Pain and social context: social, contextual and environmental factors in the perception of acute pain

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Pain and Social Context: The Role of Social, Contextual and Environmental Factors in the Perception of Acute Pain

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ABSTRACT

A number of factors have been identified as generally reliable predictors of individual differences in responses to acute pain (e.g. sex, personality traits and cultural affiliation). These factors constitute relatively stable, long-term characteristics of an individual. However, there is also significant within-individual variation in response to acute pain, suggesting that factors other than individual characteristics also influence pain response. It is known that affective-motivational state is a significant component of pain, and it has been argued also that the process of automatic evaluation effects changes in affective-motivational state through the activity of limbic structures associated with the detection and processing of emotionally valenced environmental information. This thesis proposes that through this mechanism, qualities of the immediate environment can act as modifiers of pain response.

A series of experiments were conducted to test for the effects of manipulation of social, contextual and environmental features on responses to a mechanical pain stimulus. The results show that manipulation of preparatory information and locus of perceived control within the experimental dyad resulted in significant changes in response to the second of two pain stimuli of identical intensity. Also, both the sex of the assessor and the presence of a negatively valenced feature in the test environment were shown to influence pain response significantly. These results are in line with evidence from research into automaticity and automatic evaluation, and recent evidence concerning the roles of limbic areas in emotional processing and pain.

The results provide further insight into the nature of acute pain, and suggest that individual variation in pain response may be explained in terms of an integrated biopsychosocial model, which includes what is known of the neural bases underlying the sensory and affective-motivational components of pain (the pain matrix), but also acknowledges the roles of socially acquired, long-term cognitive structures relating to individual traits, and the influence of automatic evaluation. The results have significant implications for clinical and research practices as they indicate that qualities of the environment may impact upon clinical and experimental pain measurement. Moreover, they indicate that individuals can be 'primed' for pain by qualities of their environment and as a result, may suffer unnecessarily during acutely painful clinical procedures. However, awareness of these principles may be useful in developing methods of reducing suffering in those situations.

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CHAPTER 1

INTRODUCTION

Investigations concerning individual differences in the perception of pain have concentrated largely on factors differentiating pain response between individuals. Factors such as sex, ethnicity, cultural affiliation and personality factors have been shown to be determinants of traits in the perception and reporting of pain. However, individuals respond differently to pain at different times. The same stimulus applied to the same individual at a different time often provokes a different response. This thesis investigates factors which influence within-individual variation in pain perception.

Work pertinent to the study of pain perception has been done in the area of experimental social psychology. Research investigating automaticity, particularly the preattentive evaluation of features in the environment and the subsequent effects on basic emotional-motivational states (the automatic evaluation effect) may provide an insight into how the perception of pain can be influenced by factors other than individual characteristics, or the qualities or intensity of the pain stimulus. There are a number of limbic structures that are associated with the detection and processing of emotionally salient environmental information (including information relating to pain). These structures are responsible for the classification of incoming information and the initiation of appropriate (adaptive) affective-motivational responses to that information. These responses result in either a positive or negative emotional state, and a greater behavioural propensity to approach or avoid a given stimulus or situation, consonant with that state. A number of the structures involved in processing incoming information constitute a significant part of the medial division of the pain matrix, which is involved in processing nociceptive information, and is responsible for the emotional-motivational responses to it.

In light of the relationship between emotion, motivation and pain (and the fact that they are mediated by several of the same limbic structures), individual variation in pain perception over time may be attributable to the automatic evaluation process. It is known that affective-motivational response is a significant component of the pain experience, therefore it seems likely that emotional-motivational state prior to a painful event will influence the perception of, and response to a pain stimulus. In practical terms, the perception of pain at any given

time will be (at least partly) dependent upon factors other than characteristics of an individual or the intensity or qualities of a pain stimulus. It is proposed that the social context in which a pain stimulus is applied; beliefs concerning the situation, who applies the stimulus and salient features of the immediate environment which are not related to the stimulus *per se*, all will be significant modifiers of pain perception. In short, it is proposed that social, contextual and environmental factors, through processes of automatic evaluation, influence the emotional significance of a situation in which a painful procedure occurs, and thus influence the ultimate pain experience.

The following Chapters begin by examining the phenomenon of pain in order to provide a working definition for these investigations. Following this, literature on factors influencing individual differences in pain perception is reviewed, examining similarities in mechanisms of function, and their relationship to emotional and autonomic responses to painful stimuli. The neurological bases of emotion, motivation and pain are reviewed, particularly with respect to the relationship between automatic limbic processes, affective-motivational state and pain, leading to a review of the literature from experimental social psychology investigating automaticity and the automatic evaluation effect; its influence on affective-motivational state and the implications for the perception of pain.

Defining pain

The paradoxical nature of pain

Pain is a complex phenomenon, and one of the first problems encountered in pain research is defining the phenomenon under investigation. Most people will have experienced pain at some point in their lives; anything from a stubbed toe to major trauma or illness. It is therefore reasonable to assume that everybody will to some degree have an implicit understanding of the nature of pain and an experiential insight into the qualities of the experience. However, if one were to select people at random and ask for a definition of pain (as the author has done), the most frequent responses would probably be a description, rather than a definition. People tend to define pain either in terms of its qualities (for example, sharp, shooting, dull, aching and so-on), or in terms of their emotional response to it (for example, distressing, annoying or depressing).

Due to the abstract and personal nature of the pain experience, creating an all encompassing definition of pain is problematic, and such definitions usually will be flawed. The experience of pain does not appear to conform to any laws, rather it tends to follow certain rules, to which there are often exceptions. A principal confound is that pain is not directly observable. It is a personal experience, entirely unique to the sufferer. In this, it shares qualities in common with hallucinations. The pain a person feels cannot be known to an observer, only their behavioural responses to it (e.g. groaning, grimacing or antalgic gait). Even verbal report (heavily relied upon as a method of pain measurement and a means of providing access to the subjective experience), is only a behaviour from which the observer draws inferences concerning the internal state of the sufferer (e.g. Liebeskind & Paul, 1977). The observer then relates these behaviours to his or her own experience. This has obvious limitations. For example, consider a person suffering the pain of appendicitis, being observed by a person who has never suffered appendicitis; the observer can make no valid inferences concerning the qualitative nature of the sufferers' pain, and can only make assumptions concerning the intensity and location of the pain based upon the behaviours of the sufferer. Furthermore, such assumptions depend upon whether the sufferer is stoic, or vociferous. The knowledge of pain in another is therefore an assumption on the part of the observer, though it is not an assumption to be made lightly. In hospitals for instance, the working philosophy is that a patients' pain is what the patient says it is.

Another confounding principle is that often there is no correspondence between degree of physical trauma, and the subsequent expression of pain. Traditional sensory models of pain, held in the early and middle parts of the twentieth century, argued a direct correspondence between the intensity of noxious stimulus and the experience of pain. That is, that pain was purely a sensory experience with an unpleasant quality (e.g Chapman, 1984). However, those models fail to account for the experience of pain in the absence of any discernable cause. For example, psychogenic pain, such as that which can be experienced in hallucinations (e.g. those occurring in schizophrenia), pain experienced during conversion hysteria (Weisenberg, 1977), or psychologically induced pain (e.g. Bayer, Baer, & Early, 1991).

Nor do they account for differences in pain experience in the presence of physical damage, e.g., the phenomenon of people undergoing what would by western cultural standards be considered painful mutilating rituals, with no apparent suffering. An example of this is the Indian hook-swinging ceremony, which involves a chosen man (the celebrant) having steel hooks inserted under the skin and muscle on each side of his spine and then being suspended from these hooks by ropes attached to a cart. He is then wheeled from village to village, blessing crops and children. During the 'ordeal' the celebrant shows no sign of suffering, rather he seems to be in a state of exultation (Melzack & Wall, 1982).

Chapman (1984) relates the story of a 9 year-old boy he observed in hospital, just after the boy had undergone a nephrectomy.

> *"As soon as he recovered from the anaesthetic, the boy was transferred to his room. He was given no drugs for postoperative pain in accordance with his surgeon's normal practice.*
>
> *A colleague and I had involved the boy in a transcutaneous electrical stimulation experiment in which electrodes were attached under the bandage and stimulation was initiated before the patient regained consciousness. As the youngster lay in bed with his hands outside the covers, the surgeon and his associates came to visit. The surgeon told him that he could not drink water for the entire day and gave other instructions.*
>
> *Since an experimental intervention was being tried, they repeatedly asked if he felt any pain in his belly. He said, 'No, it doesn't hurt', to repeated queries, and everyone was impressed with the apparent success of our intervention.*
>
> *After the surgeon and his retinue had gone, the boy talked more casually with the others in the room. When asked whether there was anything he feared, he began to cry and confessed his terror of the expected operation that would remove his kidney. His surprised nurse tried to reassure him that the surgery had already been done, and that there was nothing to worry about. He refused to believe her. 'But don't you remember?' she contended, 'That's why they put you to sleep this morning...so they could do the operation'. The little boy looked very threatened. 'It's not true!' he shouted, 'It's not true!' When asked why it couldn't be true, he asserted confidently, 'Because I haven't got any bandages'. We asked him to feel his belly, since his hands were outside of the bedclothes. When he did, an expression of astonishment came over his face, and he broke into tears, screaming, 'It hurts! It hurts!' Thus, the boy's 'analgesia' occurred because no one had told him that he had been operated and not because of our stimulation therapy"* (Chapman, 1984, p1256).

Under these circumstances, it would have been tempting and understandable to assume the boy had no pain because nothing physical had changed in the few minutes of the conversation. Clearly, something significant had changed, at least as far as the boy was concerned. A nephrectomy is a fairly major surgical procedure and as stated, the boy was given no post-operative analgesia. At least as interesting as the boys' reaction to his discovery of the bandages, is the apparent absence of any suffering prior to that discovery. It may be concluded that the suffering associated with a wound (in this case the result of a surgical procedure), is not necessarily a direct result of it. Moreover, that the eventual suffering of this boy was associated more with a change in his psychological state than his physical state. But what had changed? It is possible that the boy felt surprise or consternation that the procedure had taken place without his knowing it. But certainly, with the boys' discovery of his bandages would have come the knowledge that his fears had been realized and that he had been cut.

These examples illustrate some of the problems associated with attempts to define pain. They also demonstrate a dissociation between stimulus and pain experience. In other words, the ultimate experience of pain is dependant upon more than just the intensity or quality of the stimulus.

A working definition

Sternbach (1968) defined pain as an abstract concept that refers to: 1) A personal and private sensation of hurt. 2) A harmful stimulus which signals current or impending tissue damage. 3) A pattern of responses which operate to protect the organism from damage.

That pain is an abstract concept and a personal and private experience is unarguable. However, exceptions to the second point have been shown above. Moreover, as noted by the International Association for the Study of Pain (IASP), the stimulus is not pain *per se* (IASP, 1994). The third point refers not to the experience of pain but to escape and avoidance behaviours associated with it. Thus it is not so much a definition of pain, as an evolutionary rationale for its existence. It describes the most basic biological function of pain; to warn an organism of impending or actual damage and thus allow the organism to

avoid, or limit the damage and, in the presence of damage, to cause the organism to alter its behaviour in such a way that promotes healing of the injury (Chapman, 1984).

Although there are exceptions, as a general rule physical trauma results in pain, but as noted above, there appears to be a lack of correspondence between degree of trauma and the ultimate experience of pain. As stated by May (1993), to be of any use, any definition of pain must account for this apparent paradox. It must include not only what is known about the physiological basis of neuronal transmission and the general rule that physical damage results in pain, but also the apparent lack of correspondence between degree of physical damage and the severity of the resultant experience. The Gate Control Theory of Pain (Melzack & Wall, 1965; Wall, 1978) was the first to attempt to accommodate these points.

The Gate Control Theory of Pain proposes a gating mechanism in the dorsal horns (substantia gelatinosa) of the spinal cord, consisting of inhibitory interneurons. These are proposed to synapse with large myelinated afferent fibres (Aβ fibres), small thinly myelinated and non-myelinated primary afferent fibres (Aδ and C fibres respectively), and large projection neurons. Aδ fibres are thought to mediate sharp, pricking, immediate pain, whilst C fibres are thought to mediate slow, diffuse, dull or aching pain.

The primary afferent fibres enter the dorsal horn, which consists of layers of cells or laminae (of which there are six, where laminae II and III form the substantia gelatinosa). C fibres terminate in laminae I and II. Aδ fibres terminate in laminae I and V. Aα and Aβ fibres terminate in laminae III and V. These laminae contain cells which are especially responsive to activation of Aδ and C fibres.

In essence, the Gate Control Theory proposes that volleys from large diameter (Aβ) fibres excite inhibitory interneurons in the substantia gelatinosa, which in turn inhibit the activity of large projection neurons, thereby 'closing the gate' to nociceptive volleys. Activation of Aδ and C fibres are said to inhibit activity of the inhibitory interneurons, thus facilitating transmission of primary afferent volleys by the central projection transmission neurons, or 'opening the gate'.

Significantly, the Gate Control Theory proposes a mechanism of central control. Melzack and Wall (1965) note that it is now firmly established that stimulation of the brain activates descending afferent fibres which can influence afferent conduction at the earliest synaptic levels of the somesthetic system. They suggest that is it thus possible that CNS activities subserving attention, emotion and memories of prior experience, exert control over sensory (nociceptive) input, and present evidence that these central influences are mediated through the Gate Control system. More recent research has revealed the existence of powerful active central control systems (via fibres descending from higher system to lower ones), implicating the *nucleus raphe magnus* and periaqueductal grey area (see for example Liebeskind & Paul, 1977). Liebeskind and Paul suggest that other central systems of pain modification may exist, intracerebral as well as cerebrospinal.

The Gate Control Theory of Pain goes some way in accounting for the lack of correspondence between degree of tissue damage and reported pain. Although the Gate Control Theory is a theory of pain perception, it has important implications for any definition of pain. Liebeskind and Paul (1977) suggest that all the mechanisms described above, in combination, are sufficient to account for the experience of pain, but none in isolation. Therefore, the experience of pain is the result of the combined activity of many peripheral and central nervous system structures. Nociceptive volleys from primary afferent fibres are evaluated in terms of prior experience, current attentional states and meaning, and current emotional state.

More recent definitions of pain take into account these different mechanisms and the impact of psychological state and define pain as an entirely subjective, multidimensional experience involving sensory-discriminative, cognitive-evaluative and emotional-motivational components (see for example Chapman, 1984; Weisenberg, 1977). Axons from primary afferent (Aδ and C fibres) project via the spinothalamic tract to the higher central nervous system (CNS). Ascending nociceptive volleys passing up the spinothalamic tract terminate project to a number of different CNS areas. Those projecting to the ventrobasal (lateral) thalamus and somatosensory cortex are involved in the sensory-discriminative component of pain. Projections to the reticular formation, the intralamina (medial) thalamus and the limbic system are associated with aversive, cognitive and emotional-motivational components of pain.

The sensory-discriminatory component refers to the neurophysiological mechanisms which facilitate detection of noxious stimuli, and allow the sensation to be localized in space, time and intensity. However, as noted, pain is more complex than an elementary sensory experience. It also involves the attribution of meaning to the circumstances surrounding the painful event through cognitive processes such as memory, belief, expectancy and intention (Chapman, 1986).

The cognitive-evaluative component refers to the cognitive appraisal and interpretation of the situation, and the subsequent meaning of the pain to the individual, within their cognitive framework. For example, consider two middle aged men attending a business dinner. One has been warned by his doctor that he is at serious risk of heart disease, whilst the other has been told he is in perfect health. After the dinner, both suffer an attack of severe indigestion. The man warned by his doctor is aware of his risk of heart disease, and in light of that knowledge is likely to interpret the chest pain as a signal of a potentially life-threatening event. Thus, whilst the cause of pain may be the same for each man, the *significance* of the pain will be different, due to differences in pre-existing knowledge between them.

The emotional-motivational component refers to the emotional response to the sensation and the situation in which it occurs, and the resultant motivation towards escape and avoidance behaviours. Examples such as the one above also are commonly used to describe the relationship between emotion and pain. Under the circumstances described, the emotional response of the two men in the example will be very different. The man who received the warning from his doctor, and who will have formed a more negative cognitive interpretation of the pain, may become extremely anxious and fearful. This anxiety and fear will certainly compound the experience and result overall in more severe suffering. Chapman (1986) provides a similar example.

> "*In some instances, recurrent bouts of pain may trigger emotional arousal even though the experience is all too familiar to the patient. This occurs when the pain may signal an acute life-threatening event. Many heart disease patients with angina pectoris repeatedly experience high anxiety with each successive onset of retrosternal pain, because such pain may herald a fatal heart attack. In this case, the uncertainty about survival associated with the pain generates anxiety.*" (Chapman, 1986, p.164).

Whilst examples such as these are generally sound in respect of emotional responses to pain being influenced by existing knowledge and beliefs, the relationship between emotion and pain is a complex one. Negative affect is strongly associated with pain, but states of arousal such as fear and anxiety may be both a result of, and a compounding factor in the experience of pain (Craig, 1978; Robinson & Riley III, 1999). Thus there has been much confusion as to whether emotional processes should be considered as causes or consequences of pain (Craig, 1978).

The use of dichotomous terms such as "sensory-discriminatory" and "emotional-motivational" are useful in distinguishing between aspects of the pain experience. However, Liebeskind and Paul (1977) suggest that other dichotomous terms sometimes used in attempts to specify the origin of pain, such as "physiological" versus "psychological", or "organic" versus "functional" promotes a division between pain patients into those seen as having 'real' pain, and those suffering 'imagined' pain. This may result in insufficient or inappropriate treatment being provided to patients perceived as not having 'real' pain and who are therefore considered to be engaging in attention seeking behaviours.

As stated previously, this kind of judgement is discouraged in clinical practice, under the general philosophy that a patients' pain is what the patient says it is. Nonetheless, it must be tempting, when confronted with a patient complaining of pain that has no discernable origin and a large affective component, to label the patient a 'moaner' or an 'attention seeker', and unfortunately, this temptation is reinforced by those occasions when it is known to be true (there are circulated between accident and emergency departments, lists of individuals who are known to present regularly showing signs of extreme pain, solely with the aim of receiving prescriptions for controlled drugs). Liebeskind and Paul suggest that when considering the source of pain, it is more reasonable to distinguish only between pains of peripheral, central or unknown origin.

All the above has been taken into account in the IASP definition of pain, presented below.

> Pain:
> An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.
>
> Note: The inability to communicate in no way negates the possibility that an individual is experiencing pain and is in need of appropriate pain relieving treatment.
>
> Notes: Pain is always subjective. Each individual learns the application of the word through experiences related to injury in early life. Biologists recognize that those stimuli which cause pain are liable to damage tissue. Accordingly, pain is that experience we associate with actual or potential tissue damage. It is unquestionably a sensation in a part or parts of the body, but it is also always unpleasant and therefore also an emotional experience. Experiences which resemble pain but are not unpleasant, e.g., pricking, should not be called pain. Unpleasant abnormal experiences (dysesthesias) may also be pain but are not necessarily so because, subjectively, they may not have the usual sensory qualities of pain.
>
> Many people report pain in the absence of tissue damage or any likely pathophysiological cause; usually this happens for psychological reasons. There is usually no way to distinguish their experience from that due to tissue damage if we take the subjective report. If they regard their experience as pain and if they report it in the same ways as pain caused by tissue damage, it should be accepted as pain. This definition avoids tying pain to the stimulus. Activity induced in the nociceptor and nociceptive pathways by a noxious stimulus is not pain, which is always a psychological state, even though we may well appreciate that pain most often has a proximate physical cause (IASP, 1994)[1].

This definition of pain acknowledges the purely subjective nature of the experience, that it is always a psychological state and also an emotional experience. Also, it acknowledges the fact that whilst pain is usually the result of actual or potential tissue damage, this is not always the case; that activity in nociceptive pathways induced by a noxious stimulus is not in itself pain, but that the reported experience of pain in the absence on any pathophysiological cause, should be considered pain. Thus, for the purposes of this investigation the working definition of pain shall be that provided by the IASP, whilst accepting as a given the multi-dimensional nature of the experience.

Implicit within this definition of pain is that because of the lack of direct correspondence between tissue damage and pain experience due to differences in interpretation, affective and attentional states, the same person subjected to the same stimulus at different points in time may suffer entirely different pain experiences. Similarly, different people subjected to the same pain stimulus may also suffer entirely different pain experiences.

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[1] The IASP Pain Terminology list may also be viewed at http://www.iasp-pain.org/terms-p.html

Indeed, there is a significant body of research investigating individual differences in the perception of experimental pain. Many factors have been shown to influence the experience of pain, and most of these factors have been shown to do so reliably. Chapter Two reviews briefly some of the principal factors which are acknowledged as having an influence on the perception of pain between individuals.

CHAPTER 2

INDIVIDUAL DIFFERENCES IN THE PERCEPTION OF PAIN

Individual differences in pain perception have long been investigated and have been approached in at least three main ways: from the standpoints of personality variables, sex differences, and ethnic and cultural determinants. The following sections review some of the salient literature, highlighting particularly the role of emotional arousal in the mediation of these factors.

Sex

Although there is a general consensus that there are sex differences in the perception of pain, there is some debate surrounding the source of these differences. Some differences seem to depend upon stimulus type, for example some researchers have found that females rated supra threshold thermal pain stimuli significantly higher (more painful) than males (e.g. Feine, Bushnell, Miron, & Duncan, 1991; Fillingim, Maixner, Kincaid, & Silva, 1998), whilst others have found no such difference (e.g. Bush, Harkins, Harrington, & Price, 1993; Lautenbacher & Rollman, 1993). However, a fairly robust result has been obtained using pressure (mechanical) pain stimuli (Fillingim & Maixner, 1995; Riley III, Robinson, Wise, Myers, & Fillingim, 1998).

In studies using pressure algometry, males generally report higher pressure pain thresholds (e.g. Brennum, Kjeldsen, Jensen, & Jensen, 1989; Fischer, 1986, 1987; Mersky & Spear, 1964). However, the interpretation of such results requires caution. There may be physiological sex differences in response to pain stimuli (Feine et al., 1991; Fillingim & Maixner, 1995), or alternatively, there may be gender related differences in response to non-related qualities of the stimuli, such as the degree of anxiety evoked by stimulus onset-time and duration, which reflect an increased capacity for males to modulate pain through psychological means (Feine et al., 1991; Lautenbacher & Rollman, 1993).

Fillingim and Maixner (1995) note that pain response between the sexes may vary along any of the different dimensions of pain; sensory, affective or cognitive. Thus, the qualities of the stimulus, as well as intensity will have an influence, for example tonic pain (e.g. cold pressor and ischemic pain) has a significant unpleasant quality, as well as being intense.

Fillingim and Maixner point out also that a relatively neglected area of research is that of physiological and cortical responses. There are sex associated differences in respect of other, non-painful stimuli. For example, females exhibit greater facial electromyographic responses to emotional imagery compared to males, and males and females show different cardiovascular responses to laboratory stressors (Fillingim & Maixner, 1995). They suggest that both gender associated developmental differences and phasic fluctuations of gonadal hormones influence pain perception by modulating the activity of mechanisms associated with central modulation of pain (anterior, ventromedial and arcuate nuclei of the hypothalamus, medial preoptic area, periaqueductal grey area, amygdala, *nucleus raphe magnus* and the *locus coeruleus*). This is supported by evidence showing that pain perception in females varies depending on the phase of the ovulatory cycle (Riley III, Robinson, Wiseb, & Price, 1999), and through the use of oral contraceptives or with the presence or absence of dysmeorrhea (Feine et al., 1991).

That being said, sex differences in pain response have also been shown in neonates (Guinsburg et al., 2000), but by age 8, males and females have been shown to begin to differentiate between intensity and unpleasantness. Goodenough (1999) reports that subjected to venipuncture, there was a significant effect for age (but not sex) on pain intensity scores (older children reporting less intense pain), and a significant effect for sex (but not age) on unpleasantness ratings, with females reporting greater unpleasantness.

Whilst Sternberg (1995) generally endorses the model proposed by Fillingim and Maixner, particularly the aspect proposing that differences in pain response between the sexes may stem from differences at the level of intrinsic pain modulatory systems, Rollman (1995) expressed some reservation towards the more physiological aspects of the model. He argues that many of the studies reviewed by Fillingim and Maixner may have confounded anxiety with pain and that differences in anxiety between the sexes may in fact be responsible for reported differences in pain response in many cases.

