Stim	Time	Pain Level
1	2	0	1	3
2	2	0	1	3
3	2	2	2	3
4	1	0	1	3
5	1	0	1	3
6	2	0	1	3
7	1	2	1	3
8	1	0	1	3
9	2	0	1	3
10	1	1	2	3
11	1	0	1	3
12	1	0	1	3
13	2	0	1	3
14	0	2	1	3
15	2	0	1	3
16	1	0	1	3
17	2	0	1	3
18	1	0	1	3
19	2	2	1	3
20	2	0	1	3
21	1	0	1	3
22	1	0	1	3
23	2	1	1	3
24	2	0	2	3
25	1	0	1	3
26	1	0	1	3
27	2	0	1	3
28	0	1	1	3
29	2	0	1	3
30	1	0	1	3

31	2	0	1	3
32	2	0	1	3
33	2	2	2	3
34	1	0	1	3
35	1	0	1	3
36	0	1	1	3
37	2	0	1	3
38	1	0	1	3
39	2	0	1	3
40	1	0	2	3
41	2	0	1	3
42	2	0	1	3
43	1	0	1	3
44	2	0	1	3
45	1	1	1	3
46	1	0	1	3
47	2	0	1	3
48	2	0	1	3
49	2	1	2	3

Experiment Control Trial 75 Percent Tolerance

Trial Num	Tone H/L	Stim	Time	Pain Level
1	1	0	1	2
2	2	0	1	2
3	1	1	2	2
4	1	0	1	2
5	2	0	1	2
6	2	0	1	2
7	1	0	1	2
8	2	1	1	2
9	1	0	1	2
10	2	0	1	2
11	2	0	1	2
12	0	1	1	2
13	1	0	1	2
14	1	0	1	2
15	2	0	1	2
16	1	0	1	2
17	1	2	1	2
18	1	0	1	2
19	2	0	1	2
20	1	0	1	2
21	2	1	1	2
22	1	0	1	2
23	1	0	1	2
24	2	0	1	2
25	1	2	2	2

26	1	0	1	2
27	1	0	1	2
28	2	0	1	2
29	2	0	1	2
30	0	2	1	2
31	1	0	1	2
32	2	0	1	2
33	1	0	1	2
34	1	0	1	2
35	2	0	1	2
36	1	2	2	2
37	2	0	1	2
38	1	0	1	2
39	1	0	1	2
40	0	1	1	2
41	2	0	1	2
42	2	0	1	2
43	1	0	1	2
44	2	0	1	2
45	1	2	1	2
46	2	0	1	2
47	1	0	1	2
48	1	0	1	2
49	2	1	2	2

Experiment Control 60 Percent Tolerance

Trial Num	Tone H/L	Stim	Time	Pain Level
1	2	0	1	1
2	1	0	1	1
3	1	2	1	1
4	2	0	1	1
5	2	0	1	1
6	1	0	1	1
7	2	0	1	1
8	2	2	2	1
9	1	0	1	1
10	1	0	1	1
11	2	0	1	1
12	1	1	1	1
13	1	0	1	1
14	2	0	1	1
15	1	0	1	1
16	1	0	1	1
17	1	2	1	1
18	2	0	1	1
19	2	0	1	1
20	1	0	1	1
21	2	1	1	1
22	2	0	1	1

23	1	0	1	1
24	2	0	1	1
25	1	0	1	1
26	2	2	2	1
27	1	0	1	1
28	1	0	1	1
29	2	0	1	1
30	2	0	1	1
31	2	1	2	1
32	1	0	1	1
33	2	0	1	1
34	1	0	1	1
35	2	0	1	1
36	1	0	1	1
37	2	1	2	1
38	1	0	1	1
39	1	0	1	1
40	2	0	1	1
41	2	0	1	1
42	0	2	1	1
43	1	0	1	1
44	2	0	1	1
45	2	0	1	1
46	1	0	1	1
47	2	0	1	1
48	1	0	1	1
49	1	0	1	1