However, in a rebuttal, Fillingim and Maixner (1995) reaffirm their acknowledgement of psychological factors and moreover that pain responses between males and females may reflect differences in patterns of emotional arousal (i.e. that pain responses may include gender differentiated evaluations of the unpleasant quality of the pain, as well as the intensity).

Indeed, there are autonomic correlates to pain response between sexes. Differences have been shown in a number of different autonomic indexes such as cardiovascular response (Al Absi, Buchanan, Marrerob, & Lovallo, 1999) and adrenocortical response (Al Absi, Petersen, & Wittmers, 2002) suggesting that emotional arousal plays a significant role in the perception of pain between the sexes.

It is important to note that the central regions listed by Fillingim and Maixner as important areas in differential pain response form part of the limbic brain and reticular activating systems which are also associated with emotional arousal and the processing of affect (see Chapter Three). Moreover, given that emotion (including anxiety) is a significant component of the experience of pain, it is possible that Fillingim and Maixner and Rollman are in fact arguing the same case from different perspectives (physiological and psychological respectively), as two people arguing that the grass is greener on their side of the fence, where it is in fact the fence that is the artificial construct.

In any event, as emotion is an intrinsic component of the pain experience, any increase in negative emotion would serve only to make the experience more unpleasant, which would be reflected in subsequent verbal reports through such terms as 'worse pain'. The role of emotional arousal, whether viewed from a physiological perspective or a psychological one, is generally acknowledged as being an important determinant in different pain response between the sexes (Al Absi et al., 1999; Al Absi et al., 2002; Fillingham & Maixner, 1995; Fillingim, Edwards, & Powell, 1999; Goodenough et al., 1999; Rollman, 1995).

The origin of sex related differences in the perception of pain is most likely a combination of inherent biological differences in central (limbic) structures associated with the processing of emotion, and developmental differences in gender related traits acquired through social learning. There is evidence to suggest that the acquisition of gender identity through social learning may also have some influence on the development of central structures associated with emotional processing through neural plasticity. In any event, it is apparent that sex associated differences in the perception of pain stem to a significant degree from differences in patterns of emotional response to qualities of the stimulus other than simply intensity.

Ethnicity and cultural background

As well as sex associated differences, small but important social and cultural differences in pain response have also been shown. Again, social learning and differences in patterns of emotional arousal have been strongly implicated in ethnic and cultural differences in response to pain.

Bates et al. (1993) investigated 372 individuals, from six ethnic groups, undergoing treatment for chronic pain at a multi disciplinary pain-pain management centre. The ethnic groups were Hispanic, Polish, Italian, Irish French Canadian and Old American. Bates et al. found that the best predictors of reported pain intensity were ethnic group affiliation and locus of control. They discovered clear and consistent patterns of behavioural, attitudinal and emotional responses. Members of the Hispanic group reported their pain more frequently and more emotionally than members of any other group, and reported higher degrees of associated anxiety anger and tension. Second highest were members of the Italian group. Consistently lowest on these response categories were members of the Polish group. Many members of the Hispanic and Italian groups reported that emotional expression of pain was an appropriate response to that pain, whilst members of the Polish and Old American groups indicated that non-expression was the ideal response.

Weisenberg (1977) reports a study in which significant differences in trait anxiety between black, white and Puerto Rican dental patients were found. Attitude differences were also obtained, revealing differences in willingness to deny, avoid or get rid of the pain. It is a significant point that both generation and degree of heritage consistency appear to modify the influence of ethnic affiliation on the pain experience (Bates et al., 1993). Bates and Rankin-Hill (1994) found later that ethnic identity was a significant predictor of locus of control style, and suggest that the psycho-social experiences as a member of an ethnic group is probably the source of differences in locus of control style.

The examples above implicate strongly the role of social learning in pain response within cultural groups. It is not likely that there is any significant neurophysiological differences between different races, and probably fewer differences of significance between same-sex members of different races than between different-sex members of the same race. Indeed, sex differences within cultures may also be partly a function of cultural and behavioural influences such as cultural expectations concerning appropriate gender-roles and behaviours (Fillingim & Maixner, 1995; Otto & Dougher, 1985; Riley III et al., 1998).

Bates et al. (1993) proposed a biocultural model to provide an heuristic basis for conceptualising the relationship between culture and pain. This model assumes no inherent neurophysiological differences between members of different ethnic groups. Rather, it suggests a mechanism by which social learning and socially acquired patterns of pain response "*...may influence the neurophysiological processing of nociceptive information, as well as psychological, behavioural and verbal responses to pain*" (Bates et al., 1993, p109). This is strongly supported by evidence of neural plasticity in central regions associated with emotion. Data from animal studies have shown that environmental events have a profound impact on the development of the neural circuitry of emotion. Further, recent research has shown neurogenesis in areas of the limbic brain, indicating that neural plasticity continues throughout adulthood (see Davidson, Jackson, & Kalin, 2000).

It is a truism to say that at some stage early in life, the experience of pain must be novel. At that time, reactions to it are likely to be the most basic and not subject to social mores or gender-role expectations. However, parents devote a considerable amount of time and effort in helping their children cope with the inevitable periods of sickness and injury that

occur. During this time, it has been observed that the pain reactions of children changes from a spontaneous reflexive and global activity, to reactions which indicate sensitivity to the immediate context and demonstrate anticipation and goal directed action (Craig, 1978; 1986).

The transition between spontaneous patterns of behaviour in response to pain to a sequence of behaviours suggesting fear of impending pain, the reaction to the painful event itself and anger following the event has been recorded as early as 7-8 months (Craig, 1978). In helping their children through painful events, and particularly through their own reactions to the responses of their children (e.g. "*hush now! Be brave...big boys don't cry*"), parents also begin to establish boundaries for what is considered appropriate behaviour for each gender within the society.

Parents also pass on their own fears and anxieties (or lack thereof) concerning pain. According to Craig (1986), the influence of social learning becomes most apparent when children acquire maladaptive or over anxious behaviour patterns within their families. A good example of this can be seen in phlebotomy out-patients clinics (blood test rooms). It is a fairly common sight in blood-rooms that parents bringing in their children for a blood test, will provide a running commentary to the child *"it's ok, there's nothing to worry about, it won't hurt, it'll all be over soon*", whilst shielding the child's eyes from what is happening around them and thus denying them the opportunity to see for themselves that other people are accepting venipuncture with little or no signs of pain.

Fairly soon, the child who was sitting placidly in the waiting room five minutes ago, is reduced to a state of extreme anxiety. This degree of attention and concern from the parent can only signal that something terrible is about to happen. Subsequently, such children will not sit for venipuncture and the procedure has to be delayed, and the child's fear and anxiety builds. Conversely, the children of parents who behave 'normally' and allow the child to explore its surroundings, ask questions and satisfy their curiosity generally tend to be calmer, accepting venipuncture more or less with equanimity and in some cases even interest.

Within any culture, parents, peers and societal ideals play a principal role in determining the appropriate behavioural responses to pain and painful situations. Combined with personal experiences of pain, these provide the basis for the attitudes of the individual towards pain and painful situations. Further, (and in common with research into sex associated differences) the evidence suggests that social learning is a determinant of subsequent patterns of affective and autonomic arousal. Weisenberg (1977) notes that differences between ethnic groups appears to be related to the reaction or tolerance components of pain rather than threshold discrimination, which suggests that social learning within a culture is a more predominant factor in ethnic differences in pain perception than any biological differences. Underlying attitudes and anxiety reactions appear to be a major source of ethnic differences.

There is also evidence that differences in cultural attitudes influence psychophysical and autonomic function. For example, psychophysical and autonomic correlates between Yankee (the term used by Weisenberg to describe American Protestants of British descent), Irish, Italian and Jewish ethnic groups and pain response have been shown. Yankees, described as phlegmatic in attitude towards pain, showed the fastest rate of diphasic palmar skin potentials in response to electrical pain stimuli. Irish participants, described in similar terms to the Yankees as being undemonstrative, but in a repressive rather than phlegmatic way (i.e. inhibiting their responses and concerns toward the pain), showed a lower palmar skin resistance. Italian participants, described as being oriented in the present and focussing on the immediacy of pain showed a significant positive correlation between heart-rate and upper pain threshold. And Jewish participants, described as being future oriented (i.e. expressing concern regarding future implications of the pain stimulus), showed a significant negative correlation between upper threshold and heart rate (Sternbach & Tursky, 1965; Tursky & Sternbach, 1967).

Ethnic origin and cultural affiliation have been shown to be determinants of individual differences in pain response. However, the origins of these differences do not stem from any inherent neurophysiological differences between ethnic groups, but from social learning. Parental and societal values concerning appropriate behaviours in response to pain influence the development of individual attitudes towards pain and painful situations.

Whilst there are inherent biological differences between the sexes, social learning implicit in the acquisition of gender-role is implicated in the development of sex associated differences in patterns of emotional and autonomic arousal in response to pain. In the same way, and in light of recent evidence concerning neural plasticity (e.g. Davidson et al., 2000), it is likely that social learning implicit in the acquisition of cultural identity and societal values results in long-term differences in the way in which nociceptive information is processed (as suggested by Bates, (1993)), and in the development of patterns of emotional and autonomic arousal in response to painful events.

The element in common with both sex and cultural differences in response to pain and painful situations is the influence of social learning. Social learning directs the development of styles of emotional processing peculiar to gender roles within cultural groups and to different cultural groups. However, individuals within any group may respond differently to pain and painful situations, as a result of combinations of characteristics peculiar to the individual. Personality factors have also been shown to influence the way in which individuals respond to pain.

Personality factors

There is a large body of research investigating personality factors in relation to pain and coping. Factors, such as introversion/extroversion, neuroticism, Locus of Control (Rotter, 1966), self-efficacy (Bandura, 1977) and the perception of control have been shown to influence pain response. These latter three are interrelated.

Introversion/Extroversion

Introversion/extroversion and neuroticism have been shown to be associated with differences in pain response. For example, Lynn and Eysenck (1961) took measure of extroversion and neuroticism using the Maudsley Personality Inventory (MPI), and measures of pain tolerance using radiant heat stimulus. They report a strong positive correlation between extroversion and pain tolerance ($r = 0.69$), and a moderate, negative relationship between neuroticism and pain tolerance ($r = -0.36$).

Roome and Humphrey (1992) investigated the relationship between analgesic intake and personality factors in a population of thirty-two chronic back-pain sufferers. In this instance, measures of extroversion using the Eysenck Personalty Questionnaire (EPQ) were accompanied by measure of health locus of control, taken using the Multidimensional Health Locus of Control scale (MHLC). The results show a positive correlation between neuroticism and analgesic usage ($r = 0.41$), a negative correlation between extroversion and analgesic usage ($r = -0.38$) and a positive correlation between a 'powerful others' (external) locus of control style and analgesic usage ($r = 0.36$).

Taken together, these two examples demonstrate a relationship between introversion/extroversion, neuroticism and pain response. Extroverts are thought to condition less well than introverts, and so develop less anxiety concerning the stimulation. Introverts tend to have a higher level of emotional arousal than extroverts and therefore have lower pain thresholds, whilst neuroticism is associated with greater autonomic lability and higher levels of anxiety (Weisenberg, 1977).

Locus of Control, Self-efficacy and perceived control

Locus of Control (LOC) has been shown to be a determinant of pain coping. LOC may be described as a general principle that a person's attempts to control their personal environment are influenced by internal or external factors. More specifically, the extent to which an individual believes that events within their personal environment are under their own control, or are controlled by external circumstances (e.g. luck, fate or powerful others).

In general, a more internal LOC is associated with higher pain tolerance and better pain coping (e.g. Craig & Best, 1977; Crisson & Keefe, 1988; Roome & Humphrey, 1992; Toomey, Mann, Abashian, & Thompson Pope, 1991). In clinical situations a more internal LOC is associated with more positive clinical outcomes (Bates & Rankin Hill, 1994; Harkapaa, Jarvikoski, Mellin, Hurri, & Luoma, 1991; Reynaert et al., 1995), and in common with introversion and extroversion, LOC has been found to relate to analgesic usage (Reynaert et al., 1995; Roome & Humphrey, 1992). More internal LOC patients requiring lower and less frequent doses of analgesia.

There is evidence that LOC is related to self-efficacy (Rokke, Al Absi, Lall, & Oswald, 1991), those with a more internal LOC tend to have a stronger sense of self-efficacy. This is not surprising, as a prerequisite to the belief that one has control over events and circumstances within one's environment (internal LOC), must be the belief that one has the ability to influence those events and circumstances (high self-efficacy). Lefcourt (1980) notes that in general, people who have been assessed as holding more external LOC tend to behave in ways that are congruent with descriptions of helplessness. They are less likely to seek information, are less likely to utilize information that is available, and are less likely to demonstrate positive affective states than are internal LOC individuals. As noted previously, there are significant relationships between locus of control style and cultural or ethnic identity (Bates & Rankin Hill, 1994), which suggests that the acquisition of cultural traits through social learning influences the developments of locus of control styles also.

There is evidence for relationships between perceived self-efficacy, immunological function and endogenous opioid mediated analgesia. Wiedenfield et al. (1990) took 20 participants with severe snake-phobia. After taking baseline measures of (among others) self-efficacy and immunological indexes, exposed the participants to two 2-hour sessions involving activities (with snakes) designed to elevate their sense of self-efficacy in coping with snakes. These sessions resulted in a highly significant elevation of self-efficacy in the participants. The acquisition of a stronger sense of self-efficacy was associated with a significant elevation in immunocompetence.

In a similar experiment investigating self-efficacy and pain control, Bandura et al. (1987) assigned 72 participants to one of three conditions. Cognitive coping, in which participants received instructions and practice in the use of different cognitive coping strategies for 30 minutes. A placebo medication condition, in which participants were given a placebo pill described as a widely used medicinal analgesic and asked to wait 30 minutes for it to take effect, and a control condition. Participants in the control condition received only orienting instructions concerning the experimental procedure and were asked to wait for 30 minutes. After 30 minutes, all participants were administered self-efficacy assessment scales, then undertook a cold-pressor pain tolerance test. They were then readministered self-efficacy scales.

To test whether any changes in pain tolerance were mediated by activation of the endorphin system, 50% of participants in each condition were given an injection of 10mg naloxone (an opiate antagonist). The other 50% received an injection of normal saline.

The results showed that training in cognitive strategies improved self-efficacy to both tolerate pain and to reduce its severity. The placebo analgesic increased the ability to tolerate pain, but not to reduce its severity. In all conditions, the stronger the perceived sense of self-efficacy, the greater the pain tolerance. In the cognitive strategy trained group, those administered with naloxone were less able to tolerate pain than those administered with normal saline. This result also revealed that the greater the sense of self-efficacy, the greater the opioid activation. However, participants trained in cognitive coping strategies showed an increase in the ability to tolerate pain even when naloxone was administered compared to the placebo and control groups, indicating a non-opioid component in pain coping.

The relationship between self-efficacy and pain is not a straightforward one. In a later experiment, Bandura, et al. (1988) tested the hypothesis that perceived self-inefficacy activates endogenous opioid systems. Measures of perceived self-efficacy to manage pain were taken from 40 paid volunteers, after which measures of cold-pressor pain tolerance were taken. Participants were then exposed to conditions designed either to increase or reduce the participant's perceived mathematical self-efficacy (irrelevant to pain). Mathematical problems were presented on a computer monitor for 18 minutes. In the high self-efficacy condition, participants were able to control the rate at which the problems were presented. In the low self-efficacy condition, the problems were presented at a rate which exceeded the participant's cognitive abilities. Participants were told that they would be assessed for speed and accuracy, and that their results would be compared with others who had completed the task. To detect endogenous opioid activity, naloxone was given intravenously to 50% of the participants, the other 50% received normal saline.

As with the 1987 experiment, results showed that strength of perceived self-efficacy to manage pain was positively related to pain tolerance in all conditions, and the administration of naloxone was shown to diminish this affect. However, the results also provide evidence that perceived self-inefficacy in coping with cognitive stressors (irrelevant

to pain) also activates endogenous opioid systems. Participants high in self-inefficacy showed elevated levels of subjective stress in response to their apparent cognitive impairment. These stressed participants were able to cope with increasing pain stimulation in the saline condition, whilst participants in the same condition given naloxone were unable to tolerate much pain stimulation.

The results of these two experiments may appear to raise a question concerning the relationship between self-efficacy and pain coping. Whilst there is no direct evidence to contradict the findings that higher levels of self efficacy are associated with better pain coping, how can it be that higher levels of self-inefficacy are also associated with better pain coping? Bandura et al. point out that perceived coping inefficacy not only activated higher autonomic arousal during the problem solving, but left participants in a sensitized inefficacious state that persisted beyond the task. Therefore, it was not perceived self-inefficacy *per se* that was responsible for opioid activation, rather it was the resultant stress and anxiety.

As well as activating endogenous opioid systems, it is likely that the stress resulting from perceived self-inefficacy also acted as a distraction. This is supported by Al Absi and Rokke (1991), who investigated the effects of relevant and irrelevant anxiety on pain rating and tolerance in a cold pressor test. Using a 2 (high or low anxiety) x 2 (relevant or irrelevant anxiety) design, 100 female participants were assigned to one of four groups. Participants were given briefings designed to evoke either high or low anxiety about either the cold-pressor test (relevant anxiety) or about an electric shock they were told to expect (irrelevant anxiety). Participants were connected to a dummy electric shock machine, and then exposed to the cold-pressor. Measures of cold-pressor pain rating and tolerance were taken. Participants in the high-relevant anxiety condition reported the most pain, whilst participants in the high-irrelevant anxiety condition reported the least pain, and significantly less pain than participants in the relevant-anxiety condition.

It seems then that there is a degree of specificity involved in the role of self-efficacy. A high general sense of one's ability to cope, or a higher sense of self-efficacy specific to managing pain are associated with greater pain tolerance and better pain coping. On the other hand, a low sense of self-efficacy specific to pain management results in greater anxiety towards

the pain stimulus and is associated with less pain tolerance and poorer pain coping. Self-inefficacy, and the resultant anxiety and stress not relevant to the pain stimulus acts as a distractor and is associated with better pain coping. Distraction, in a variety of forms is known to be an effective cognitive pain-coping strategy (see for example Beers & Karoly, 1979; Chaves & Barber, 1974; Holms, Hekmat, & Mozingo, 1983; Weisenberg, 1989, 1998).

Another related factor is perceived control. The belief that one is in control of events (Internal LOC), and that one has the ability to influence events (high self-efficacy), must be accompanied by the perceived means to do so. For example, when confronted with a flat tyre, a person may believe that responsibility for changing it lies with him or herself, and that they have the ability to change it. But these are of little use without the belief that they can obtain a jack and a wheel brace. In terms of pain management, the perception of control has been defined as "*...the belief that one has at one's disposal a response that can influence the aversiveness of an event*" (Thompson, 1981, p.90), and has been shown to mediate pain coping (e.g. Litt, 1988; Miller, 1979, 1980; Weisenberg, 1989).

Control may be perceived as instrumental, where a behavioural response is available, or cognitive, where a cognitive strategy is available (Litt, 1988; Thompson, 1981). It is important to note that control need not actually be provided, it simply needs to be perceived to be available (Law, Logan, & Baron, 1994; Litt, 1988; Thompson, 1981).

Whilst LOC and self-efficacy are directly related, perceived control, though also related, differs from LOC and self-efficacy in that it depends upon some external component, particularly information. People with a more internal LOC style tend to seek information, whilst those with a more external LOC style are more likely to avoid it (Lefcourt, 1980). The efficacy of information depends upon the coping style of the individual. Those who seek information cope better, show less distress and lower levels of pain when it is provided. Those who avoid information cope better when it is withheld (Law et al., 1994; Miller & Mangan, 1983; Weisenberg, Wolf, Mittwoch, Mikulincer, & Aviram, 1985). In general, perceived control benefits most those who are most confident they can use it (Litt, 1988).

Summary

Determinants of individual differences in pain perception include sex, ethnicity and cultural affiliation and personality factors, particularly introversion/extroversion, neuroticism, LOC and self-efficacy. These factors share certain characteristics in common. In all cases, social learning is strongly implicated. Ethnic and cultural attitudes towards pain and determinants of pain response are influenced through the acquisition of societal norms and ideals with respect to behaviour and appropriate response to painful events. Whilst there is a biological component involved in sex-differences in pain perception, social learning is implicit also in the acquisition of gender-roles and appropriate gender-related behaviours. Social learning processes involved in the acquisition acceptable behavioural norms within familial and societal contexts influence the development of central systems associated with processing nociceptive and emotional information (Bates et al., 1993; Davidson et al., 2000; Fillingim et al., 1998). Ethnicity and cultural identity have been shown to be significant predictors of LOC style (Bates & Rankin Hill, 1994), which implicates social learning as a determinant of LOC style also.

These 'trait-like' determinants of pain response operate through a similar mechanism. They determine patterns of autonomic and emotional arousal in response to painful stimuli. Correlations have been shown between sex and autonomic and emotional responses to pain (Fillingim et al., 1998), and also between ethnicity and autonomic and emotional responses to pain (Sternbach & Tursky, 1965; Tursky & Sternbach, 1967). LOC style is associated with differences in autonomic and emotional response. Those with a more internal LOC style have been shown to exert greater control over physiological processes, particularly EEG alpha rhythm (Johnson & Meyer, 1974), and the perceived availability of personal or external resources to control pain influence its emotional impact. Self appraisals of power or potency have been shown to be major determinants of emotional states (Craig, 1978).

Due to the inherent nature of these trait determinants, they are slow to change. That these factors have been shown to be reliable supports this contention. However, whilst these factors go some way to explaining differences in pain perception between individuals, they do not explain differences within individuals.

People display different responses to pain at different points in time. Whilst trait determinants have been shown to be reliable predictors of differences in pain response between individuals, research into these factors does not take into account the dynamism of the relationship between individuals and their environment.

What has yet to be acknowledged is the role of environmental elements; situational and contextual variables which influence the basic affective-motivational state of the individual. The importance of the emotional-motivational component of pain experience has already been established. However general discussion of the relationship between emotional arousal and pain tends to have three things in common. First, in most cases emotion is spoken of in terms of conscious experiences, such as anxiety, depression, fear and anger. Second, emotional arousal is spoken of in direct association with pain; that pain and emotional arousal are concomitant (Chapman, 1986; Robinson & Riley III, 1999). Third, emotional processes are referred to in terms of being a *result* of cognitive appraisal (see for example Craig, 1978; Craig, 1986; Weisenberg, 1977).

Before considering the possible influences of contextual and environmental factors on the experience of pain, it is necessary to understand the nature of emotion in relation to pain. The affective-motivational component of pain is clearly a significant contributing factor in the ultimate experience, but why? The IASP definition of pain as "An unpleasant sensory and emotional experience..." implies that noxious stimulation of sufficient intensity to result in pain will always result in a collateral negative-affective state. However, the IASP definition, and the fact that strong negative-affective states can and do occur in the absence of pain, suggest also a degree of independence between processes underlying pain and emotion.

As affective-motivational processes may be a key factor in within-individual variation in the perception of pain, it is important to understand the bases of those processes. Where do emotions come from? What are their functions and how do they relate to pain? The following Chapter reviews the neurological bases of affect, and reviews literature on the neurological bases of pain in order to clarify the ways in which they relate to one another.

CHAPTER 3

THE NEUROLOGICAL BASES OF EMOTION

> "*To make progress in behavioural neuroscience, I think, we must abandon ancient and inappropriate philosophical hypotheses and focus our efforts on the attempt to discover the neural basis of behaviour, the activities that animals, including humans, actually perform in their daily lives.*" (Vanderwolf, 1998, p 137).

The Limbic System

All interactions with the environment have an emotional quality of some sort. In a review, Cardinal et al. (2002, p 322) suggest that "it is likely that emotions evolved from simple mechanisms that gave organisms the capacity to avoid harm and seek physiologically valuable resources". This suggestion provides an evolutionary rationale for emotion as having evolved from basic mechanisms driving adaptive approach and avoidance behaviours. They go on to suggest that "Consequently, simple and evolutionarily old brains systems may serve fundamental aspects of emotional processing, and provide information and motivation for more recently evolved neurological systems to control complex behaviour". Research mapping the course of neural pathways in the brain has shown that all sensory information from both the external and internal environments pass through the limbic system. After processing, the information is redistributed to the cortex for analysis, after which it is returned to the limbic system for determinations as to whether the highly processed, multi sensory information is salient or not (Bloom & Lazerson, 1988; Cytowic, 1993b).

Whilst the anatomical structures of the brain and certain aspects of its function have been known for some time through lesion, ablation and stimulation studies, more recent methods such as Positron Emission Tomography (PET) and Functional Magnetic Resonance Imaging (fMRI) have allowed researchers to investigate in-vivo, functional changes in the brain in response to specific, emotionally valenced stimuli. Much of this research supports earlier ideas concerning the function of the 'emotional brain', but more important, it gives a clearer view of the way the brain processes emotionally salient information. The prevailing view now is that (as with pain) emotion is not a function of specific brain centres, but of circuitry (e.g. Kandel, Schwartz, & Jessell, 1991).

The following sections constitutes a 'Cook's tour' of the 'emotional brain', reviewing recent research into those structures most associated with emotion and pain.

The Circuit of Papez

In 1937, based upon experiments that showed the hypothalamus to be a significant component in emotional expression, the anatomist James Papez proposed a neural circuit that provides the anatomical basis for emotional processing (see for example Bloom & Lazerson, 1988; Brodal, 1992; Kandel et al., 1991; Kolb & Whishaw, 1990). Papez argued that since emotions reach consciousness and conversely, higher cognitive functions affect emotions, the hypothalamus must communicate reciprocally with higher cortical centres. This argument has been supported using more modern research techniques, and the circuit of Papez still stands as a basic model for what is known about the neural bases of emotion.

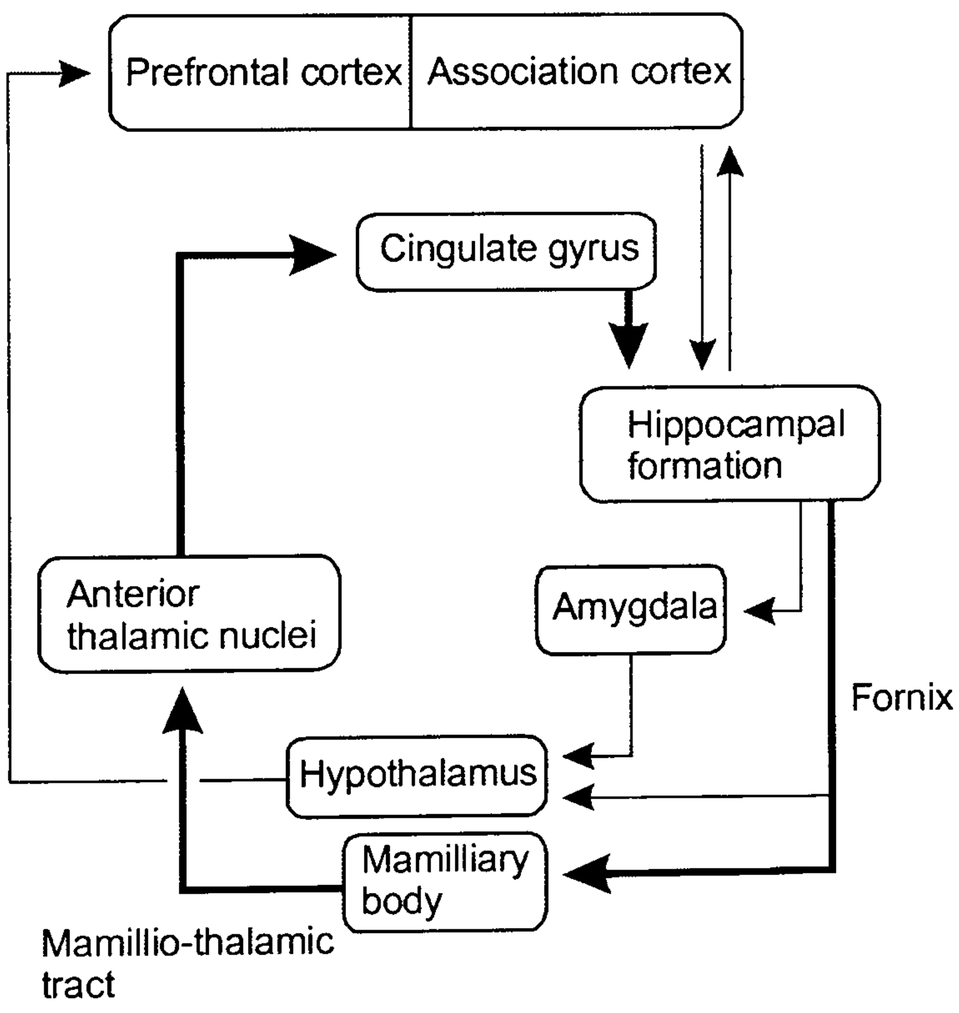

Figure 1 The circuit of Papez. The original is shown in thick lines. More recent additions are shown in thin lines.

However, whilst recent research has not contradicted the original concept of an 'emotional circuit', research has shown the anatomy and physiology of these structures to be much more complex than Papez's original suggestion. Research has shown extensive and direct connections between neocortical areas, the hippocampal formation, and the amygdala (Bloom & Lazerson, 1988; Kandel et al., 1991) (Figure 1. More recently determined connections shown in thin lines).

The circuit of Papez includes the key structures associated with emotion and motivation. Collectively, these structures form what is now known as the limbic system (Figure 2). The term 'limbic system' was introduced by Paul Broca to describe gyri which form a border around the brainstem. These gyri include the parahippocampal gyrus, the cingulate gyrus, and the subcallosal gyrus (the anterior and inferior continuation of the cingulate gyrus). Also included are the fornix, the septal nuclei, the olfactory bulb, the mamilliary body, the amygdaloid nucleus, the hippocampus and the underlying cortex of the hippocampal formation (Kolb & Whishaw, 1990). Sometimes included is the anterior thalamic nucleus (Brodal, 1992). All these structures are thought to be phylogenetically ancient, and in structure and function the limbic system seems to be essentially the same in all mammals (Bloom & Lazerson, 1988) reflecting a common evolutionary heritage.

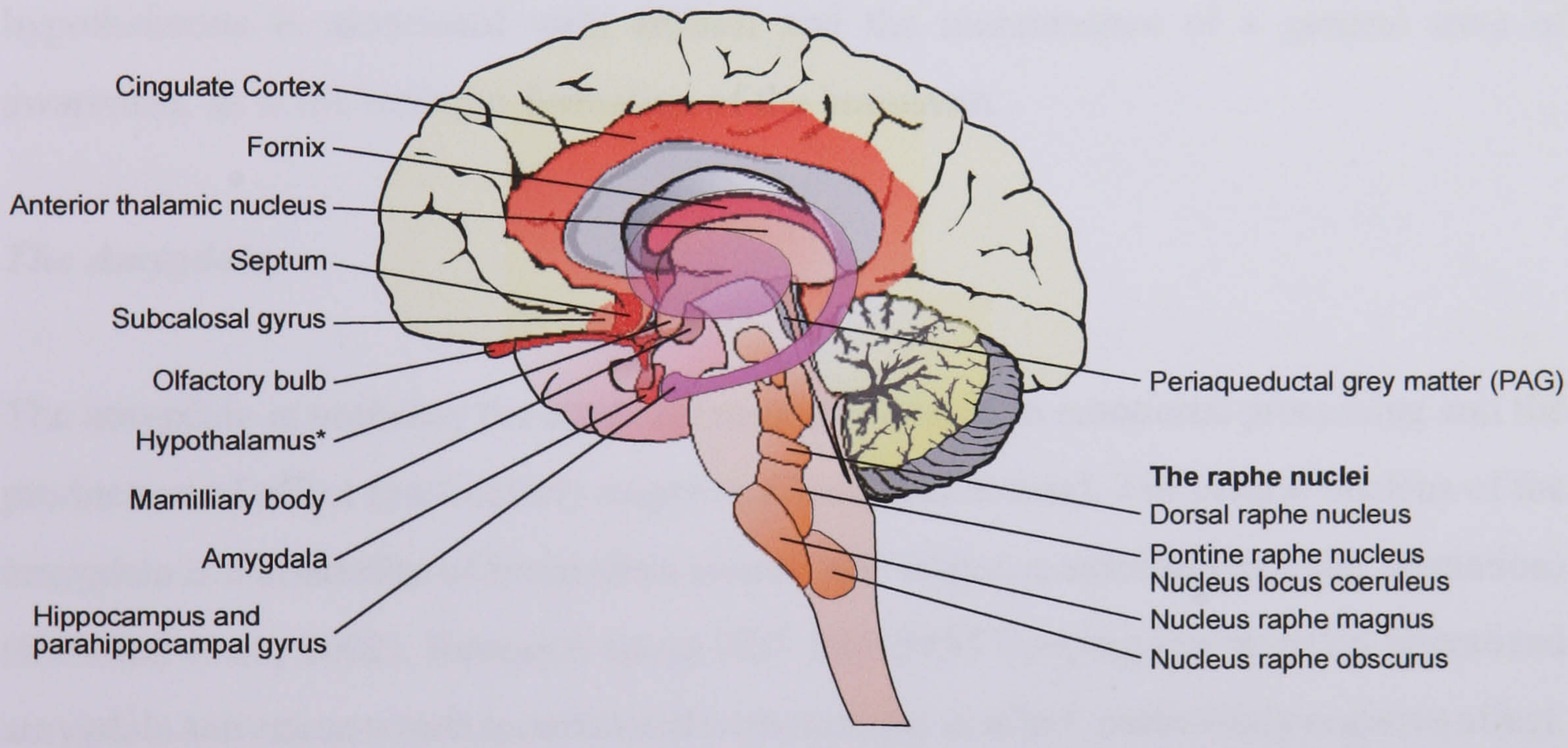

Figure 2 Sagittal section showing principal components of the limbic system (labelled left) and brainstem (labelled right).
* The hypothalamus is not usually considered a part of the limbic system. It is included here because it forms a central part of the circuit of Papez.

Although though many of the structures involved are related in function, and some of the effects of ablation or stimulation of several of the nuclei in the limbic system are similar, there are also differences (Brodal, 1992). Many of the nuclei involved serve other functions as well as being involved in emotion. Consequently, the term 'Limbic system' should be used with caution as it implies an inappropriate degree of functional unity. The term is used here only as a collective term for the structures listed above.

The Hypothalamus

The hypothalamus and closely related structures are primarily associated with the maintenance of homeostasis through the regulation of endocrine secretion and autonomic function. Neurons of the hypothalamus specifically effect changes in the autonomic nervous system that are associated with emotion, such as heart rate, respiration, blood pressure and galvanic skin response (Bloom & Lazerson, 1988). The hypothalamus is also associated with emotional functioning and motivated behaviour (e.g. avoidance of harmful stimuli and the search for food). Afferent connections of the hypothalamus show that it has reciprocal relationships with, and can be influenced by both the peripheral organs and tissues it controls, and also by higher levels of the nervous system (as argued by Papez), primarily the frontal lobes, cingulate gyri, hippocampal formation, septal nuclei, and the amygdalae (Brodal, 1992). As well as regulating these specific motivated behaviours, the hypothalamus is associated with arousal and the maintenance of a general state of awareness, as is the reticular formation of the brainstem.

The Amygdala

The amygdala is probably the structure most implicated in emotional processing and the production of affect (particularly negative affect) and arousal. The central nucleus of the amygdala is a controller of brain stem arousal and response systems (reticular formation) (Cardinal et al., 2002). Research using PET and fMRI imaging has revealed lateralized amygdala activation which is correlated with changes in affect, particularly negative affect. The left temporal cortex appears to be of particular significance (Hagemann et al., 1999; Lane et al., 1997). PET imaging has shown an increase in cerebral blood flow (CBF) for the left amygdala, and a decrease in CBF for the right amygdala related to the experimental induction of negative affect (see for example Schneider, Grodd, Gur et al., 1997; Schneider, Grodd, Weiss et al., 1997; Schneider et al., 1995).

The amygdala has also been shown to be a site of plasticity in the brain and has been implicated in certain forms of associative learning and emotional memory formation (Davidson et al., 2000). This appears to be particular to tasks which require the coordination of information from different sensory modalities, the formation of associations

between objects and their emotional meaning, or the association of a stimulus with an affective response (Cahill & McGaugh, 1998; Davidson & Irwin, 1999; Davidson et al., 2000; Kandel et al., 1991). It is thought that the amygdala (particularly the basolateral nucleus) is involved not so much in direct memory storage, but in the modulation of memory storage processes in other brain regions (Cahill & McGaugh, 1998).

Research has shown also that the amygdala plays a significant role in the *evaluation* of emotionally valenced stimuli independent of the modality of presentation. For example, it has been shown that the amygdala is particularly important for the recognition of cues of threat or danger (Davidson et al., 2000), and is involved in the evaluation of negatively valenced information in a range of modalities; semantic (written words) (Tabert et al., 2001), images (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Lane, Chua, & Dolan, 1999; Lane et al., 1997) and emotionally valenced vocalizations (Morris, Scott, & Dolan, 1999).

The Anterior Cingulate Cortex

The anterior cingulate cortex (ACC) is a part of the medial prefrontal cortex, and there is a large body of lesion, neuroimaging and electro physiological data which supports the view that the prefrontal cortex is an important part of the circuitry that implements both positive and negative affect (Davidson & Irwin, 1999). Experimental and clinical data show that, as with the amygdala, electrical stimulation of the cingulate cortex influences autonomic function, including alterations in respiration, heart-rate and blood pressure (Brodal, 1992).

The ACC has also been strongly implicated the processing of emotionally salient information (see Cardinal et al., 2002). For example, the ACC is reliably activated by cocaine related stimuli in cocaine users, more than by neutral stimuli in the same individuals, or by cocaine related stimuli in non users. The ACC is similarly activated by emotionally significant non drug stimuli in normal humans (Cardinal et al., 2002; Lane et al., 1997). Significantly, there is also a large body of evidence that the prefrontal cortex is involved in approach/avoidance behaviours (see Davidson et al., 2000, for a detailed review).

According to a review by Bush et al. (2000), an important guiding principle is that cognitive and affective information are processed separately within different regions of the ACC (Figure 3). Several functions have been ascribed to the cognitive subdivision, including selective attention, response selection, complex motor control, motivation, novelty, error detection and working memory. As shown above, the affective subdivision is primarily involved in assessing the salience of emotional and motivational information and the regulation of emotional responses.

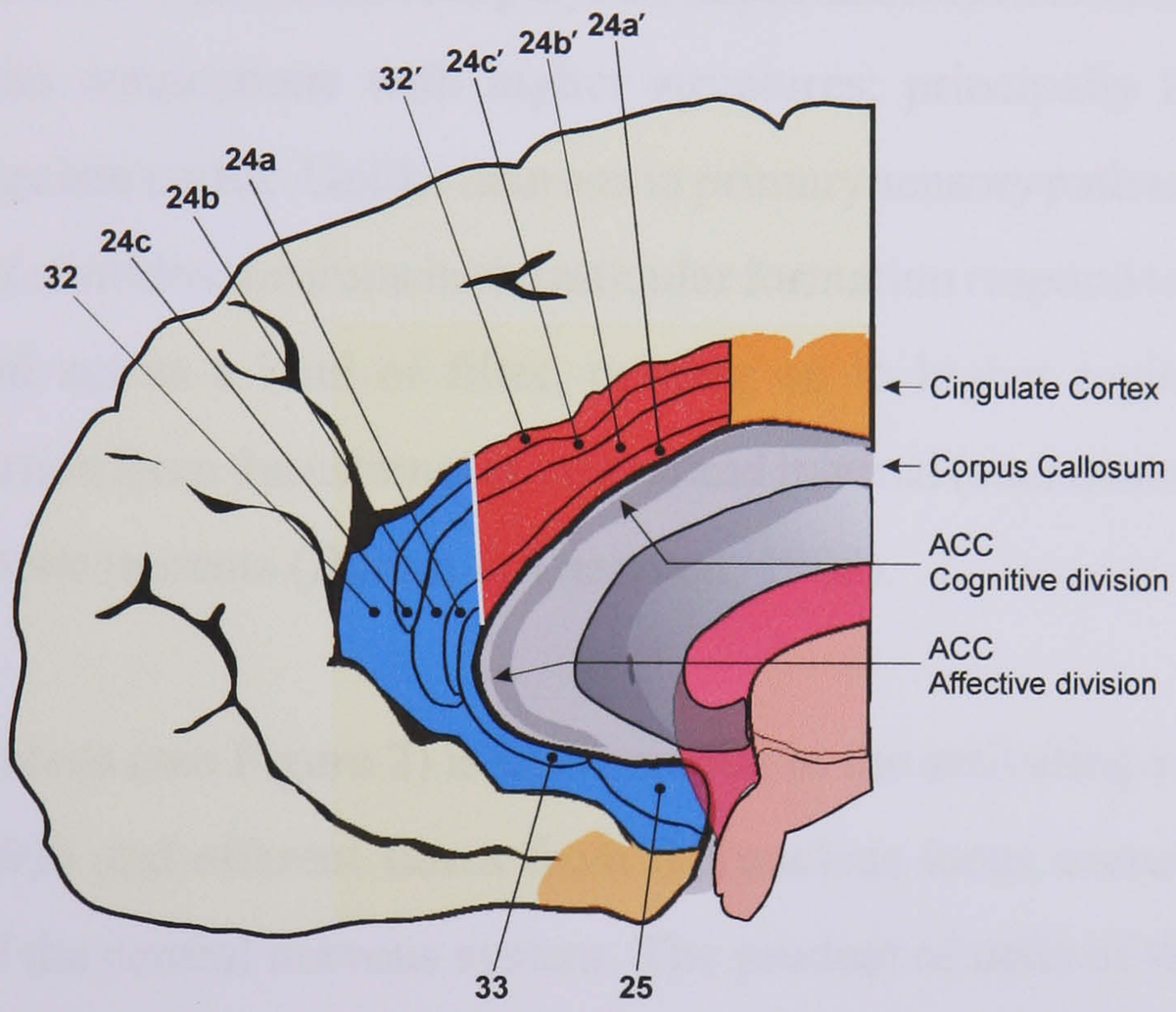

Figure 3 Sagittal section showing anterior cingulate cortex. Affective division in blue, cognitive division in red.

It is of significance to the study of pain that areas of the ACC also receive nociceptive information (Cardinal et al., 2002; Chen, 2001; Treede, Kenshalo, Gracely, & Jones, 1999). Surgical lesions of parts of the cingulate cortex have been performed in some patients with intense, chronic pain that could not be alleviated using conventional treatments. Some of these patients reported their pain as being less intense and disabling after the surgery (Brodal, 1992). It of interest that the effect of such surgery is similar to that produced by opiate analgesia in acute pain, in that surgical lesions to the anterior cingulate cortex do not abolish chronic pain, but reduce the unpleasantness (Jones, 1997).

Also of significance is that reciprocal suppression of the cognitive subdivision during intense emotional states has been observed. Individuals with severe depression and normal subjects anticipating pain and experiencing experimentally induced emotion all showed deactivation of the cognitive subdivision (Bush et al., 2000). This may partly explain the intrusive, 'nagging' nature of intense pain; the quality that demands attention and does not allow the sufferer to concentrate on anything else.

The Brainstem

The reticular formation in the brainstem plays an important role in emotion and particularly arousal through its connections with higher structures; principally the hypothalamus, amygdala and cingulate cortex. Unlike neurons in primary sensory pathways which respond to only one type of stimulus, neurons in the reticular formation respond to information from many stimuli, and act as a kind of filter, passing on to higher regions only novel or persistent information from the external (sensory) and internal (somatosensory, visceral and proprioceptive) environments (Bloom & Lazerson, 1988).

The nucleus coeruleus (see Figure 2) is instrumental in the activating system of the brain stem (Brodal, 1992) and efferent fibres from the nucleus locus coeruleus connect with nearly all parts of the central nervous system. The product of cells of the locus coeruleus (noradrenaline), is known to trigger emotional arousal (Bloom & Lazerson, 1988). Also located at the locus coeruleus, is the encephalenergic system, which controls the action of endogenous opiates (endorphines) and is also involved both in different reaction to novelty and familiarity and reinforcement (see Zajonc, 1980).

Summary

The limbic system can be thought of as the 'emotional core' of the human nervous system (Cytowic, 1993b), evaluating the emotional significance of incoming information, before passing it on to higher structures. Although undeniably, there are large gaps in knowledge concerning the neurological bases of emotional processing, sufficient is known to outline (broadly and in simple terms) the associative relationships between limbic structures and emotional processes and subsequent motivated behaviours. Beginning with the 'flagging'

and selective relaying of novel or persistent stimuli from the external or internal environments and immediate arousal in response to it (reticular formation and nucleus coeruleus). On to the increased attention to the stimulus and determinations concerning its salience (ACC) and the recall of emotional significance associated with the stimulus, determining its valence (amygdala). To the affective response to the stimulus (ACC and amygdala), and the selection of appropriate behavioural response (ACC) and autonomic and endocrine changes associated with arousal and motivated behaviour in response to the stimulus (ACC and hypothalamus). Finally, the formation of new, or reinforcement of existing associations between the stimulus and the outcome (basolateral amygdala). It should be noted that whilst these processes are presented in a serial fashion, many of them occur in parallel.

What has this to do with pain? As suggested by Cardinal et al. (2002), it is probable that emotions evolved from simple mechanisms that gave organisms the capacity to avoid harm and seek physiologically valuable resources. In other words, mechanisms which underlie adaptive, motivated behaviours which evolved to help the organism survive. According to the IASP definition of pain (given earlier) pain is "An unpleasant sensory and emotional experience associated with actual or potential tissue damage." One of the principal imperatives for survival is the avoidance or limitation of physical harm. In evolutionary terms, even relatively minor physical damage can compromise fitness for survival; impairing the ability of an organism to hunt, achieve a mate or to escape predation. Therefore, it is more than likely that pain, painful stimuli and environmental cues associated with pain or the possibility of harm constitute fundamentally salient stimuli in terms of arousal, affective response and motivated behaviour.

The following section reviews some of the literature on the neurological bases of pain, particularly with respect to the relationship between nociceptive systems and systems associated with the affective-motivational component.

The neurological bases of pain

The Pain Matrix

Noxious stimuli activate nociceptors. These are the peripheral terminals of primary afferent neurons. Compared to other, more specialized receptors which convey information from other sensory modalities, nociceptive primary afferent fibres are the least differentiated, existing as free nerve endings with no specialized peripheral structures. Thinly myelinated Aδ fibres mediate both thermal and mechanical information. They conduct at a rate of around 5-30 m s^{-1}, and are associated with sharp, pricking (fast) pain.

The peripheral terminals of thin, non-myelinated C fibres are polymodal receptors, which have a wide dynamic range and are activated by a variety of high intensity stimuli; mechanical, chemical and heat (>45°C) and cold stimuli. C fibres conduct at a rate of around 0.5-2 m s^{-1}. Activity in C fibres is associated with dull, aching (slow) pain. C fibres terminate in lamina II (substantia gelatinosa) whereas Aδ fibres terminate in laminae I and V of the dorsal horn.

Although nociceptive information ascends via several pathways, there are two major ascending systems associated with nociception: The spinoreticular tract and the spinothalamic tract. The spinoreticular tract ascends in the anterolateral quadrant (extralemniscal pathway) as does the spinothalamic tract. Some axons of the spinoreticular tract send branches that terminate in the reticular formation and the thalamus. Another ascending pathway, the spinomesencephalic tract also contains niciceptive axons which project to the reticular system, the periaqueductal grey (PAG) and other mid-brain sites. The PAG has reciprocal connections with the limbic system through the hypothalamus.

The spinothalamic tract is the major 'pain pathway', and is comprised of axons of nociceptive specific and wide dynamic range neurons. Unlike the spinoreticular pathway, all fibres in the spinothalamic tract cross the midline and ascend in the contralateral extralemniscal pathway (anterolateral white matter). Two major subdivisions of thalamic nuclei receive information from the spinothalamic tract: The medial nuclear group and the lateral nuclear group.

In common with emotion, pain has no unique, dedicated centre in the brain. Rather, the overall experience of pain appears to be a result of circuitry. An anatomical matrix has been relatively reliably isolated and identified (Figure 4), which can be divided into two main divisions. The lateral nociceptive system (named after its projections through the lateral thalamic nuclear group), which involves the brain stem, thalamus and the primary and secondary somatosensory cortices (SI and SII), and the medial nociceptive system (named after its projection through the medial thalamic nuclear group), which involves areas of the limbic system. Structures in the identified pain matrix share many functions other than pain.

The sensory discriminative component of pain has been attributed to the lateral nociceptive system (Chen, 2001; Treede et al., 1999), particularly the SI (e.g. Bushnell, Duncan, Hofbauer, Chen, & Carrier, 1999). It is involved in three main aspects: Localization (where is the injury?), intensity (how severe is the pain?) and quality (e.g. is it an aching or a sharp pain?). These different aspects may be processed in parallel by separate pathways (Treede et al., 1999). The sensory discriminative division of the pain matrix has been studied extensively and research has generated evidence that its cellular properties (from primary afferent fibres to the somatosensory cortex) can account fully for the sensory discriminative component of pain perception (see Treede et al., 1999, for a review).

More pertinent to this investigation is the affective-motivational division of the pain matrix, which involves the medial nociceptive system and consists principally of the medial thalamus and the ACC. The affective-motivational component encompasses several different but closely related aspects of pain. The negative affective response to pain; the (unpleasant) quality of a pain stimulus, and the susbsequent emotional and psychological reactions to it. These include elevation of general levels of arousal and stimulus related selective attention, and the psychological motivation and behavioural propensity to terminate the painful stimulus (Treede et al., 1999).

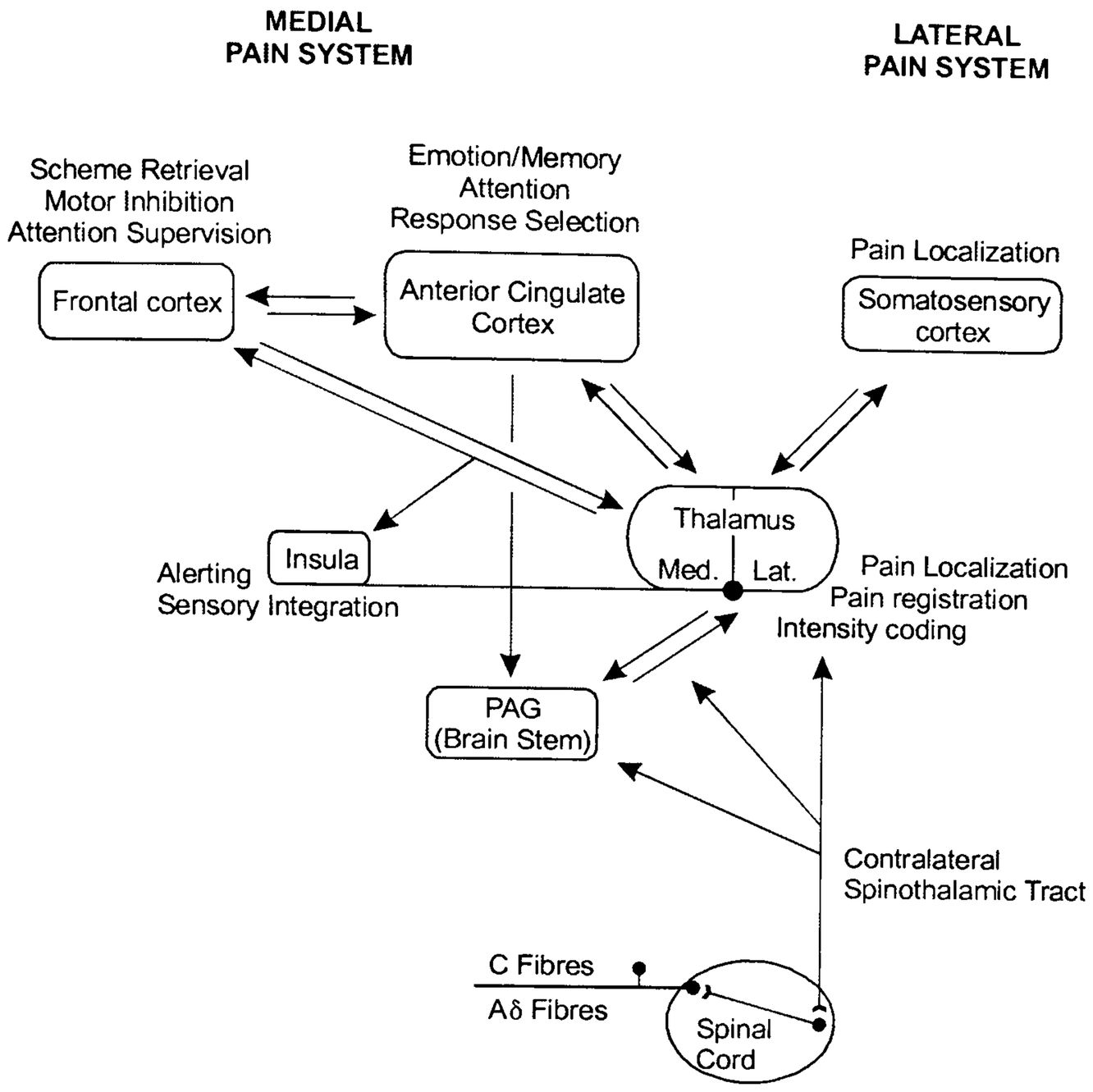

Figure 4. The pain matrix: Lateral ands medial nociceptive systems.

The central processing of the affective-motivational component of pain in the medial nociceptive system is not as well understood as the sensory-discriminative component, although it is known that limbic structures involved in affective-motivational processing of pain stimuli are the insula, hypothalamus, amygdalae, hippocampus and cingulate cortex (Chen, 2001).

According to Jones (1997) it has been shown clearly that it is predominantly the more frontal cortical structures such as prefrontal and particularly the ACC that respond to the suffering (affective-motivational) components of both acute and chronic pain. fMRI studies provide evidence of ACC involvement in the multidimensional nature of pain perception (see for example Kwan, Crawley, Mikulis, & Davis, 2000), and nearly all PET studies of acute pain stimuli show activation of the ACC including one study in which ACC activation occurred in the absence of noxious stimuli using the thermal grill illusion[2] (see Craig, Reiman, Evans, & Bushnell, 1996).

2

The thermal grill illusion consists of a grid of bars. Warm and cool water flowing through alternate bars provides a grill of alternate warm and cool bars. The temperature of the bars never reaches noxious levels of heat or cold, but the combination of the two elicits the experience of pain.

ACC response to painful stimuli has been shown also to be open to modulation through hypnosis (e.g. Croft, Williams, Haenschel, & Gruzelier, 2002; Kropotov, Crawford, & Polyakov, 1997). Jones (1997) suggests that particular support for the involvement of the ACC in the affective of components of pain comes from PET studies of patients with atypical facial pain syndromes, in which psychogenic mechanisms are thought to contribute to the perseveration of the pain. These patients showed increased ACC responses and reduced prefrontal responses to a standardized experimental pain stimulus, compared to controls.

The ACC is one of several opiate receptor rich sites in the limbic system and is modulated by (morphine) analgesia, as are the amygdalae and thalamus (Chen, 2001). As mentioned, surgical lesions in parts of the cingulate cortex are performed to treat otherwise intractable chronic pain often reduce the unpleasantness without removing the pain (Jones, 1997), a effect similar to that produced using opiate analgesics. Descending afferent fibres project from the ACC to medial thalamic nuclei and the periaqueductal grey (PAG) in the brainstem. According to Jones (1997), this suggests that the ACC may also be involved in the modulation of reflex responses to noxious stimuli and the central control of pain. The PAG is a cluster of neurons lying in the thalamus and the pons, surrounding the cerebral aqueduct (see Figure 2). Electrical stimulation of the PAG has been shown to produce analgesia in rats. PAG stimulation in humans has shown good results in chronic-pain patients. Although PAG stimulation results in analgesia, it does not reduce tactile sensitivity (Brodal, 1992), which suggests that the analgesic effects of PAG stimulation do not involve modulation of the sensory-discriminative component of pain.

Of particular interest is a study by Hutchison et al. (1999). Whilst investigating pain related ACC neurons, they found neurons with nociceptive specific responses. For example, one neuron increased firing rate in response to a decrease in temperature (noxious cold), but not to noxious mechanical stimulation. They found one neuron which responded to noxious mechanical stimulation (pin prick), but not to noxious heat, cold or non-noxious stimuli (e.g. deep pressure, touching and rubbing). Significantly, this cell also responded when the patient watched pin pricks being applied to the fingers of the examiner. When pin pricks were again applied to the patient, the cell responded before the skin was contacted. In other words, the cell responded to the *anticipation* of pain. Hutchison et al. suggest it is possible that these ACC cells may also contribute to the thermal grill illusion mentioned above.

As mentioned earlier, the ACC has been shown to respond to emotionally significant stimuli (e.g. Cardinal et al., 2002; Lane et al., 1997). Hutchison et al. (1999) note that the observed responses of some ACC neurons to complex visual stimuli that are pain related resemble those of monkey ACC neurons that respond both to pain and to environmental queues associated with anticipated pain. According to Hutchison et al., this suggests that cells within the ACC are involved not only in mediating the affective components associated with a painful stimulus but also with selective attention and (significantly) recognition and anticipation of an impending pain stimulus.

There is evidence to suggest that although the lateral and medial sub-divisions of the pain matrix interact in healthy individuals, they are capable of independent function. Ploner et al. (1999) report the case of a 57 year old male who had suffered a cardioembolic stroke. The stroke resulted in a lesion which was confined to the right postcentral gyrus (determined using MRI), comprising the hand area of the primary and secondary somatosensory cortices (SI and SII). Using a thermal laser, pain thresholds of 200mJ were recorded for the right hand and both feet. These stimuli evoked well localised (2-3cm) pain sensations that were characterised by the patient as 'pinprick like'. For the left hand (affected by the stroke), stimulus intensity up to 600mJ evoked no pain sensation. However, at stimulus intensities of 350mJ and above, the patient spontaneously described "...'a clearly unpleasant' intensity dependent feeling emerging from an ill localised and extended area, 'somewhere between fingertips and shoulder' that he wanted to avoid".

The patient (described as 'fully cooperative and eloquent') was unable to describe the quality, location or intensity of the stimulus, beyond that which he had already given. Further, the patient denied all suggestions from an adjective checklist containing items such as 'warm, hot, cold, touch, burning, pinprick-like, slight pain, moderate pain and intense pain'. In effect, the patient had lost sensory discriminative ability, but had retained the affective-motivational component (the sense of an 'unpleasant' somatic event that the patient wanted to 'avoid'). Ploner et al. conclude that pain affect and the ability to detect and respond to a pain stimulus do not require the integrity of the sensory-discriminative structures.

Similar results have been shown using hypnosis (e.g. Dahlgren, Kurtz, Strube, & Malone, 1995; Rainville, Carrier, Hofbauer, Bushnell, & Duncan, 1999). Rainville et al. (1999) used hypnosis to selectively modulate the emotional-motivational and sensory components of pain in a series of three experiments. Their first experiment evaluated the effect of hypnotic suggestion for reducing pain affect. Their second experiment compared the effects of suggestions for increased pain affect to suggestions for decreased pain affect and their third experiment evaluated the effects of hypnotic suggestions for increased and decreased pain sensation.

The results of the first two experiments showed significant changes in pain unpleasantness that were significantly greater (and independent of) concomitant changes in pain sensation (intensity). The results of their third experiment showed significant changes in reported pain intensity, but no significant changes in unpleasantness (after accounting for the effects of intensity ratings). Of note is the finding that pain-evoked heart rate (measured in their second experiment) was significantly correlated with pain unpleasantness, but not with pain intensity, suggesting that autonomic response to pain was associated with activity in the affective but not the sensory division of the pain matrix.

Summary

In Chapter Two, it was shown that trait determinants of pain perception (sex, ethnicity/cultural affiliation, and personality factors) influence the experience of pain through a common mechanism. Specifically, that it is not so much the factors in themselves that influence the experience of pain, rather, these factors are determinants of patterns of affective-motivational arousal in response to a pain stimulus. It was shown that ethnicity, cultural affiliation, personality factors and sex (which also has a biological component) are associated with different patterns of emotional response to painful events, and that in the absence of any significant physiological differences, these were most likely to have been acquired through social learning (including gender-role differences).

Social learning leads to the formation of regulatory strategies by shaping what are considered appropriate behavioural responses to painful events within the culture or society, and through observation of the reactions of others within that culture (particularly parents), learning the degree of importance to attach to painful events.

When 'trait-like' regulatory strategies occur over a long period of time, plastic changes in the central circuitry of emotion are likely to be produced (Davidson et al., 2000), particularly in the amygdala, hippocampus and areas of the prefrontal cortex and ACC. Thus, the acquisition of societal and familial norms in response to painful events shapes long-term 'trait-like' patterns of emotional motivational response to them. It is the differences in patterns of affective-motivational response to a painful event that is associated with individual differences in pain experience, as the pattern of emotional arousal in response to pain constitutes the affective-motivational component of the pain experience, determining the degree of unpleasantness and resultant 'suffering' associated with it.

In Chapter Three, the neurological bases of emotion, motivation and the affective-motivational component of pain were reviewed. This latter section raises some important points. First, emotional processing and the production of emotion, motivated behaviours and autonomic changes associated with emotion are driven by phylogenetically ancient, subcortical areas; the brainstem, hypothalamus and limbic brain. All sensory information passes through the brainstem and limbic brain where decisions are made concerning novelty and familiarity, valence (positive or negative) and salience of the information, before the information proceeds to higher cortical areas (Bloom & Lazerson, 1988; Cytowic, 1993b). The amygdala and ACC have been shown to be involved in the evaluation of a range of emotionally valenced information presented across different modalities, not just those pertinent to pain. The decisions concerning valence (positive or negative) and salience of the information result in changes in basic motivational state (approach or avoidance) that are associated with emotion, and appropriate preparatory changes in autonomic function. Therefore information reaching higher cortical areas already contains a degree of emotional 'colour'.

Second, there is evidence that detection of noxious stimuli, the generation of an affective response (interpretation of the stimulus as 'unpleasant') and the motivation to remove it (or remove one's self from it) can be served by the older limbic structures associated with the medial (limbic) subdivision of the pain matrix, *independently* of the higher neocortical structures associated with the lateral subdivision of the pain matrix (e.g. Ploner et al., 1999; Rainville et al., 1999). So the neurological mechanisms for emotion and motivation which preceded higher systems, although normally operating conjointly with these higher systems, have retained a degree of functional independence.

Third, in terms of evolutionary fitness, the ability to detect potentially damaging stimulation, though fundamental to the survival of an organism, must be secondary to the drive to avoid contact with the stimuli to begin with. The ability to discriminate accurately the precise location, intensity and quality of a damaging stimulus (though clearly useful), would quickly become academic were it not preceded by a basic motivation to avoid it. For example, the difference between discriminating precisely where one has been bitten by a snake, and avoiding being bitten in the first place. This requires recognition (not necessarily on a semantic level) of the association between an object and its emotional-motivational significance, and more important, that the motivational state associated with avoidance behaviour *precede* any pain stimulus.

The ACC and amygdala in particular have been implicated in recognition of negatively valenced (avoidance oriented) information and the formation of stimulus-threat associations, and bilateral asymmetric activation of areas of the medial prefrontal cortex has been shown to be associated with approach/avoidance responses (e.g. Davidson et al., 2000). This, and the discovery of ACC nociceptive cells that respond not only to noxious mechanical stimuli, but also to the visual cues of a pain stimulus being applied to another and to the anticipation of pain *prior* to contact with a pain stimulus, shows a neural basis for such an avoidance function.

These points have implications in terms of the relationship between pain and affect. As mentioned in Chapter Two, in general discussion of the relationship between emotion and pain, emotional arousal is usually spoken of in direct association with pain; that pain and emotional arousal are concomitant or emotional arousal as a result of pain. However, whilst not incorrect, in light of the information presented above, this must be only half the story.

If all information reaching higher areas of the brain have already undergone some level of processing in the limbic regions and therefore carries with it information pertaining to the emotional significance of the incoming information, then human interaction with the environment cannot be without emotional quality. In other words people must, on an emotional level, be responding constantly to their environment and given the evidence presented above, these affective responses are likely to occur outside of the volition of the individual and even below the level of conscious awareness.

This being the case, affective changes induced by incoming information must in turn influence interpretation of subsequent information in an ongoing, non-volitional process of evaluation and preparatory changes in affective-motivational state. Therefore, in terms of the perception of pain, it cannot be simply individual trait determinants or qualities of the pain stimulus itself that influence the experience of pain. Situational and contextual factors; events leading up to the advent of pain and environmental cues as to the affective-motivational significance of the situation (particularly the potential for harm) must also exert some influence. In other words, factors that are not an inherent characteristic of the individual and are unrelated to the pain stimulus are also likely to influence the way in which a painful event is experienced.

Is there any evidence for such a process; that evaluation of the environment for emotional meaning is a constant, non-volitional process that operates outside of conscious awareness and thus independently of cognition? If there is, then is there evidence that such a process can affect directly emotional-motivational state and propensity towards subsequent approach/avoidance behaviours? Chapter Four reviews the research into automaticity and preattentive processes, and the influence of environmental features on affective-motivational state and behaviour.

CHAPTER 4

AUTOMATICITY

> *"...affect is always present as a companion to thought, whereas the converse is not true for cognition. In fact, it is entirely possible that the very first stage of the organism's reaction to stimuli and the very first elements in retrieval are affective. It is further possible that we can like something or be afraid of it before we know precisely what it is and perhaps even without knowing what it is."* (Zajonc, 1980, pp 154).

Predominance of Affect

The argument by Zajonc (1980; 1984) was principally that affect and cognition were capable of independent function and therefore that it was possible that there were circumstances under which affect could precede cognition. As an adaptive characteristic this makes sense. On the most basic level, the capacity to evaluate something novel for potential threat must take precedence over the slower process of recognition and classification. For example, the initial reaction of certain primates to the presentation of a length of hosepipe is immediate and fearful, demonstrating an immediate avoidance motivation. To sit and observe the hose for colour, texture, quality and direction of movement and to attempt to classify the object (is it a snake? Is it venomous? Is it approaching?) wastes valuable time should the answers to those questions be yes. In such cases, where negative results of such cognitive process (not a snake, not venomous, not approaching) has no direct benefit to the organism, and the escape behaviour (even in the case of a false positive, i.e. a benign stimulus identified as dangerous) has no significant cost to the organism, such cognitive processes are redundant.

There are many arguments in support of the predominance of affect in everyday life. Dijksterhuis (2000) observed that; "When evolution comes up with a new species, it does not throw away old modules or systems so as to make a fresh start. Instead, new parts are simply added to parts that already existed..." (P 37). The neurologist Richard Cytowic (1993b) notes that human beings are unique among mammals in being advanced in both limbic and cortical dimensions. Reflecting the observation by Dijksterhuis, Cytowic notes that the limbic system did not get left behind in evolution, the limbic system and the cortex

co-evolved, and in humans it is the limbic system which reaches its greatest development. Neurological research has shown the number of limbic fibre tracts to be greater both in relative size and absolute number compared to any other fibre system. Moreover, the neocortex has more inputs from the limbic system than the limbic system has from the cortex. Cytowic points out that the functional significance of these connections turned out to be the reverse of what had been assumed for decades. Although there is a reciprocal relationship between the cortex and the limbic system, each regulating the other, "the number and nature of the recursive feedback circuits ensures that the influence of the limbic system is greater" (Cytowic, 1993b, p167).

There are clinical examples of the predominance of affect. For example, when coma patients recover they undergo a 'set sequence' of recovery. They first manifest automatisms (involuntary movements), then voluntary movements and childlike speech that is emotionally immature. As recovery continues, their behaviour gradually becomes more rational and adult like. This pattern of recovery suggests that higher cognitive and intellectual processes cannot be recovered unless emotional processes recover first (Cytowic, 1993a). In cases of prosopagnosia (an inability to recognise faces), it has been shown that when patients are shown a picture of someone they knew well before their illness, two contradictory things happen. The patient fails to recognise the face on a conscious level, and denies knowing the person in the picture. However, at the same time a sharp galvanic skin response (GSR) shows that recognition has in fact occurred, but at a level outside of awareness (Cytowic, 1993a; Vanderwolf, 1998). In other words, recognition, on an affective level, can be dissociated from conscious awareness of it.

In temporal lobe epilepsy (TLE), seizures originate in the limbic system. TLE can cause involuntary actions (automatisms) that seem purposeful, but for which the person has no awareness or recollection. In a review, Vanderwolf (1998) relates a case reported by J. Hughlings Jackson concerning a physician who developed *petit mal* epilepsy and kept careful records of his own seizures. Following an attack during a game of tennis he had no recollection of the strokes during a minute or two. However, his opponent noticed no change in his playing. On another occasion, the physician made a competent medical diagnosis during the course of a seizure, but was not aware that he had done so until later, when he discovered a note in his own handwriting.

There is also a large and growing body of experimental evidence supporting the hypothesis of a greater subcortical than cortical involvement in emotional processes (e.g. Schneider et al., 1995), and also that affective responses can occur outside of conscious awareness. For example, Bernat et al. (2001) conducted an EEG study measuring event related potentials (ERPs) in response to the presentation of positively and negatively emotionally valenced mood adjectives. The words were presented for both supraliminal and subliminal durations (40 ms and 1 ms respectively). They found that for both stimulus durations, a greater amplitude positivity was elicited by unpleasant as opposed to pleasant stimuli, particularly for the P3 and LP (late positive potential) components.

For the subliminal stimulus duration, these responses were lateralized to the left side. The supraliminal stimulus duration elicited bilateral effects for the P3 and LP components and left side effects for the earlier P1 and N1 components. Bernat et al. conclude that evidence from this study supports the growing consensus that affective responses can happen without conscious awareness. They suggest further, that on the basis of evidence already available, it appears that an effective meaning can be modified (conditioned, be elicited and influence conscious appraisals) all without the direct involvement of consciousness.

The evidence from their study suggests that such processes can occur within 100 milliseconds, and can change from pleasant to unpleasant valence within seconds to randomly presented valenced words. Bernat et al. (2001) conclude that given this evidence, it appears that a substantial range of affective processes can occur without benefit of consciousness. That subcortical perceptual, affective and motivational processes can and do occur without the benefit of consciousness is an underpinning principle of automaticity.

Automaticity

> "*The strongest knowledge (that of the total unfreedom of the human will) is nonetheless the poorest in success, for it always has the strongest opponent: human vanity.*" (Nietzsche, 1879).

It has been suggested that much of everyday life; thinking, feeling and doing, is automatic and determined not by conscious intent and choice, but by recent and current features of the environment (i.e. the behaviour of others, social norms, roles, contexts, objects and settings). Further, that direct control over affect and behaviour by the environment can and does occur (see Bargh, 1997; Bargh & Chartrand, 1999; Bargh & Gollwitzer, 1994; Spielman, Pratto, & Bargh, 1988). The term automaticity refers both to the pre-conscious, evaluative processes that determine affect and motivation, and to automatic behaviours that can occur as a result of those processes, which are developed by constant and frequent mapping of stimuli to responses.

Research into automaticity concentrates on specifying the relationships between features of the environment and cognitive and behavioural responses to them. It attempts to establish the underlying *'if - then'* relationships between situations and behaviours that do not require conscious mediation between the perception of the situational features, and the cognitive and behavioural responses (e.g. Bargh, 1992). According to Bargh (1997) there are three distinctive systems that can operate outside of awareness to influence behaviour. Environmental features can trigger unconscious processing in the perceptual (cognitive) system, in the evaluative (affective) system and in the motivational system. Although these systems are interactive and operate in parallel, they have distinctive mechanisms and operating characteristics (see Bargh & Ferguson, 2000). As noted by Todorov (2002), the preconscious processing of environmental stimuli by these three systems "determines the psychological situation of the individual as phenomenologically perceived by himself".

Two main classes of automaticity are preconscious and goal-dependent. Preconscious automatic processes require only the presence of the environmental stimulus linked to the cognitive or behavioural response, whilst goal-dependent processes require a conscious intention to initiate the process.

A common characteristic of automatic processes is that they are autonomous, and once they have started, require little or no conscious control in order to run to completion. They are also fast and efficient, using few if any attentional resources (see Bargh, 1989, for a detailed description of different varieties of automatic effects).

Examples of goal-directed automaticity are behaviours which occur during an activity such as driving, or playing a musical instrument. Automatisms associated with goal-directed automaticity are essentially the same as those occurring in preconscious automaticity, but would not occur in the absence of the goal-directed behaviour. They require a deliberate intent to engage in the activity, but once initiated, many of the actions involved are carried out automatically and without conscious thought, and in many cases will run to completion without conscious mediation. For example, an experienced guitarist can play a well practised piece of music whilst holding a meaningful conversation. A less practised musician, or one playing a novel piece could not. One or other activity would suffer. The conscious intent to play is necessary to initiate the activity, but once initiated, the action can continue automatically. Conscious mediation is required only to moderate the action.

On the other hand, preconscious automaticity effects require no prior intent. These are effects such as attitude and stereotype activation and automatic (also known as preattentive) evaluation, and require only the triggering stimulus (attitude object or event), and occur prior to, or in the absence of any conscious awareness of that event (Bargh, 1989). These processes operate involuntarily, autonomously and are uncontrollable. It is important to note that although automatic processes are uncontrollable, the ultimate behaviour is open to moderation. For example, the Stroop colour word task, in which people have to name the colour in which a word is presented. People take longer to name the colour of the word, when the word itself is the name of a different colour (e.g. the word 'blue' in red ink). It is important to note that participants in this task are usually correct in their responses (e.g. saying 'red'). Although the competing response (saying the word 'blue') is automatically triggered, the increased response latencies comes from the participant consciously moderating the automatically activated competing response (see Bargh, 1988; Bargh & Chartrand, 2000). In other words, it is the internal events and propensities towards subsequent behaviours which are uncontrollable, not the ultimate responses.

Of the two main forms of automaticity, preconscious automatic effects are most pertinent to this thesis. If environmental features trigger automatic effect in cognitive, emotional and motivational systems and can influence subsequent behaviour, then there are significant implications for the study of pain.

As mentioned earlier, the experience of pain is entirely subjective and the emotional-motivational component forms a significant part of that experience, as it determines the degree of unpleasantness and suffering associated with a painful event. Further, the only way one has of knowing that another is experiencing pain is through observation of their behaviour. Clinical pain assessment and experimental pain rating, be it verbal report, marking a point on a scale, or choosing a word from an adjective checklist are simply behaviours. Because of this, in its most basic form, experimental pain research (and clinical pain assessment) for all practical purposes, is generally restricted to a form of stimulus-response paradigm. An experimental pain stimulus is applied, and the behavioural response is measured.

The underlying assumption is that the response relates directly and only to the stimulus. Even on this very specific level, there is the problem that people may respond to different aspects of the same stimulus (e.g. Fillingim & Maixner, 1995). On a broader scale and in light of the principles of automaticity, can it really be said that an individual exposed to a pain stimulus is responding only to the pain stimulus? Or might it be that current features of the environment (e.g. the behaviour of others, social norms, roles, contexts, objects and settings) are also determinants of the response? What follows is a brief investigation of the particular automatic effects (behavioural and affective-motivational) that are most likely to have implications for pain research, beginning with automatic effects on behaviour.

The Perception-Behaviour Link

An important preconscious automatic effect is the perception-behaviour link, which posits the existence of a non-conscious connection between the act of perceiving and the act of doing. Thus, for example, the act of observing a behaviour in another makes one more likely to engage in that same behaviour (see Chartrand & Bargh, 1999).

A direct link between perception and behaviour can be seen in many other species, for example the fast, coordinated movement of herds of antelope or schools of mackerel (see Bargh & Ferguson, 2000; Dijksterhuis, Bargh et al., 2000). These are prey animals, and the herding and schooling behaviours are adaptive, limiting the chances of fitter individuals being lost to predatory attack, as older and weaker animals get forced to the outside of the group or are left behind. As noted by Dijksterhuis et al. (2000), the mechanisms that drive such behaviours in other species are still present in the human brain.

Bargh and Chartrand (1999) suggest that although William James popularized the principle of 'ideomotor action' (that the mere act of thinking about an action increases the likelihood of its occurring), the 'ideo' in ideomotor action could just as well come from outside the head as from within it. They suggest that automatic perception of features in the current environment induces the ideas to act. For example, an often cited example of the illusive nature of control over one's own behaviour is the 'readiness potential' (see for example Libet, 1985). Briefly, the readiness potential describes the buildup of activity that can be recorded in the motor cortex that begins around 800 ms before the conscious decision to move has been made.

Cytowic (1993b) suggests that one conclusion is that the 'decision' to move is simply an interpretation one gives to a behaviour that has been initiated by another part of one's self and which exists outside of consciousness, before one is aware of making a decision at all. According to Bargh and Ferguson (2000), the impetus or intention to move is directly traceable to the experimental instruction to move. Thus, the original propensity to move was triggered by an environmental event.

Based on the principle of ideomotor effect, Chartrand and Bargh (1999) suggested that simply observing an action increases the possibility that one will engage in it. They suggest that 'echo-reactions' such as echolalia (a tendency to mimic the speech of another) and echopraxia (a tendency to mimic the behaviour of another) which are both commonly observed in people suffering from conditions which compromise their ability to consciously and intentionally regulate their behaviour, show that in the absence of intentional forms of behaviour control, the perception-behaviour link remains intact. This contradicts the idea of conscious choice as a mediator.

Chartrand and Bargh (1999) performed a series of three experiments based upon the human (and non-human primate) tendency to mimic the behaviours of those around them (see Bargh, 2001; Bargh & Ferguson, 2000; Dijksterhuis, Bargh et al., 2000). These experiments demonstrated a form of preconscious automaticity known as the 'chameleon effect' which can be described as the propensity for people to mimic the behaviour of others with whom they are socially interacting.

In the first experiment, participants were paired with confederates in two trials involving non-related tasks (describing photographs). The confederates had been instructed to perform certain behaviours (either foot shaking or face rubbing, counterbalanced between trials) and facial expressions (smiling or not smiling) throughout the tasks. The deliberate mannerisms performed by the confederate was shown to result in the participant engaging in the same mannerisms, and the degree of mimicry by the participant was shown to be significantly higher than chance level.

To test whether mimicry was a function of liking and rapport, or whether liking and rapport increased mimicry, the situations were reversed in the second experiment. During the same non-related task, the confederate either mirrored the mannerisms of the participant, or engaged in neutral, nondescript behaviours. After the task, participants were asked to complete questionnaires in which they were asked to rate how much they liked the confederate and how smoothly they thought the task had gone. Participants in the experimental condition (in which the confederate mirrored their mannerisms) indicated a greater liking for the confederate and that the task had gone more smoothly than participants in the neutral condition.

The third experiment measured mimicry as a function of individual differences in the cognitive structures that are activated by environmental features, in this case, perspective taking (the ability to take and understand the perspective of another). Results of this experiment showed that those assessed as high in perspective-taking engaged in mirroring behaviour significantly more frequently that those measured as low in perspective-taking. In all cases, participants were unaware of the mirroring behaviour in themselves or the confederates.

Through these three experiments, Chartrand and Bargh demonstrate three important points. First, they demonstrate a direct, non-conscious link between perception and behaviour in a social interaction. Changes in the behaviour of a participant were caused by changes in the behaviour of the confederate and participants were unaware of the influence showing that the effect is unconscious, requiring neither conscious choice or intent. Second, they show a causal direction which demonstrates the adaptive function of the behaviour; that the behaviour resulted in higher liking and rapport, acting as a kind of 'social glue'. Third, they demonstrate that patterns of automatic behaviours are at least partly dependent upon individual differences in the activation of existing cognitive structures. Pre-existing cognitive traits (in this case the ability to understand the perspective of another) influenced the degree to which the participant engaged in the automatic behaviour.

It has been shown that in social situations, the expectancies of the perceiver can also influence the behaviour of the perceived (see Higgins & Bargh, 1987). An example of this was shown by Chen and Bargh (1997). They carried out an experiment involving two phases. The first phase was ostensibly a 'dot-estimation' task in which white participants were told that they had to estimate whether the number of dots presented for a short time on a computer screen was odd or even. During this phase, participants were 'primed'. Before the dots were presented, participants were exposed subliminally to a black and white photographs of either an African American (according to Chen & Bargh, the African American stereotype includes hostility as a trait construct) or a Caucasian face for 13 ms. This was followed by two mask patterns, also presented for 13 ms each, after which a picture containing between 4 and 24 small coloured circles (the number varied for each trial) appeared for 3 seconds. Participants were asked to indicate whether there had been an even or an odd number of circles.

The second phase of the experiment involved pairing the 'primed' participant with a non-primed 'target' participant. The participants were informed that they were to take part in a verbal performance task in the absence of any visual information. The task would involve them playing a game of 'Catch Phrase' in which one player (the guesser) has to guess a word or phrase from clues given by the other player, who was not allowed to say or spell the word or phrase.

Each participant was placed in a separate room and the two communicated using microphones and headphones. Participants played for 3 minutes, after which they switched roles and played for a further 3 minutes. At the end of the session, participants completed Impression Formation Questionnaires on which they indicated their impressions of each other. Verbal interactions during the game were recorded and coded for hostility, using a standardised scale, by independent coders who were blind to the experimental hypothesis.

The results showed that the non-primed target participants who had interacted with participants primed with African American faces were rated as more hostile by both their primed participant partner, and outside observers compared to target participants who had interacted with Caucasian-primed participants. The expectations of the primed participants had resulted in changes in behaviour concordant with the expectation of hostility. In short, the target participants had become more hostile. The increase in hostile behaviour of target participants was a response to this hostility, and served to confirm the expectations of the primed participants.

The above are examples of a robust effect. The preconscious activation of a wide range of stereotypes and trait constructs has repeatedly been shown to result in changes in behaviour concordant with the trait construct activated, that occurs outside the awareness of the participants. For example, priming the trait constructs for rudeness or politeness results in a significant decrease or increase (respectively) in the time taken for participants to interrupt a conversation (Bargh, Chen, & Burrows, 1996; see also Bargh & Gollwitzer, 1994). Priming the trait 'forgetfulness' associated with the stereotype of elderly people resulted in poorer performance on memory tasks (Dijksterhuis, Aarts, Bargh, & van Knippenberg, 2000). Priming the traits of slowness and weakness associated with the stereotype of elderly people resulted in participants walking more slowly (Bargh, Chen et

al., 1996). Using stereotypes such as 'professor' and 'football hooligan' to prime the traits 'intelligence' and 'stupidity' resulted in increased or decreased performance (respectively) in participants answering questions from the game 'Trivial Pursuit' (see Bargh & Ferguson, 2000). Similar results have been shown for traits such as hostility (Bargh, 1988; Bargh, Chen et al., 1996) and aggression (see Todorov & Bargh, 2002).

Taken together, these studies demonstrate a link between perception and behaviour that occurs outside awareness. Activation of stereotypes, and their associated trait constructs through presentation of features in the environment associated with the stereotypes can result in behaviours congruent with the trait construct. Moreover, that expectancy plays a role and the behaviours resulting as a result of priming can in turn, influence the behaviour of others with whom the primed individual interacts (but who have not themselves been primed), in such a way as to confirm the expectation of the primed individual.

Importantly, the studies by Chartrand and Bargh (1999) show that individual differences in the cognitive structures that are activated by the environmental stimuli influence patterns of behavioural response. In terms of clinical and experimental pain measurement (which, as mentioned, is simply the observation of a behaviour), patients and participants represent one half of a social dyad in which clinicians and researchers represent the other. Thus, it is likely that the social context also influences the ultimate report of pain.

As shown above, the presentation of a stereotype results in the activation of trait constructs associated with it. Snyder et al. (1977) state that "*...stereotypes can and do channel dyadic interaction so as to create their own social reality.*" Indeed, the fact that scientists, doctors and nurses are what they are may be sufficient in itself to activate certain stereotypical constructs and congruent behaviours. In the hospital environment for example, each part of the dyad (clinician and patient) have their own expectations. People admitted to hospital or undergoing medical examination tend to take a submissive psychological stance, adopting the 'patient role' (see Pickering & Friedman, 1991; Pitts, 1993b; Taylor, 1979). Particular features of the patient role are loss of control, reduction in self-efficacy and depersonalisation (Taylor, 1979). People can no longer decide for themselves when to eat, sleep or bathe.

Adoption of the patient role is often assisted (unwittingly) by hospital staff. To the medical staff, patients frequently become their condition: 'the compound fracture we admitted last night' or 'the transplant in room two that is doing particularly well'. The adoption of the patient role is facilitated further by the style of language adopted by clinical staff. A mature adult who, for example, may hold a directorship in a large company, or carry the responsibility for hundreds of lives as an airline pilot is asked to 'pop into bed and slip off your clothes so we can look at your tummy' (see Pitts, 1993a).

It is fair to say that doctors, nurses and scientists adopt roles when dealing with patients or participants. This is often necessary in order to maintain a degree of clinical detachment and professionalism. But in doing so, the clinician or researcher tends to behave in such a way so as to elicit confirmatory behaviour in the patient or participant; an example of the effect shown by Chen and Bargh (1997). Further, the stereotypical 'clinician' behaviour activates patient-trait constructs (e.g. illness, helplessness and pain) and the patient role and associated behaviours are reinforced.

Similar principles apply in the research environment. The work of Stanley Milgram (1963; 1974) demonstrates the authority of the 'scientist' as perceived by the participant. The participant, naive as to the experiment, gives control to the scientist; who knows precisely what is going to happen. The scientist has responsibility and accountability for the welfare of the participant and so must adopt a controlling role. Even briefing the participant of their rights to stop or withdraw at any time reinforces this role. Even though it most certainly is not the case, the explicit statement of the right of the participant to withdraw implies that it is within the power of the researcher to either grant *or* withhold that right.

The adoption of the clinician or scientist role confirms patient or participant stereotype expectations and facilitates the adoption by the patient or participant of the complementary roles and behaviours (the self-fulfilling prophesy effect). It is likely that the context in which the patients and participants perceive themselves to be will exert a universal influence on behavioural tendencies as a whole.

According to Higgins (1987), the hypotheses people form concerning what is likely to happen in a given situation play a critical role in the selection of information from the environment to be encoded. Moreover, these hypotheses are automatically driven by the data present in the current situational context, and cognitive organisation of previous related experiences (schemata, frames or scripts) have been hypothesised to guide the interpretation process. Therefore, just as in the example given by Chapman (1984), of the boy he observed in hospital who cried with pain only on discovery of his dressing, when a patient or participant is asked to quantify their pain, at least a portion of the rating may be due to the situational context. In other words, it may be that it hurts partly because in that environment, and situation, it is *expected* to hurt, and in that context it is a part of the role of patient (or participant in pain research contexts) to say so.

Of course, this is not to suggest the absence of pain, or that reports of pain influenced by environmental factors are dissociated from the subjective experience. This section has reviewed only behavioural effects of preconscious processes, and it is suggested here that pain report, as a behaviour, is likely to be influenced to some degree by the expectancies of the patient or participant which are driven by features of the environment, such as the behaviour of the clinician or researcher. However, as shown in Chapter Three, human interaction with the environment cannot be without an emotional component. The perception-behaviour link has shown two main ways in which behaviours within a social dyad can be influenced on a non-conscious level by features of the dyad, but by definition, each of these non-conscious behavioural responses has an underlying affective motivational component. Negative affect in the case of hostility in response to stereotype trait activation, and positive affect in the case of social mimicry.

The above examples are dependent upon the behaviour of others, or interaction with others after exposure to some priming event or stimulus and therefore the effects require social interaction in order to manifest. There is another, more pervasive route by which affective-motivational state and subsequent behaviour can be influenced. This involves what may be termed a direct perception-affect link and is a very basic process which produces changes in basic affective state and motivational tendency towards a given stimulus.

The Automatic Evaluation Effect

It has been suggested that the valence of a stimulus (positive or negative) is the basic dimension by which the brain deals with information, and that decisions concerning the valence of a stimulus result in either a positive (approach) or a negative (avoidance) motivational system being activated by the stimulus (Bargh, 1997). Automatic evaluation refers to the processes underlying the preconscious decisions concerning the valence of environmental information.

Automatic evaluation is described as a universal and unconditional process that is reflexive and uncontrollable, requiring neither intent nor awareness (e.g. Bargh, 1988; Bargh, 2001; Bargh & Chartrand, 1999). In line with the suggestion that much of everyday life; thinking, feeling and doing, is automatic and determined by features of the environment, it has been shown that people evaluate the valence of most, if not all environmental information (objects and events both social and non-social) (e.g. Bargh, Chaiken, Govender, & Pratto, 1992; Bargh, Chaiken, Raymond, & Hymes, 1996). Further, that the classification of features in the environment as either '*good*' or '*bad*' has been shown to occur within 250 ms (see Bargh, 2001; Bargh & Ferguson, 2000; Giner-Sorolla, Garcia, & Bargh, 1999).

This is in line with the neurological data reviewed in Chapter Three, showing that all sensory information passes through the brainstem and limbic brain where decisions are made concerning novelty and familiarity, emotional valence and salience of the information (Bloom & Lazerson, 1988; Cytowic, 1993b). As shown, the amygdala and ACC in particular have been implicated in recognition of negatively valenced information and the formation of stimulus-threat associations. Further support comes from data showing the prefrontal cortex to be involved in approach/avoidance behaviours and the evidence showing asymmetric prefrontal and anterior temporal activation in response to experimentally induced positive and negative affect, suggesting that approach and avoidance systems are implemented in partially separable circuits (Davidson et al., 2000).

Automatic evaluation has also been shown to affect directly motivational state and subsequent behavioural tendency. In other words, one of the results of automatic evaluation is an immediate tendency to either approach or avoid the stimulus, depending upon the valence of the stimulus. Chen and Bargh (1999) conducted two experiments in which

participants were presented with a series of 92 emotionally valenced words on a computer display. Attached to the computer was a lever attached to an electronic switch which would allow the direction of action (push or pull) and response latency to be recorded.

In the first experiment, participants were told that they were being tested on how quickly they could classify words as good or bad. They were assigned to one of two conditions; congruent or incongruent. In the congruent condition, participants were instructed to pull the lever if they classified the word as positive in meaning, and to push the lever if they classified the word as negative in meaning. In the incongruent condition, the instructions were reversed (pull if negative, push if positive). The results showed that participants were faster to push than to pull the lever if they classified the word as negative, and faster to pull the lever than to push when they classified the word as positive. There was also an overall main effect for valence. Participants were faster to push when presented with a negative word than to pull when presented with a positive word.

For the second experiment, everything was identical except that participants were not told to evaluate the words, just to always push (or always pull) the lever on presentation of a word. No mention of evaluation was made, and participants believed it to be a reaction time study. Halfway through the trial, participants were given new instructions. Those who had been instructed to always push the lever were told to always pull for the remainder of the trial and visa versa. The results showed that although latencies were faster overall (due to the absence of the need to classify the words) the overall pattern of congruence remained. Participants were faster to pull the lever when presented with positively valenced words, and faster to push when presented with negatively valenced words. The main effect for valence was also reproduced.

The results of the first experiment demonstrate a direct link between the automatic process of classification and motivational state. The results of the second experiment show that the effect occurs in the absence of any conscious intent to classify the stimulus. The non-conscious evaluation of a stimulus object or event immediately prepares the appropriate muscular tendency to approach or avoid the stimulus. Further, the main effect for valence (a faster congruent response to negatively valenced stimuli) is in line with the neurological evidence (Chapter Three) that limbic systems are particularly responsive to cues pertaining to threat or danger in the environment (e.g. Davidson et al., 2000).

The adaptive value of such a mechanism is clear. For example, the survival of an organism often depends on the order in which questions such as 'can I eat it?' and 'can it eat me?' are answered. As the former question becomes entirely academic should the answer to the latter question be yes, it is more than likely that organisms in which the avoidance system was faster than the approach system were more likely to survive. The mechanism is a way of answering the most important questions first (e.g. is it dangerous, should I avoid it?), and therefore mechanisms which evolved to help the organism avoid danger are faster.

It has been noted that emotions differ from affective-motivational state. Automatic evaluation results in direct (i.e. preconscious) activation of affective-motivational systems within 250 ms. This occurs outside of conscious awareness, but emotions are declarative (I feel sad, I feel happy) and therefore must be conscious (e.g. Clore, 1997). However, Isen and Diamond (1989) point out that there are two ways to conceptualise affect. Firstly as a quality (valence) assigned to a stimulus, for example rating a stimulus with regard to its degree of goodness or badness, or pleasantness or unpleasantness. Thus, although as noted above there are distinctive mechanisms for affect and motivation, at the evaluative level affective response to a stimulus and motivation to either approach or avoid the stimulus are indivisible for all practical purposes. Secondly (according to Isen and Diamond), affect can be conceptualised as a declarative feeling state. Studies have shown that automatic evaluation is a non-conscious contributing determinant of emotional state, mood and subsequent judgement (Bargh & Chartrand, 1999; Bargh & Ferguson, 2000; Bargh & Pietromonaco, 1982), and to influence the way in which subsequent information is interpreted. For example, interpreting deliberately ambiguous stimuli in a way that is congruent with the valence of a previously presented subliminal 'prime' (see Bargh & Ferguson, 2000).

According to Bargh (2000), research on the effects of priming on subsequent mood "...demonstrates that the automatic appraisal of stimuli accrues over time into an effect on one's general mood state: given that the process and effect is entirely nonconscious, it would seem that evaluation processes serve as a kind of signal as to the overall quality of one's environment." Further, the behavioural consequences as shown by Chen and Bargh (1999) shows that automatic evaluation results in behavioural readiness within a fraction of a second to either approach positive or avoid negative objects in the environment. Chen and Bargh conclude that through its effect on mood, the automatic evaluation effect serves as a signalling system for the overall safety versus danger of the environment.

The continual universal and unconditional evaluation of the environment, and immediate, nonconscious classification of features of the environment into either 'good' (approach) or 'bad' (avoid) categories has clear adaptive grounds and reflects precisely the kind of mechanism suggested in the summary of Chapter Three. The evidence reviewed supports the suggestion by Zajonc (1980; 1984) of a separate affective information processing system to account for the fact (among others) that one can usually declare a preference between several items, before being able to state the reason for that preference.

The effects of automatic evaluation of features of the environment have been shown to influence behaviour, mood and subsequent cognition. As such, automatic evaluation is a significant determinant not just of behavioural propensity, but of the way in which a person experiences and interprets life. As noted previously, the preconscious processing of environmental stimuli "determines the psychological situation of the individual as phenomenologically perceived by himself" (Todorov & Bargh, 2002). This echoes the observation by Spielman (1988) that "All aspects of phenomenal experience are determined at least in part, by forces in the environment operating outside awareness".

As shown in Chapter Three, all information reaching higher areas of the brain have already undergone some level of processing in the limbic regions and therefore carries with it information pertaining to the emotional significance (valence and salience) of the incoming information. The evidence reviewed above goes further, showing that not only can human interaction with the environment not be without an emotional quality, but that preconscious determinations concerning the valence of incoming information have direct consequences for subsequent emotion and behaviour. Therefore, as suggested previously, in terms of the perception of pain, it cannot be simply trait determinants (sex, ethnicity/cultural affiliation and personality factors), or qualities of the pain stimulus itself that influence the experience of pain. The evidence reviewed above suggests that situational and contextual factors; events leading up to the advent of pain and features of the environment in which a painful stimulus occurs, must also exert some influence. In other words, factors that are not an inherent characteristic of the individual and are unrelated to the pain stimulus are also likely to influence the way in which a painful event is experienced.

In terms of the research into preconscious automaticity, individual differences in response to pain discussed in Chapter Two, can be described as combinations of chronically accessible cognitive structures, comprising stereotype traits and personality trait constructs that are acquired through social learning. That is, they represent individual differences in relatively stable, socially acquired long-term cognitive structures, which are activated by preattentive evaluation of features of the environment in predictable ways during painful events. Thus, as mentioned, they can be characterised as 'trait-determinants' of the perception and response to pain stimuli.

It is suggested here that automatic evaluation of social, contextual and environmental features can account (at least partly) for within-individual variation in the perception and response to pain stimuli. In other words, social context and environmental features can be characterised as 'state-determinants' or modifiers of the perception and response to a painful stimulus. The evidence reviewed in Chapters Three and Four show that social context and environmental factors determine (at least partly) the affective-motivational state of a person, and as affective-motivational state is a significant component of pain, it is suggested that manipulation of social context and environmental features can influence the interpretation of a painful stimulus.

RESEARCH AIMS

The aim of this thesis was to investigate the effects of social, contextual and environmental factors on the interpretation of a pain stimulus. The research reviewed above shows pain to be a multidimensional experience, which includes both sensory-discriminatory and affective-motivational components. The affective-motivational component is responsible for the 'suffering' associated with human pain; the negative emotional and psychological response to a pain sensation, the sense of 'unpleasantness' associated with the pain stimulus, and the motivation to avoid it.

It has been shown that social learning is strongly implicated in the development of long-term cognitive structures associated with constructs such as gender-role stereotypes and expectations, self efficacy, locus of control and neuroticism. These have been shown to influence patterns of emotional arousal in response to pain and as such are reliable predictors of pain response. Painful events generate strong affective responses in themselves, and the affective-motivational component of pain is usually associated with, and spoken of in terms of being a component of the *response* to a painful event.

However, the evidence reviewed above has shown that *all* information entering higher areas of the central nervous system undergoes some level of emotional processing, thus human interaction with the environment cannot be without an emotional quality. Evidence provided by research into automaticity described above suggests that individuals monitor their environment constantly, and that the emotional valence of features in the environment has a direct influence upon the basic affective-motivational state of an individual. In other words, the net valence of emotionally salient information signalling the relative safety or danger (potential for harm) within the current environment determines basic affective-motivational state (positive/approach or negative/avoidance). This process has been described as 'universal and unconditional' and has been shown to have measurable behavioural and emotional consequences.

This being the case, the research question is: Can differences in social, contextual and environmental factors influence the perception of a pain stimulus?

Whilst the presentation of emotionally valenced words or images have been shown to have an effect on affective-motivational state, these stimuli are often presented through means which would not usually occur in natural situations (e.g. flashing emotionally valenced words or images on a computer monitor). But what of factors which are inherent in more natural conditions such as clinical situations? Are there features of normal interactions preceding an acutely painful procedure, which are likely to influence significantly the perception of a pain stimulus?

A series of experiments were conducted with the aim of investigating the influence of contextual factors on the perception of a pain stimulus. In other words, factors which, in light of the research reviewed above, are likely to influence the affective-motivational state of the individual by altering the meaning of the situation as perceived by the individual.

Two experiments were conducted to assess the validity of a pressure algometer designed and built by the author for the purposes of this investigation (see general methods), and used in conjunction with subjective pain rating using visual analogue scales (VAS). Three experiments were designed to test the influence of social and environmental factors (i.e. factors other than intensity or quality of the pain stimulus) on the perception and reporting of pain. The factors under investigation represent three common facets of clinical and research situations: The perception of the context according to the information provided within the situation (**what is said**), the activation of sex stereotypes within the social dyad (**who says it**), and the evaluation of features of the environment in which a pain stimulus is applied (**where it is said**).

What is said

In clinical and experimental situations, the context as perceived by an individual is determined largely by the information provided by the clinician or researcher. The provision of information within these dyads is usually one-way (i.e. from clinician to patient) informing the patient or participant of what they may expect to happen (providing predictability). This facilitates the adoption of congruent roles within the dyad (e.g. Pitts, 1993b; Taylor, 1979), and a function of this interaction is a shift in the locus of perceived control (Taylor, 1979).

The perception of the context is one determinant of the affective-motivational state of the individual, and as discussed above, individual differences in cognitive structures activated by features of the environment determine individual differences in the interpretation of an event. Therefore, it was expected that changes in the perception of the nature of the context in which a pain stimulus is applied would result in changes in the experience of the pain stimulus, subject to individual differences in chronic trait activation.

Who says it

One step down from the explicit nature of the provision of information within a given situation is the implicit nature of social stereotypes. Aside from the stereotypes of 'doctor' 'nurse' and 'scientist', clinicians and researchers are people and possess individual characteristics. For example, a clinician can be female, male, black or white or any combination of these and many other characteristics.

The acquisition of gender roles through social learning (Chapter Two) influence not only what behaviours are appropriate for one's self as a member of a gender category within a given culture, but what behaviours a person might reasonably expect from members of the opposite sex within that culture. Exposure to members of these groups (males and females) is much greater than exposure to 'construct' groups such as clinician and researcher, thus the male and female sex stereotypes and expectancies concerning the behaviour of each category are likely to be more deeply ingrained than for 'doctor' or 'scientist' stereotypes.

As shown, the activation of stereotypes and stereotype trait constructs has been shown to result in changes in behaviour that are congruent with the stereotype or construct activated (e.g. Bargh, 1988; Bargh, Chen et al., 1996; Bargh & Ferguson, 2000), and that are confirmatory of the expectations held by the individual concerning the stereotype (e.g. Chen & Bargh, 1997). Therefore, it was expected that stereotype activation occurring as a result of the social dyad (the mere presence of a male or a female) would influence the perception and reporting of pain in a way that is congruent with the sex stereotype.

Where it is said

Automatic evaluation of features in the environment is a universal and unconditional process that has direct effects on affective-motivational state and subsequent interpretation of events. Thus, beyond the explicit facet of social interaction and the implicit factors of social stereotypes, are non-social objects and features of the environment which are automatically categorised as good or bad, providing information concerning the safety or otherwise of the immediate situation. The results of this evaluation elicit directly a general behavioural propensity to either approach or avoid a stimulus (Chen & Bargh, 1999). Therefore, it was expected that the mere presence of negatively valenced attitude objects in the environment would influence the perception of a pain stimulus.

It should be noted that the objective of these studies was not to establish or test for the existence of automatic effects that have already been shown, but taking these preconscious automatic effects as given, to investigate their influence, in ecologically valid conditions, on the interpretation of a potentially painful event and subsequent response to a pain stimulus. Thus, the purpose was to bring together two (largely disparate) areas of psychological investigation (models of automaticity and pain research), and in doing so, to investigate whether the automatic (preattentive) effects described above could account for within-individual variation in the perception and reporting of pain.

CHAPTER 5

GENERAL METHODS

Ethics and other considerations

By definition ethics applies equally to all research involving human participants. However, research involving the administration of noxious stimuli carries with it particular ethical considerations as a result of the increased potential for harm, and is therefore in a sense, first among equals. Every effort was made to ensure that the research conducted for this thesis adhered to the Ethical Guidelines for Research with Human Participants, as laid down in the British Psychological Society Code of Conduct, Ethical Principles and Guidelines (Appendix VIII). As such, all participants were of an age and condition that allowed them to provide informed consent and participants were provided with information concerning all aspects that might reasonable be expected to influence the provision of consent (section 3; 3.1). In experiments involving repeated measures, consent was obtained at the start of each measure (section 3; 3.9). The rights of the participants to halt or withdraw from the experiment at any time, or to withdraw retrospectively their consent and to require that their data be destroyed were stated explicitly at the start of each experimental session (section 6; 6.1).

No participant was directly misled. Where it was not possible to reveal the full experimental objectives without compromising the experiment, or where through necessity, information was withheld, it was determined through consultation with colleagues and non-participating members of the participant population that the information withheld would not result in any negative effects once it was revealed during debriefing (sections 4; 4.1 & 4:4.3). All participants were fully debriefed after their participation. The debriefing revealed fully the objectives of the research and the nature of any manipulation involved. All participants were given the opportunity to have answered any questions they may have had concerning the experiment, and all participants were provided with contact details of the principal researcher should any issues arise at a future time (sections 5; 5.1 & 8; 8.2).

All participants were assured of confidentiality and anonymity. In experiments involving repeated measures, where it was necessary to ensure that data collected from a participant at one time point could be related to subsequent measures from the same participant, this was achieved through coding. No information that would allow the identification of any participant was recorded (section 7; 7.1).

Research conducted on the premises of the University of Westminster (Experiments 1, 4 and 5) was covered by the University Ethics committee based at Northwick Park. Experiments 2 and 3 were conducted off University premises and in these cases the research conformed to the ethical principles and guidelines as laid down by the relevant institutions.

Experiment 2 was conducted in the Clinical Neurophysiology department of Great Ormond Street Hospital. Ethical approval was granted by the Ethics Committee of The Hospital for Sick Children, Great Ormond Street. Experiment 3 was conducted in a cubicle adjacent to the Renal Transplant Unit of the Royal Free Hospital in Hampstead. Ethical approval was granted through Chairman's action by Dr. Pegg, Chairman of the Ethics Committee of The Royal Free Hampstead NHS Trust. Both institutions required that participants were provided with form giving full information concerning the study in which they were to participate, conforming to the principle of informed consent (see Appendix III). Volunteers participating in these studies were also required to sign a consent form.

Pain stimuli

The administration of pain stimuli through any modality (e.g. mechanical, electrical, thermal, or chemical), will always carry the risk (however slight) of long-term damage or actual tissue injury. Further, a major criticism of pain research is that pain induced experimentally in a laboratory setting does not relate to pain experienced in a clinical setting, and thus lacks ecological validity. The aim therefore, was to select a method of pain stimulus that would avoid unnecessary suffering, that was high in ecological validity and was as low as possible in the potential for harm. There are many pain induction techniques available, most of which have been developed for specific purposes. However, each has advantages and disadvantages.

Electrical stimuli

Electrical stimulation is commonly used as pain stimulus in animal and human pain research (Handwerker & Kobal, 1993), principally because it is easy to control. However, electrical stimuli excite afferent fibres in an unnaturally synchronised fashion. They also excite all types of peripheral nerves, both small and large, and activate the fibre directly, bypassing the receptor. Whilst low voltage currents applied peripherally may hold little potential for actual harm, the unnatural nature of the stimulation means that this method is low in ecological validity.

Chemical stimuli

Chemical pain stimuli have been developed for particular purposes and are often used to selectively excite nociceptive nerve endings and to study inflammatory processes (Handwerker & Kobal, 1993). These substances may be applied in a variety of ways (e.g. topically, or subcutaneously). However, should the participant request that the stimulation be removed, it is difficult to stop the chemical action immediately. Moreover, many of these chemical hold the potential for harm. For example, Capsaicin ($C_{18}H_{27}NO_3$), the active ingredient found in hot peppers, is often used to research inflammatory responses. As with electrical stimulation in the form of Transcutaneous Electrical Nerve Stimulation (TENS), capsaicin also has applications in pain control. Capsaicin cream is also used to treat the neuropathic pain of post-herpetic neuralgia. Application of capsaicin causes a burning sensation, but a part of its function is to allow an influx of calcium ions to enter the neuron, and extended exposure to calcium ions causes the fibres of the neuron to die.

Thermal (heat) stimuli

Tonic heat stimuli are not used in pain research as prolonged exposure to heat at noxious levels quickly results in damage to the skin. Studies using radiant or contact (thermode) heat stimulation tend to be used to study specific small (myelinated and non-myelinated) fibre neuropathy and abnormalities in heat sensation (see for example Dyck et al., 1993). Thermal stimuli is known to primarily involve C-fibre activation, which makes this form of pain stimuli less suitable for more general pain research. Moreover, there appears to be a low density and variable distribution of thermal receptors over the surface of the body, compared to the denser and more generalised distribution of cold and pain receptors (Dyck et al., 1993).

This may account for the often unpredictable results shown in studies using thermal stimulation discussed in Chapter Two, where some researchers have found that females rated supra threshold thermal pain stimuli as significantly more painful than males (e.g. Feine et al., 1991; Fillingim et al., 1998), whilst others have found no such difference (e.g. Bush et al., 1993; Lautenbacher & Rollman, 1993).

Thermal (cold) stimuli

A commonly used experimental stimulus is the cold pressor test. This involves the participant immersing their hand and distal forearm in water held at a temperature between 1°C and 4°C. The pain is thought to be a result of the activation of deep nociceptors associated with large veins. Pain occurs as a result of vasoconstriction as the temperature of deep tissue layers rapidly decreases (Handwerker & Kobal, 1993). The pain is quite intense and the onset of pain is almost immediate, hence the cold pressor test is usually used as a measure of pain tolerance rather than threshold. However, unlike most acutely painful clinical procedures, the cold-pressor test is self-administered. The pain is a result of the action of the participant and not the researcher. Therefore, whilst undeniably effective as a method of pain induction, it was thought firstly, that the cold pressor test would induce greater pain than necessary in light of the nature of this investigation. Secondly it was thought that as the cold-pressor test is a self-administered stimulus, the locus of perceived control would be different (and therefore not comparable) to clinical situations in which painful stimuli are applied to the patient by another.

Mechanical stimuli

Mechanical stimuli in the form of pressure (force) is easy to control, and evokes a deep, tonic pain (Janal, 1996; Kosek, Ekholm, & Nordemar, 1993; Kosek & Hansson, 1997). As discussed in Chapter Three, mechanical stimuli of sufficient intensity to evoke the experience of pain activates both Aδ and C fibres (p 41), and is generally considered to equate to the experience of acute (non-experimental) pain (Bartholomew, Lewis, Linder, & Cook, 1996). Moreover, measures of pain threshold using mechanical stimuli means that the stimulus is removed at the advent of pain, thus the suffering of the participant is kept to an absolute minimum. Of all methods available therefore, mechanical pain stimulation was considered the most ecologically valid, and the most ethically acceptable.

Measures

Pain stimulus: The Pressure Algometer

The application of pressure (force) is one of the oldest methods of inducing experimental pain. Manual palpation used as a diagnostic tool to assess sensitivity is at least as old as physical therapy. However, the need for reproducibility and quantification of manual pressure gave rise to the development of the pressure algometer, which has also gone under the names of dolorimeter (Fischer, 1987), palpometer and pressure threshold meter (Hogeweg, Langereis, Bernards, Faber, & Helders, 1992).

As noted above, pressure pain stimulus evokes a deep pain (Janal, 1996; Kosek et al., 1993; Kosek & Hansson, 1997),which is thought to be closely related to the experience of acute, non-experimental pain (Bartholomew et al., 1996). Evidence for the ecological validity of pressure algometry as a measure of pain threshold has been found in the investigation of individual differences in pain. For example, in their meta-analysis on gender differences in the response to noxious stimuli, Fillingim & Maixner (1995) concluded that sex associated differences occur most consistently with pain induction techniques that produces deep, tonic pain sensations similar to those experienced in the natural environment. On the other hand, evidence for sex associated differences in pain responses has been inconclusive in studies employing electrical or thermal pain stimuli (e.g. Bush et al., 1993; Lautenbacher & Rollman, 1993).

There are a range of pressure algometers currently available, for example, Kosek et al. (1993) used a Somedic® hand held pressure algometer. This consists of a pistol-grip with a pressure sensitive strain gauge at the tip and is used by pushing the tip of the algometer onto various body surfaces. Mersky and Spear (1964) used a simple pressure algometer consisting of a plunger mounted on a calibrated spring, rather like the inverse of the spring scale used by fishermen. Reeves et al.(1986) and Fischer (1987) used a Pain Threshold Meter Model PTH-AF2, which consists of a plunger which drives a pointer round an analogue dial calibrated in kg/cm^2, while Jensen et al. (1986) used a pressure algometer similar to the Somedic®, consisting of an acrylic handle shaped like a large pen, with a pressure-sensitive strain gauge at the tip. This is connected to a power supply and an amplifier, which in turn is connected to a pen recorder.

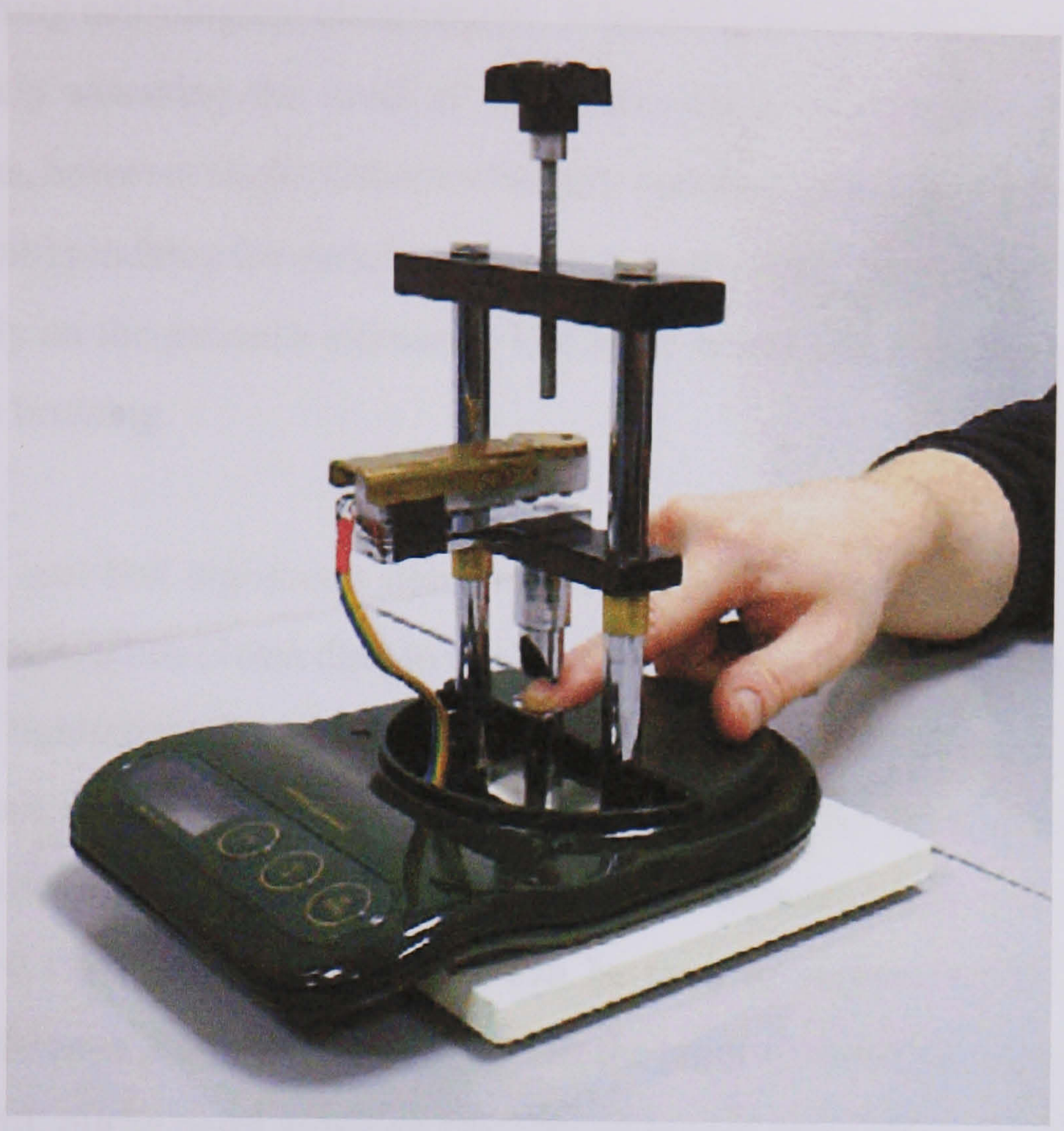

Figure 5. The nail-bed pressure algometer. A participant's hand can be seen in position.

As mentioned, all currently available algometers (e.g. the Somedic®), require that the tip of the instrument be pushed with varying force into soft tissue. Although such instruments come with a range of tip sizes, (e.g. circular discs ranging from 0.5 cm^2 to 2.cm^2 in area), the application of force to soft tissue will always carry the risk (however small) of bruising.

When researching clinical pain, such as myofascial trigger point sensitivity (e.g. Delaney & McKee, 1993; Reeves et al., 1986), patients with arthritis (e.g. Gerecz Simon, Tunks, Heale, Kean, & Buchanan, 1989; O'Driscoll & Jayson, 1975) or post operative pain (e.g. Dahl, Rosenberg, Molke Jensen, & Kehlet, 1990), the application of force to specific soft tissue target sites is unavoidable. However, for the purposes of this thesis (and other research in which the site of pain stimulus application is not considered a factor), the prototype algometer is thought to provide an advantage by virtually eliminating the risk of soft tissue trauma.

The reliability and validity of pressure algometers has been investigated for many years. In general, the results of such studies have indicated a high degree of reliability (see for example Brennum et al., 1989; Fischer, 1987; Jensen et al., 1986; Mersky & Spear, 1964; Reeves et al., 1986). Some investigators have reported an increase in PPT over time. Jensen et al. (1986) recorded an increase in PPT over five consecutive determinations at weekly intervals. Kosek et al. (1993) reported no change in mean PPTs between the first and second session one week apart, but a significant increase in PPTs at the third session approximately ten weeks later. However, they note that most of their subjects had their summer vacation between the second and third session and suggest that it is possible that their subjects were less strained and fitter, which may have influenced the measurements.

Other researchers report no such increase, for example Ohrbach and Gale (1989) report no differences between sessions for eight consecutive weeks after the first session. Differences in Pressure Pain Threshold (PPT) have been found in different anatomical locations such as muscle bellies, joint capsules, nerve tissue and ligaments (Kosek et al., 1993), nonetheless, pressure algometry has been shown to be reliable within subjects, that is, PPTs obtained from any one point on any one participant tend to be reliable over repeated measures. The high degree of reliability reported applies across the range of pressure algometers and output modes.

All these pressure algometers are used in essentially the same way, in that they all involve the tip of the instrument being pushed with some force onto soft tissue. Brennum et al. (1989), using the Somedic® reported that following PPT measurements, skin indentations were seen in most subjects which could last for hours. They state that it is thus possible that a decline in pressure pain threshold could have been found if the measurement had been repeated at a later time when a local inflammatory response may have developed.

With this in mind, the author developed a prototype algometer that would deliver a safe and scalable mechanical pain stimulus, but which would avoid the application of force to soft tissue (Figure 5. See Appendix I for details).

The application of nail-bed pressure is common custom and practice on hospital wards by nurses performing neurological observations. It is one of several 'rough guide' techniques used for quickly assessing the level of unconsciousness of a patient, without causing physical trauma, however slight. Other techniques include supra-orbital pressure (using the ball of the thumb) pinching the earlobes, or medial-sternal pressure (applied by rubbing the knuckles firmly on the patient's sternum). The latter is less commonly used as it is more likely to cause bruising.

The prototype nail-bed algometer delivers a scalable force via a 1.5cm straight edge rounded to 0.5mm radius (1mm dia.) to the lunula of the nail of the index finger. The force is applied by tightening the screw (Figure 6, top), and is read from a digital display (invisible to participants during use) calibrated in grammes. By replacing the screw with a weight of a known value, the scale can be calibrated between trials, and is known to be accurate to ± 0.1% (5g). The algometer can be used to measure either pressure pain threshold or tolerance. Participants report either the point at which the increasing pressure becomes painful, or the point at which they are no longer prepared to tolerate the pain.

The weight of evidence shows pressure algometry to be a safe, simple and reliable method of inducing experimental pain that is ecologically valid, inducing acute pain which shares the same qualities as acute pain suffered in the natural environment. The application of pressure to the nail-bed causes the area to blanch whilst the pressure is applied, but causes no lasting effects; it leaves no soft tissue indentation, carries no risk of bruising or other soft tissue trauma and produces no local inflammatory response.

Moreover, in trials during the construction of the algometer, it was consistently reported by volunteers that the point at which the increasing pressure became painful was abrupt and 'obvious'. It also lacks the 'unpleasant' pre-pain quality that can occur applying force to soft tissue in certain areas, for example, the area between the thumb and forefinger, which induces an unpleasant, dull sensation that is hard to classify as pain. This being the case, it makes the application of force to the nail-bed an ideal method for experimental pressure pain threshold measures as used in this investigation.

The International Association for the Study of Pain (IASP) define pain threshold as " *the least experience of pain which a subject can recognize*". The IASP note that traditionally pain threshold has been defined as the least stimulus intensity at which a subject perceives pain. Moreover, that it has been common for most pain research workers to define pain threshold in terms of stimulus intensity. The IASP point out that pain threshold is the experience of the subject whereas the stimulus intensity measured is an external event, and that the stimulus is not pain and therefore cannot be a measure of pain (IASP, 1994). The IASP acknowledge however, that the threshold stimulus can be recognized as such and measured. Therefore, taking into consideration the IASP definition of pain threshold, for the purposes of this investigation, PPT is defined as the stimulus intensity at which the participant reports the advent of pain.

Pain Rating: The Visual Analogue Scale

There are a number of pain measures available, such as verbal descriptor scales, category scales and Visual Analogue Scales (VAS). Any of these may be appropriate for use in this type of investigation. However, the VAS was chosen as there is considerable evidence that it fulfills most, if not all of the criteria for an ideal method of pain measurement (Price & Harkins, 1987).

A major advantages is that these scales are quick and easy to administer with minimal instruction. This is an important practical consideration in investigations employing more than one measure per trial. Also, being simply a ten centimetre line anchored at each end by a simple descriptor (from 'no pain', to 'the worst possible pain'), it is more likely these scales have essentially the same meaning to different subjects. This is not the case with verbal category scales as any given adjective does not necessarily have the same meaning for different people, and the choice of response option can influence the response (Duncan, Bushnell, & Lavigne, 1989; Gannon & Ostrom, 1996).

In an overview of pain measurement, Chapman et al. (1985) conclude that of the two primary methods of subjective pain reports (VAS and category scales), visual analogue scales are more sensitive, just as valid and may be more reliable, as category scales may produce artificially augmented scores. Moreover, when response categories are taken at face

value, it is difficult to specify the size of each category and whether the categories are of equal spacing. A further advantage to the VAS over category scales, is that it provides a large possible response continuum (100 for practical purposes), between two semantic absolutes. Category scales, on the other hand, may have a tendency to restrict the subjects response to the categories presented by the scale, though the boundaries of each category cannot be known as it will vary from individual to individual (Chapman et al., 1985).

A study by Duncan et al. (1989) comparing the verbal descriptor checklist and visual analogue scales concluded that both visual analogue and verbal descriptor measurement techniques successfully quantify both sensory intensity and affective aspects for noxious and near-noxious temperatures. However, they note that data derived from the verbal descriptor scales showed that participants rated the painful temperatures as relatively more intense than unpleasant. A difference which could not be detected using the visual analogue scales.

They conclude that while both visual analogue and verbal descriptor techniques successfully quantify sensory intensity and affective aspects of pain, verbal descriptors may provide the more sensitive tool for separating intensity and unpleasantness. However, a weakness of verbal descriptor scales is that they imply that as pain increases beyond a level described as, for example "*discomforting*" it is replaced by an experience described as "*distressing*" (Price & Harkins, 1987). As Price and Harkins note, this is not necessarily the case as pain may just as easily pass from being discomforting to being frustrating or irritating.

Visual analogue scales have been shown to be quick and simple for participants to understand and to use; requiring minimal instruction, and as reliable and sensitive as other, more complex instruments, whilst avoiding some of the pitfalls associated with them. Visual analogue scales represent an efficient way of quantifying subjective pain experience in a manner that means essentially the same to each participant, without unduly influencing (by providing adjectives that the subject may not necessarily have chosen under the same circumstances) or forcing (by limiting the subjects responses to pre-set categories) the participant response.

The data yielded by VASs are straightforward. Although some researchers choose to treat the data obtained from VASs non-parametrically (Chapman et al., 1985), many consider multidimensional VASs to be a convenient method to quantify the intensity and unpleasantness of pain in a way that is appropriate for parametric analysis (Chapman et al., 1985; Duncan et al., 1989).

Why Combined Measures?

As pain is a multidimensional experience involving physiological, psychological and emotional components, it makes sense to use an experimental method which would address these different components. Price and Harkins (1987) assert that separate measures of pain sensation, intensity and affect are necessary for assessing psychological and contextual influences on the experience of pain and subsequent behaviour. Measures of PPT have been classed as 'semi-quantitative' (combined subjective and objective) (e.g. Dahl et al., 1990) and require minimal processing by participants. On the other hand, pain rating, where participants are required to quantify the pain experience, is entirely subjective and requires a deeper level of processing and interpretation by the participant.

At face value it might seem pointless to ask participants to quantify their pain experience at pain threshold stimulus intensity. Intuitively, one might expect that as pain threshold signals the advent of pain, subsequent quantitative measures of pain intensity would be just above "*no pain*". However, such an expectation assumes a direct correspondence between stimulus intensity and subjective experience. It also assumes that these tools measure *only* what they purport to measure.

Chapman et al. (1985) in a review of pain measurement methodology note that a common problem is that use of VAS assumes pain to be a unidimensional experience that varies only in intensity. But to assume that a pain intensity rating scale measures only the intensity or 'amount' of pain contradicts the multidimensional nature of the pain experience. The experience of pain, by definition, must contain all the elements that make it 'painful', including the affective motivational component. Therefore, it seems likely that any subjective measure of pain intensity will be influenced by the current affective-motivational state and interpretation of the situation as a whole, and reflect not only the stimulus intensity, but the degree of unpleasantness associated with it.

The evidence presented in Chapters Three and Four suggests that any method of assessing pain intensity (including VAS), is in fact a measure of the sum of the multidimensional pain experience, reflecting a combination of perceived intensity and emotional-motivational response to the situation. Similarly, measures of PPT, whilst in themselves measuring only stimulus intensity at pain threshold, reflect more than just the advent of pain. It is suggested that they will be influenced by evaluation of the context and the subsequent affective-motivational state of participants. Thus it is proposed that observations of the relative changes between measures of PPT and subjective pain rating (VAS) will provide a greater degree of information than either measure alone.

Methods

Experimenter

The experimenter in all Experiments was a white male, 36 - 41 years of age. The same experimenter conducted each Experiment. For Experiment 4 investigating the effect of experimenter sex, a female experimenter was paired with the male experimenter. She was of an equivalent age and of the same ethnic background as the male experimenter.

Participant inclusion/exclusion criteria

All participants were healthy adult volunteers. Participants from the student body of the University of Westminster were recruited under the University research participation scheme[3]. No financial or other incentive was offered to potential volunteers. All volunteers needed to be healthy, and of sufficient age to provide consent (>16 years). Exclusion criteria were that volunteers should not be suffering from any chronic pain condition. Volunteers should not be suffering from any arthritic or osteoporotic condition, particularly of the hands. Volunteers should not currently be taking any form of analgesia.

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3 The research participation scheme is a method of encouraging active participation of undergraduate students of Psychology in practical research. All students of Psychology at the University of Westminster are required to become involved in research, either as participants or assistants for a total of 3.5 hours over the course of their first year. All students have the option of not participating, in which case they are required to write a short essay.

Materials

In all Experimental trials, the nail-bed pressure algometer was used to take measures of PPT. Subjective ratings of pain were taken using a 10cm VAS scales, anchored at each end from "*No pain*" to "*The wost pain imaginable*" (Appendix I).

General procedure

Prior to measures of PPT, participants were instructed on the use of VAS scales, (and the LOC questionnaire and category scales for Experiment 3). As soon as participants indicated that they were clear on the use of these scales, they were given a standardised briefing: "*Place your finger on the rest and when you are ready, I will begin to increase the pressure slowly. As soon as you feel that the pressure has become painful, say stop, and I will stop. As soon as the measure is complete, please indicate how much pain you felt using the VAS scale*".

To obtain pressure-pain threshold measurements, participants placed the index finger of their dominant hand on the finger rest (see Figure 6). The experimenter zeroed the scale and when the participant was ready, began to apply pressure at a rate of approximately 100 g s^{-1} as measured by the sweep hand of a watch. Once the participant reported pain threshold, the pressure was removed and the force was recorded. The participants then rated the pain using the 10cm VAS (from "*No pain*" to "*The wost pain imaginable*"). Prior to dominant hand PPT measures, each subject underwent a familiarisation trial, using their non-dominant hand.

CHAPTER 6

EXPERIMENTAL SECTION

Experiments 1 and 2 were designed as validation studies. They were conducted principally in order to establish the reliability and validity of the prototype nail-bed pressure algometer (VASs already having been validated as a reliable measure (e.g. Chapman et al., 1985)). Experiment 1 examines the test-retest reliability of the nail-bed algometer, and Experiment 2 examines the sensitivity of the nail-bed algometer to an intervention known to be effective in moderating deep, tonic pain; vibration stimulation.

VALIDATION STUDIES

EXPERIMENT 1: TEST - RETEST RELIABILITY

Introduction

The aim of this Experiment was to assesses the test-retest reliability of the nail-bed pressure algometer and the combined measures protocol. As discussed above, the pressure algometer as a method of experimental pain induction has been shown to provide highly reliable measures of stimulus intensity at pain threshold within participants. In other words, PPTs obtained from any one point on any one participant tend to be reliable over repeated measures. Therefore, it was expected that under stable conditions (the same environment and the same experimenter), the nail-bed algometer would provide reliable measures of pain-threshold stimulus intensities over repeated measures.

Methods

Design

Using a repeated measures design, 5 consecutive measures of PPT and VAS pain rating were taken at weekly intervals.

Participants

The participants were 22 healthy first-year student volunteers who had responded to advertisements placed on the University research participation scheme noticeboard.

The sample consisted of 7 males and 15 females (mean age 30 years, SD 8.26 years, range 19 - 57 years). 3 were left handed (two male, one female).

Procedure

The experimental trials were conducted in an empty classroom in the University of Westminster. Measure of PPT and VAS pain rating were taken (as detailed in general methods) at weekly intervals for five consecutive weeks. Each participant was tested individually in the same room, at the same time of day, on the same day of the week at each trial. At the first session the participants were briefed on the procedure and on the use of Visual Analogue Scales. For all subsequent sessions, the participants were simply asked if they knew what to do and if they had any questions. The rights of the participants to halt or withdraw from the study were re-stated at the start of each trial. After the final trial, all participants were given a full debriefing concerning the nature and objectives of the Experiment and asked if they had any questions or issues concerning their experience.

Results

The data recorded consisted of five measures of PPT and five measures of VAS pain rating. Figure 6 presents the means and standard deviations of PPT values and pain ratings for all 22 participants over five successive weeks.

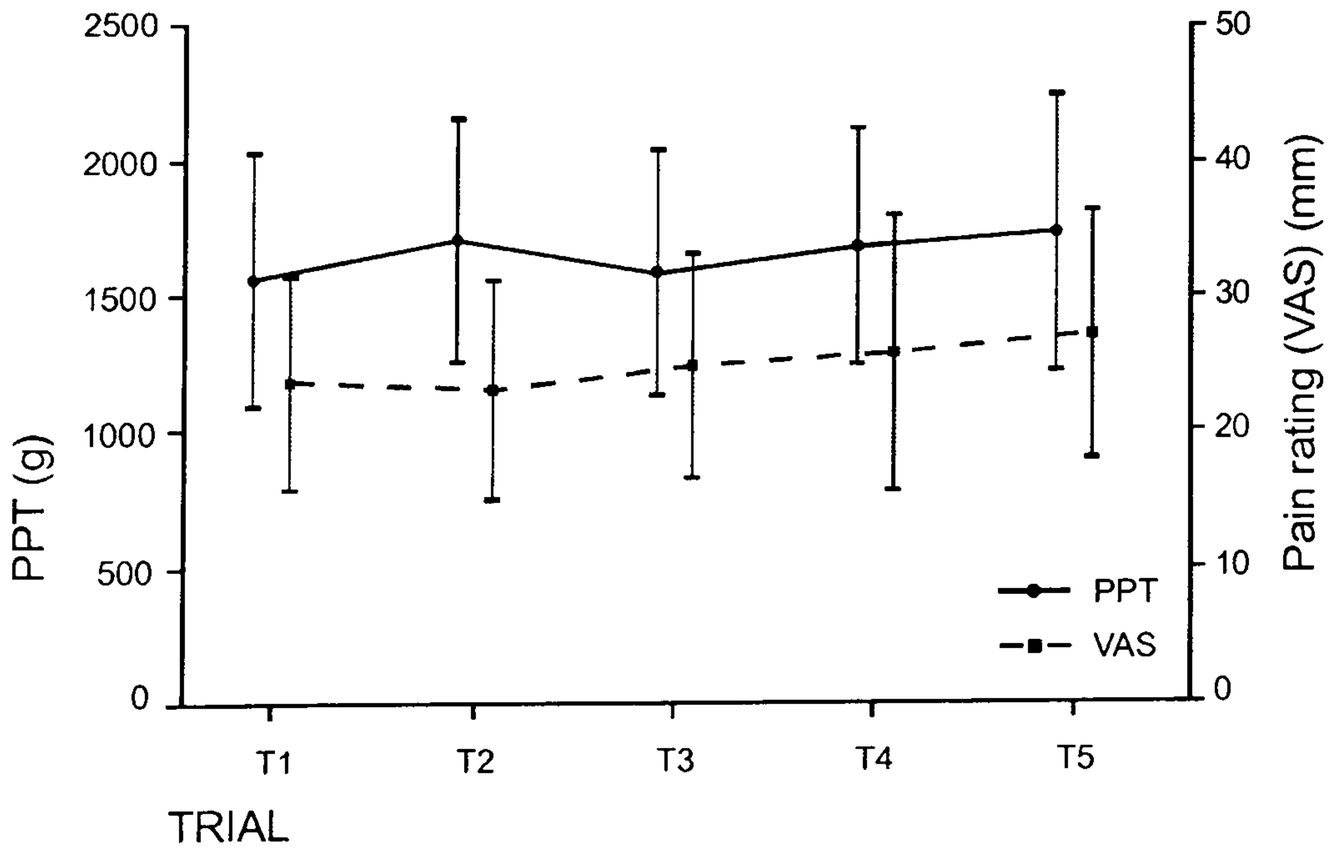

Figure 6 Means for PPT and VAS scores over 5 trials. Error bars present ± 1 standard deviation.

The large (but stable) standard deviations and the large ranges (Table 1) for PPT and VAS reflect a wide distribution of pain thresholds and subjective pain ratings between-participants. However, the Standard Errors of the means (Table 1) suggest that the measures are reliable over the series of trials, indicating that pain thresholds are stable within participants.

Table 1. Ranges (SE Means) of PPT and VAS pain ratings over 5 trials.

TRIAL	1	2	3	4	5
PPT (g)	3720	3850	4135	3555	4300
	(202.37)	(193.26)	(194.35)	(188.52)	(219.02)
VAS (mm)	55	51	49	78	66
	(3.99)	(3.45)	(3.53)	(4.31)	(3.98)

The data were analysed using repeated measures ANOVA. There were no significant main effects for either PPT ($F_{4,84} = 0.581, p = 0.68$) or VAS pain rating ($F_{4,84} = 1.499, p = 0.21$) over five trials.

As examples of the relationship between-trials for PPT and VAS measures, Figures 7 and 8 present the data from the trials furthest apart (first trial measures against the last trial measures) for measures of PPT and VAS pain ratings (respectively).

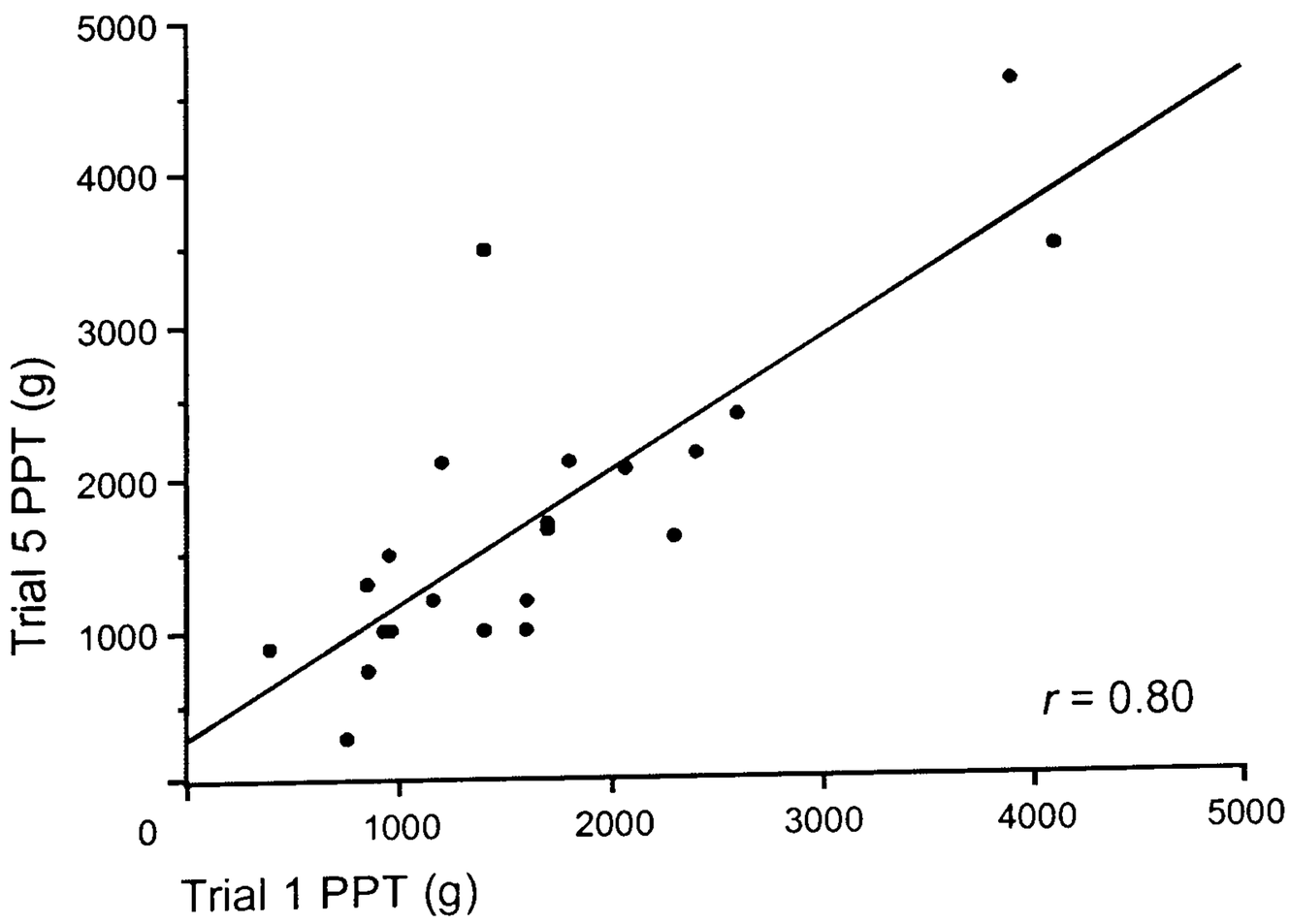

Figure 7 Relationship between trial 1and trial 5 PPTs

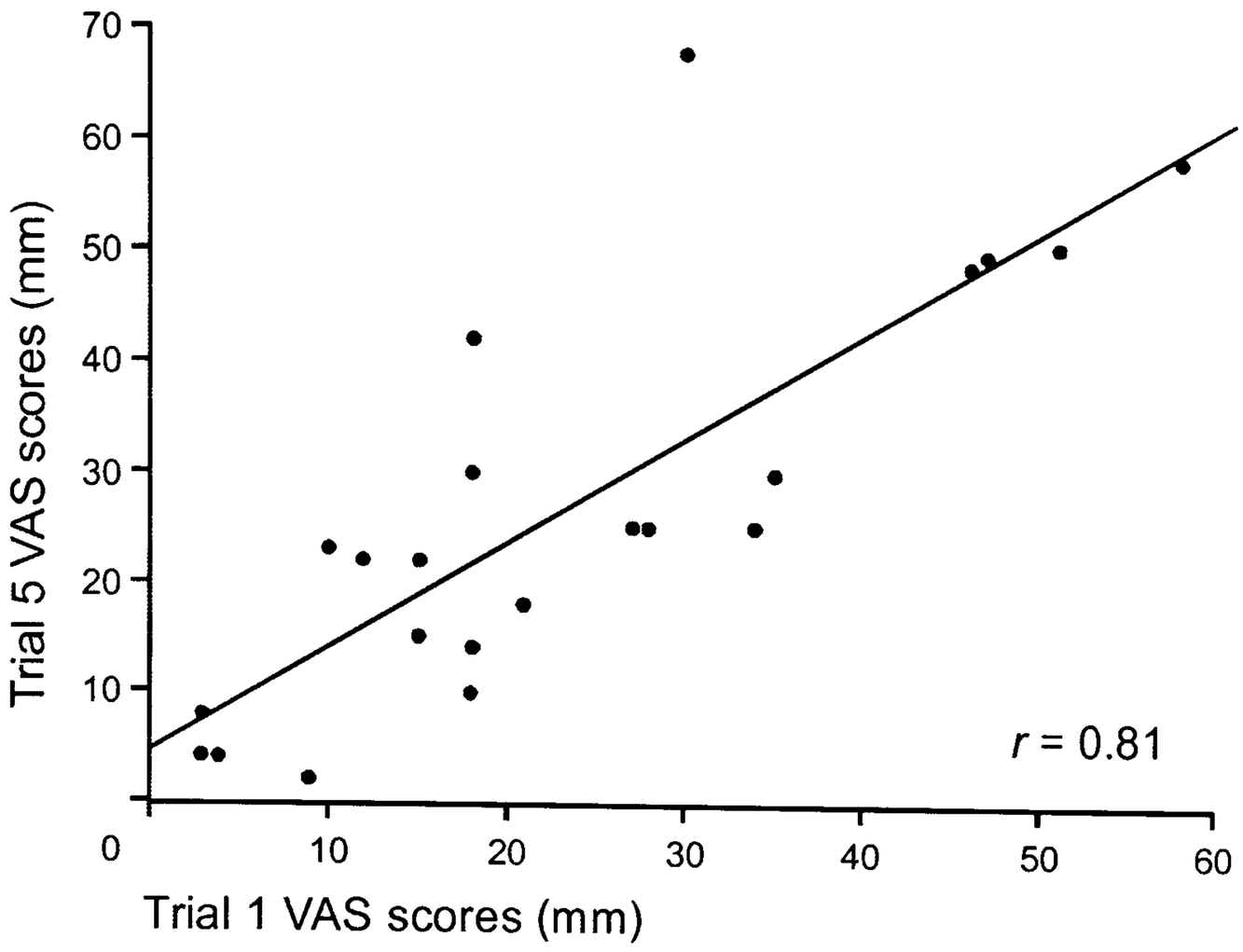

Figure 8 Relationship between trial 1 and trial 5 VAS pain ratings.

Pearson product-moment correlations revealed strong between-trial correlations for both PPT and VAS (Tables 2 & 3).

Table 2. Pearson's product moment correlation coefficients for measures of PPT by trial.

CORRELATIONS	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4
TRIAL 5 (*N*22)	0.802**	0.924**	0.835**	0.950**
TRIAL 4 (*N*22)	0.815**	0.936**	0.824**	-
TRIAL 3 (*N*22)	0.630*	0.773**	-	-
TRIAL 2 (*N*22)	0.925**	-	-	-

* $p < 0.005$ (2-tailed)

** $p < 0.0005$ (2-tailed)

Table 3. Pearson's product moment correlation coefficients for VAS pain ratings by trial.

CORRELATIONS	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4
TRIAL 5 (*N*22)	0.811**	0.923**	0.938**	0.981**
TRIAL 4 (*N*22)	0.770**	0.882**	0.890**	-
TRIAL 3 (*N*22)	0.811**	0.965**	-	-
TRIAL 2 (*N*22)	0.893**	-	-	-

** $p < 0.0005$ (2-tailed)

The mean correlation coefficient for PPT was 0.84 and the mean correlation coefficient for VAS pain rating was 0.89. There were no significant correlations between PPT and VAS on any trial.

Discussion

The aim of Experiment 1 was to assess the test-retest reliability of the nail-bed pressure algometer and the combined measures protocol (the use of nail-bed pressure algometry in conjunction with subjective pain rating). The results of this study demonstrate a high degree of test-retest reliability and are in accordance with those of other studies (see for example Brennum et al., 1989; Fischer, 1987; Jensen et al., 1986; Mersky & Spear, 1964; Reeves et al., 1986).

The strong between-trials correlations for both PPT and VAS pain rating show that the values obtained from any participant from each trial are highly predictive of values from the same participant over subsequent trials under stable conditions. This suggests a high degree of stability for pain threshold within participants. Also shown are large between participant variances for PPT and VAS pain rating, indicated by the large standard deviations and ranges recorded. Due to individual differences and the personal and subjective nature of the pain experience, this was to be expected.

Although it has been argued that it is a matter of dispute whether there is such a thing as a measurable pain threshold (Mersky & Spear, 1964), numerous investigations since then, which have demonstrated reliable measure of PPT, and also Experiment 1 presented above, suggest that there is such a thing. Whilst it is acknowledged that PPT is a measure of stimulus intensity at the advent of pain rather than pain *per se*, it is highly improbable that participants tested for PPT could report a reliable cut-off point for an increasing stimulus intensity over five consecutive trials, each a week apart, without there being some kind of cue.

It is suggested therefore that the reliability of such measures is in itself an indication of validity, in so far as the most probable cue a participant has for reporting the same cut-off point to a stimulus of increasing intensity over repeated trials (all else being equal) is the advent of pain; a pain threshold. This in turn suggests that under stable conditions, pain threshold in response to a given stimulus applied to the same location is stable within participants.

As mentioned previously, the large between participant variance shown for PPT and VAS pain rating are a function of the subjective nature of pain rating and as such, are to be expected. Jensen (1986) stated that due to high inter-individual variation, determinations of PPT for group comparisons should include large sample populations, whereas in paired studies, the relatively small intra-individual variation allows the investigation of much smaller groups. The results of this study are in accordance with this view and show that this approach is appropriate for further experiments in this investigation.

EXPERIMENT 2: THE EFFECT OF VIBRATION ON PRESSURE-PAIN THRESHOLD AND SUBJECTIVE PAIN RATING

Introduction

Having shown that the nail-bed pressure algometer provides a reliable measure of PPT, the next step was to assess its sensitivity to an intervention known to be effective in the moderation of pain. Vibration has long been acknowledged as an effective intervention for the mediation of many forms of pain, such as experimental cutaneous pain (Kakigi, Matsuda, & Kuroda, 1993), acute and chronic musculoskeletal pain, acute oro-facial pain (Hansson & Ekblom, 1984) and chronic pathological pain (Kosek & Hansson, 1997). The majority of these studies demonstrate effects consistent with the Gate Control Theory of Pain (Melzack & Wall, 1965; Wall, 1978).

Broadly, the Gate Control Theory proposes an interaction between four classes of neurons in the dorsal horn of the spinal cord (figure 9). C fibres (non-myelinated nociceptive afferent fibres) have both a direct and indirect influence on the projection neuron. Impulses resulting from noxious stimuli are attenuated by the simultaneous inhibition of the inhibitory interneuron and excitation of the projection neuron (the activity of which results in the sensation of pain). The application of mechanical stimulation (vibration) excite the larger myelinated Aα and Aβ afferent fibres which simultaneously excite both the inhibitory interneuron and the projection neuron resulting in attenuation of nociceptive signals.

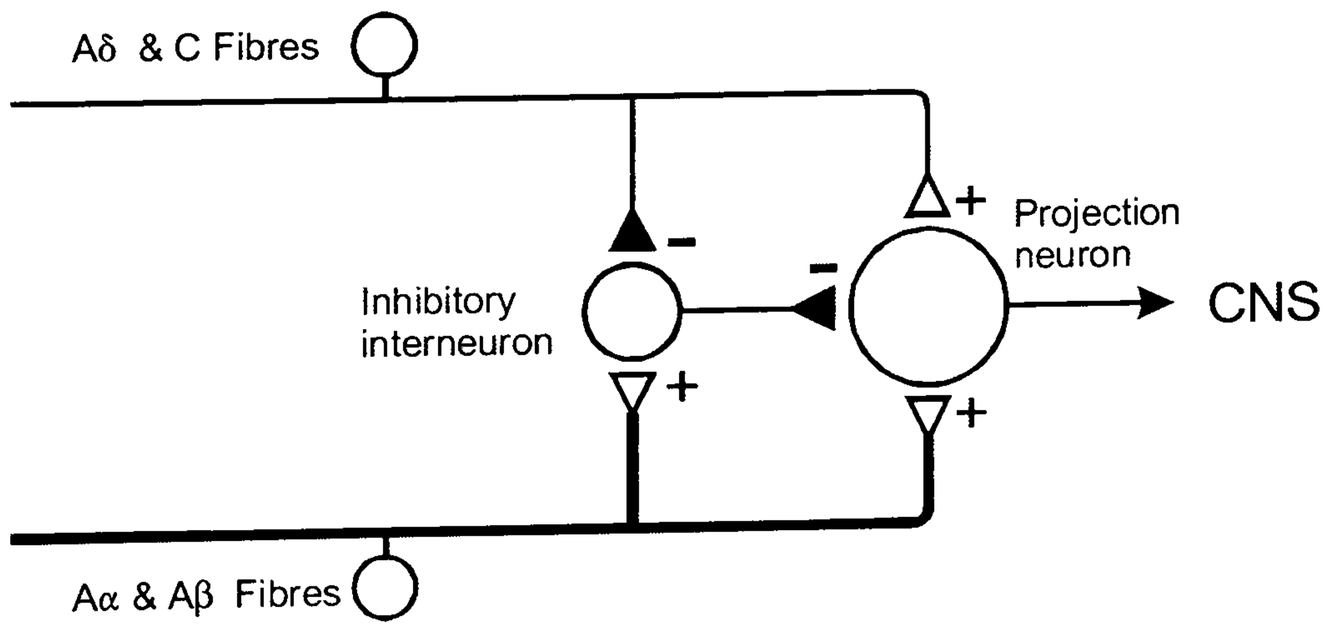

Figure 9 Possible gating mechanism, modified from Melzack and wall (1965).

It has been shown that in order for the stimulation of Aα and Aβ fibres to be effective in the attenuation of nociceptive signals, it is necessary that the stimulation be applied to a related receptive area (dermatome), that is, intra segmentally (e.g. Ekblom & Hansson, 1985; Kakigi et al., 1993; Kakigi & Shibasaki, 1992). Further, there is evidence that distance is a factor in the intra-segmental application of vibration stimulus. Sherer et al. (1986) tested two sites for the application of vibratory stimulation (VS), one distal and one proximal to the site of pain stimulation.

Their results reveal an increase in pain threshold in both conditions, but a significant elevation of pain threshold only in the group receiving VS distal to the site of pain stimulus. Importantly however, the distance between the site of VS and pain stimulus were different between groups. The distal VS was applied adjacent to the site of pain stimulus (within 4 - 6cm), whilst the proximal VS was applied 20-30 centimetres from the point of pain stimulus.

Clinical literature reports a change in subjective pain rating following VS, but these studies are generally investigating the effect of VS on the experience of (often chronic) suprathreshold pain (e.g. Ekblom & Hansson, 1985; Hansson & Ekblom, 1984; Lundeberg, 1984; Lundeberg, Nordemar, & Ottoson, 1984), and VS has generally been shown to reduce the intensity of existing (non-scalable) pain. On the other hand, experimental pain studies have investigated the effect of VS on pain threshold in healthy subjects (e.g. Kakigi et al., 1993; Kakigi & Shibasaki, 1992; Kosek & Hansson, 1997; Sherer et al., 1986) but these studies did not include measures of subjective pain experience.

As by definition, pain threshold signals the *advent* of pain, it is suggested that the subjective experience at pain threshold should remain the same, irrespective of the stimulus intensity required to achieve it. Therefore, it was hypothesised that, in line with previous research, intervention in the form of vibratory stimulation would result in an elevation of PPT. No changes in VAS pain rating were expected.

Methods

Design

Using a repeated measures design, PPT and VAS pain ratings were taken at three time points. Baseline (pre-vibration), at 30 minutes (during vibration) and at 45 minutes (15 minutes post-vibration).

Participants

The participants were 10 healthy volunteers who had responded to advertisements placed in both the University of Westminster (under the research participation scheme) and the Royal Free Hospital. 4 males and 6 females (mean age 34.20 years, SD 6.78 years, range 26 - 46 years), of which 2 were left handed (one male, one female). All participants were naive as to the experimental hypotheses.

Materials

The nail-bed pressure algometer was used to obtain measures of PPT. Subjective pain ratings were collected using 10cm Visual Analogue Scales. Vibration was applied through a steel T- bar, approximately 7cm long by 4mm in diameter. This was attached to a Ling Dynamics V201 vibrator, powered by a model LDS PA 25E amplifier. The wave-form and amplitude were controlled using an AM/FM Function Generator (8105, Topward Electric Instruments Ltd.). The vibration stimulus took the form of a 1mm amplitude sine wave at 100Hz.

Procedure

The Experiment took place in a laboratory in the department of Clinical Neurophysiology of Great Ormond Street Hospital. In accordance with the ethical guidelines of Great Ormond St. Hospital, each volunteer was presented an information sheet describing the nature of the study, and including a description of the procedure and instructions on the use of visual analogue scales (see Appendix III).

Each participant was given the standard verbal briefing (as shown in general methods), after which baseline measures of PPT and VAS pain rating were taken. Participants were then asked to rest their index finger on the T-bar of the vibrator.

The elbow and proximal forearm of the participant was supported so that with the arm relaxed, the finger rested on the T-bar with sufficient force to maintain contact with the bar during vibration. Vibration was applied to the palmar aspect of the first phalanx of the dominant hand index finger, approximately 5 cm proximal to the site of pain stimulus (both sites within the C7 dermatome) for 30 minutes. At 30 minutes a second measure of PPT and VAS pain rating were taken. The vibration was removed and the subjects remained seated for a further 15 minutes, after which the final set of measures were taken.

The entire procedure took 50 minutes. After the trial, participants were given a full debriefing and the objective of the Experiment was explained. Before participants left, each was asked whether they had any residual effects of the vibration, such as numbness, tingling or other persisting sensations.

Results

The data consisted of measures of PPT and VAS pain rating taken over three time points. Figure 10 presents the means (± 1 standard deviation) of PPT and VAS scores for all participants (N = 10) over three measures; Pre-VS baseline, at 30 minutes VS and 15 minutes post VS.

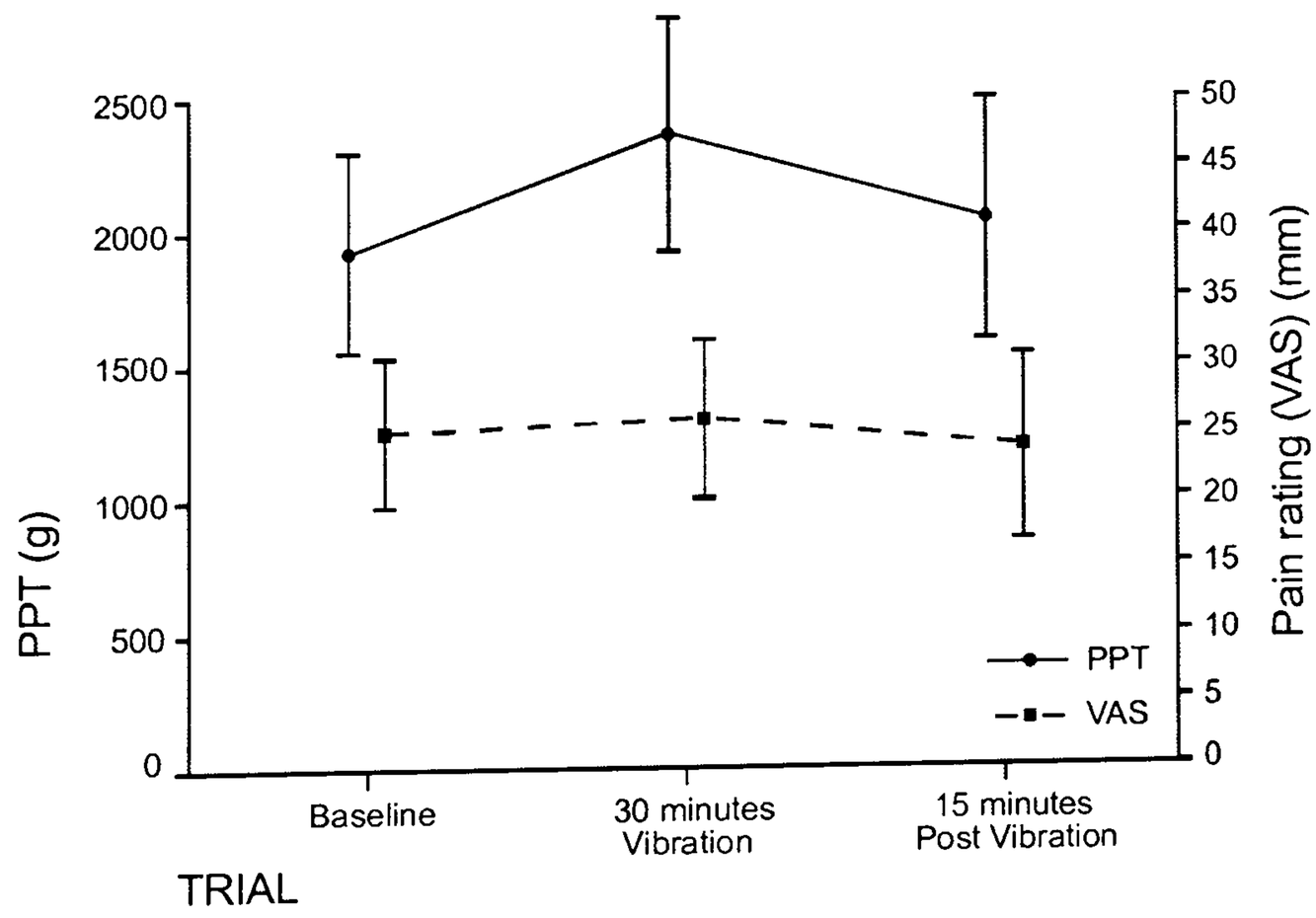

Figure 10 Means for PPT and pain rating over baseline, vibration and post-vibration measures. Error bars represent ± 1 standard deviation.

As for Experiment 1, the comparatively large standard deviations (Figure 10) and ranges (Table 4) indicate large between-participant differences in PPT and VAS pain rating.

Table 4. Ranges of PPT and VAS pain ratings over 3 measures.

TRIAL	1	2	3
PPT (g)	2250	2300	2900
VAS (mm)	40	40	49

The data were analysed using a repeated measures ANOVA. The results revealed a significant increase in PPT at 30 minutes vibration ($F_{2, 18} = 6.57$, $p = 0.007$). However, there was no significant change in VAS pain rating over three measures ($F_{2, 18} = 0.379$, $p = 0.74$). Analysis using a paired sample *t*-test showed no significant difference between baseline PPT and PPT at 15 minutes post vibration ($t = -0.905$, $df = 9$, $p = 0.39$).

Discussion

The results of Experiment 2 demonstrate the attenuation of pain through VS, congruent with the Gate Control Theory of Pain (Melzack & Wall, 1965; Wall, 1978). Significantly greater force was required in the presence of VS to achieve the advent of pain than in the absence of VS. The results show no change in subjective pain rating across three measures, congruent with the suggestion that as pain threshold signals the *advent* of pain, experimental measures of PPT will result in similar pain experiences even though, due to VS intervention, a significant increase in force was required to reach pain threshold. In short, the subjective experience of pain threshold is the same, regardless of the stimulus intensity required to reach it.

Whilst it is acknowledged that the absence of evidence does not constitute evidence of absence, the VAS is a validated measure and has been shown to be sensitive to changes in the experience of pain. Therefore, had there been any significant change in subjective experience, it is reasonable to expect this to have been indicated by changes in VAS pain rating.

The results of Experiments 1 and 2 show the nail-bed pressure algometer to be a reliable measure of PPT and sensitive to an intervention of known efficacy. Further, they have shown that under experimental conditions where participants have explicit control to halt the procedure at pain threshold, manipulations designed to influence PPT do not result in changes to subjective pain rating, supporting the contention that the experience of pain threshold remains the same, regardless of the stimulus intensity required to reach it.

As stated, the first two experiments were conducted in order to validate the prototype nail-bed algometer. The next series of experiments constitute the investigative component of the experimental section. These experiments were designed to investigate the role of social, contextual and environmental factors in the perception of acute pain.

As discussed previously, the factors under investigation represent three common facets of clinical and research situations: The perception of the situation and context according to the information provided (what is said), the activation of sex stereotypes within to the social dyad (who says it), and evaluation of features of the current environment (where it is said). Experiment 3 investigated the effects of manipulation of the context, as perceived by participants, on the perception of a pain stimulus. Perception of the context was manipulated by differences in pre-procedure briefings relating to levels of predictability and locus of perceived control.

CHAPTER 7

EXPERIMENT 3: INFORMATION, PERCEIVED CONTROL AND LOCUS OF CONTROL: EFFECTS ON THE PERCEPTION OF A PAIN STIMULUS.

Introduction

The situation as perceived by individuals in clinical and research contexts depends largely upon the information with which they are provided by the clinician or researcher. The provision of preparatory information within these dyads usually take the form of briefings concerning what is about to happen (common to both research and clinical situations). This facilitates the adoption of roles within the dyad placing the locus of perceived control with the clinician or researcher, as the possessor of the information and controller of subsequent events (e.g. Taylor, 1979). As stated in the introduction, perceived control has been defined as "the belief that one has at one's disposal a response that can influence the aversiveness of an event" (Thompson, 1981, p.90). As noted by Higgins (1987, p387), "...temporary expectancies are automatically driven by the data present in the current situational context". Briefings given in clinical and experimental situations constitute (arguably) the most salient environmental data available, therefore differences in the information presented will result in differences in interpretation of the situation, and different expectancies concerning the outcome.

The information provided in such circumstances may vary in at least two ways; what one may expect to happen (predictability) and the degree of control one has over it. An example of this in a clinical context is the difference in the instructions given for two very similar acute procedures; venipuncture (blood sampling) and cannula insertion (for the intravenous delivery of fluids over time). Both procedures are invasive and the physical stimulus is more or less the same; the insertion of a needle into a vein. However, with venipuncture greater control can be given to the patient. It is a very quick procedure and the needle may be withdrawn at any time. On the other hand, the process of cannula insertion, though the physical trauma is more or less identical, takes a little longer and once the process is instigated, it is clearly pointless to stop until the cannula is fully in position.

The briefing for venipuncture amounts to 'You will just feel a little scratch, let me know if it hurts too much and I'll stop' (high predictability, high control). The explicit provision to stop is usually given in venipuncture as the normal site for venipuncture (brachial fossa) also contains the median and radial nerves (medial and lateral to the fossa, respectively). The precise location of these nerves varies between individuals, so any 'shooting' pains the patient experiences indicates that the needle is approaching one of these nerves, and the procedure should be halted in order to prevent nerve damage. Therefore, within this short briefing there is both information pertaining to what the patient is likely to experience, and the provision of a degree of control over the event.

On the other hand, the usual sites for cannula insertion are more distal and away from joints (the back of the hand, or the lower dorsal or ventral aspects of the forearm), thus the chances of striking a nerve are minimal. Moreover, as mentioned, it is pointless to stop the procedure before the cannula is in position, therefore the briefing given to the patient undergoing cannula insertion amounts to 'this may be a little uncomfortable, but try to hang on until it's in place' (low predictability, low control). In this example, the briefing is different on both dimensions. The patient is warned that the procedure *may* be a little uncomfortable, and the freedom to stop the procedure is not given explicitly, although the clinician would have to stop upon direct request from the patient, as this counts as withdrawal of consent.

As discussed in Chapter Two, locus of control (LOC) style represents an individual difference in long-term cognitive structures that are acquired through social learning. The acquisition of particular LOC style (internal or external) determines the particular traits of the LOC construct which are chronically accessible within the individual. It has been shown that people are more sensitive to environmental information that is relevant to their individual long-term trait constructs (e.g. Bargh, 1990; Bargh & Pratto, 1986). Therefore, features of a briefing which are relevant to control are likely to have different effects depending on the chronically accessible trait-availability determined by the LOC style of the individual. In other words, information within a briefing which indicates a shift in the locus of perceived control from the patient or participant to the clinician or researcher, is likely to have a different effect on someone who already believes control to lie in the hands of luck, fate, or powerful others (i.e. that they have little direct control themselves), than someone who believes that events within their personal environment are under their own control.

In summary, information may vary in the provision of both predictability and control, influencing participant expectancies and degree of perceived of control respectively. The former will influence the hypotheses held by the individual concerning what is about to happen and thus the interpretation of the nature of the situation, and the latter will be interpreted according to the long-term trait accessibility of the individual. Together, these are likely to have a significant influence on the evaluation of the situation as a whole. Therefore, it was expected that differences in the information provided in a pre-procedure briefing would result in different interpretation of the second of two pain stimuli of identical intensities.

The hypotheses were that participants provided with information providing predictability with respect to the impending stimulus intensity, but denied any apparent means of influencing it would rate the second of two identical pain stimuli as being more painful compared to the first. Further, it was predicted that pain ratings from participants denied both preparatory information and perceived control, having nothing explicit to influence their coping strategy, would depend on the activation of chronically accessible traits associated with their individual LOC style (those with a more internal LOC reporting lower pain than those with a more external LOC).

Methods

Design

Using a mixed 3 (conditions) x 2 (measures) design, three experimental groups were generated using verbal briefings. The conditions were Information plus Control (I+C: Control group), Information with No Control (I-NC) and No Information and No Control (NI-NC)[4].

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[4] There was no *'control - no information'* condition because the aim was to assess the effects of differences in pre-test briefing upon the perception of the second of two pain stimuli of identical intensities. Participants presented with perceived control but denied information would probably have shown a reduction in PPT measures for the trial condition. This would invalidate the trial, as participant's subsequent pain rating could not be compared with their baseline.

For the purposes of this study, preparatory information was designed to provide predictability with respect to the intensity of the impending stimulus and was either provided or withheld. Control was defined as the explicit authority to stop the trial using a verbal signal (instrumental control). Control was perceived by the participant as being in the hands of either the experimenter or the participant. It is important to note that overall control (the option to halt or withdraw from the experiment) was never withheld from participants.

Participants

The participants were 61 healthy volunteers recruited from the staff of the Royal Free Hospital, Hampstead NHS Trust. Volunteers had responded to advertisements placed on the medical school and hospital staff notice-boards. The sample consisted of 20 males and 41 females (mean age 29.10 years, SD 7.04 years, range 19-50 years). 7 were left handed; 4 male, 3 female.

Materials

PPTs were measured using the nail-bed algometer. Subjective pain measures were collected using 10cm VAS (as detailed in general methods). Participants were required to compare the second of two identical pain stimuli with the first using a five-point Likert type scale from 1 (*much less*) to 5 (*much more*). Measure of internal/external locus of control were taken using the Internal/External Locus of Control Questionnaire (Rotter, 1966) (Appendix IV).

Procedure

The experimental trials were conducted in an empty (save for a table and chairs) room next to the annexe of the Renal Transplant Unit of the Royal Free Hospital. In accordance with the ethical guidelines of The Royal Free Hampstead NHS trust, each volunteer was presented an information sheet describing the nature of the study, and including a description of the procedure and instructions on the use of visual analogue scales. Participants were also required to sign consent forms (Appendix III).

Participants were allocated randomly to one of the three groups and were tested individually. Each participant was instructed on the use of the scales and fully informed of their rights to halt the study and withdraw at any time. Participants were told only that the objectives of the experiment was to test for a correlation between LOC and pain threshold.

Each participant was given the standard verbal briefing (as in general methods). Baseline measures of PPT and VAS pain rating were taken. Participants were then required to complete the LOC questionnaire. Lower scores indicate a more internal LOC style and higher scores indicate a more external LOC style. After completing the LOC questionnaire, participants were presented with one of three verbal briefings designed to induce the experimental conditions. The briefings were as follows:

Information + Control:
"*This time I'll look only at your dominant hand. Again, I'll slowly increase the pressure. As soon as you feel the pressure has become pain, say stop and I will stop. After that, you mark the scale again*".

Information - No control:
"*This time I'll look only at your dominant hand. Again, I'll slowly increase the pressure. However, there is no point in saying stop this time. I know your pain threshold value is (x) from the first measure, so I'll take you up to that value, after which you mark the scale again*".

No Information - No Control:
"*This time I'll only look at your dominant hand. Again, I'll slowly increase the pressure. However, there is no point in saying stop this time. I'm going to take the pressure up to a predetermined value, after which you mark the scale again*".

The briefing given in the I+C (control) condition was identical to the initial baseline trial briefing given to all groups, reinforcing their explicit authority to halt the trial with a verbal signal (high predictability, high control). The briefing given in the I-NC condition gave information about the intensity of the impending pain stimulus (high predictability), but withheld explicit control from the participant and placed it with the experimenter - "*...there is no point in saying stop this time... I'll take you up to that value...*" (low control). The briefing given in the NI-NC condition provided neither information about the impending stimulus intensity nor explicit control (low predictability - low control).

After the briefing, participants in the I+C group simply repeated the baseline trial, halting the trial as soon as they felt the pressure had become painful. Each participant in the I-NC and NI-NC groups was subjected to exactly the stimulus intensity they had reported at pain threshold for their baseline PPT measures. No participant in the I-NC or NI-NC groups was subjected to pain stimulus greater than that which had been determined by their baseline PPT. All participants provided VAS pain ratings and compared their second pain experience to their first using the five-point comparison scale.

After the trials were complete, participants were fully debriefed. The full objectives of the study were explained and it was made clear that regardless of any impressions they had formed due to the experimental pre-test briefing, the second stimulus intensity was identical to their first, and in no case had they been subjected to stimulus intensity greater than that at which they had reported pain threshold at baseline. Participants were given the opportunity to comment on the procedure and to discuss their responses to the debriefing.

Summary of data

The aim of Experiment 3 was to test for the effects of the experimenter briefing on the second of two identical stimuli. However, participants in the I+C (control) group were given explicit control to stop the stimulus increase at any time for both trials. Should there be no change in pain rating across measures for the control group (as expected), it was necessary to establish that there was also no change in stimulus intensity for the control group across trials.

The mean PPTs for the two trials were extremely close ($\bar{x}_1 = 1535.26$g, SD = 552.02g; $\bar{x}_2 =$ 1523.16g, SD = 576.03g). Also, PPT measures were strongly correlated across trials ($n = 19$, $r = 0.93$, $p < 0.0005$). A paired samples t-test showed no difference between baseline and condition PPT measures for the I+C group ($t = 0.25$, $df = 18$, $p = 0.81$), showing that, as for the experimental groups, the control group was effectively subjected to the same stimulus intensity across trials.

The pain rating (VAS) data took the form of three samples over two repeated measures. The response distributions of each group for baseline and condition measures are shown in Figure 11.

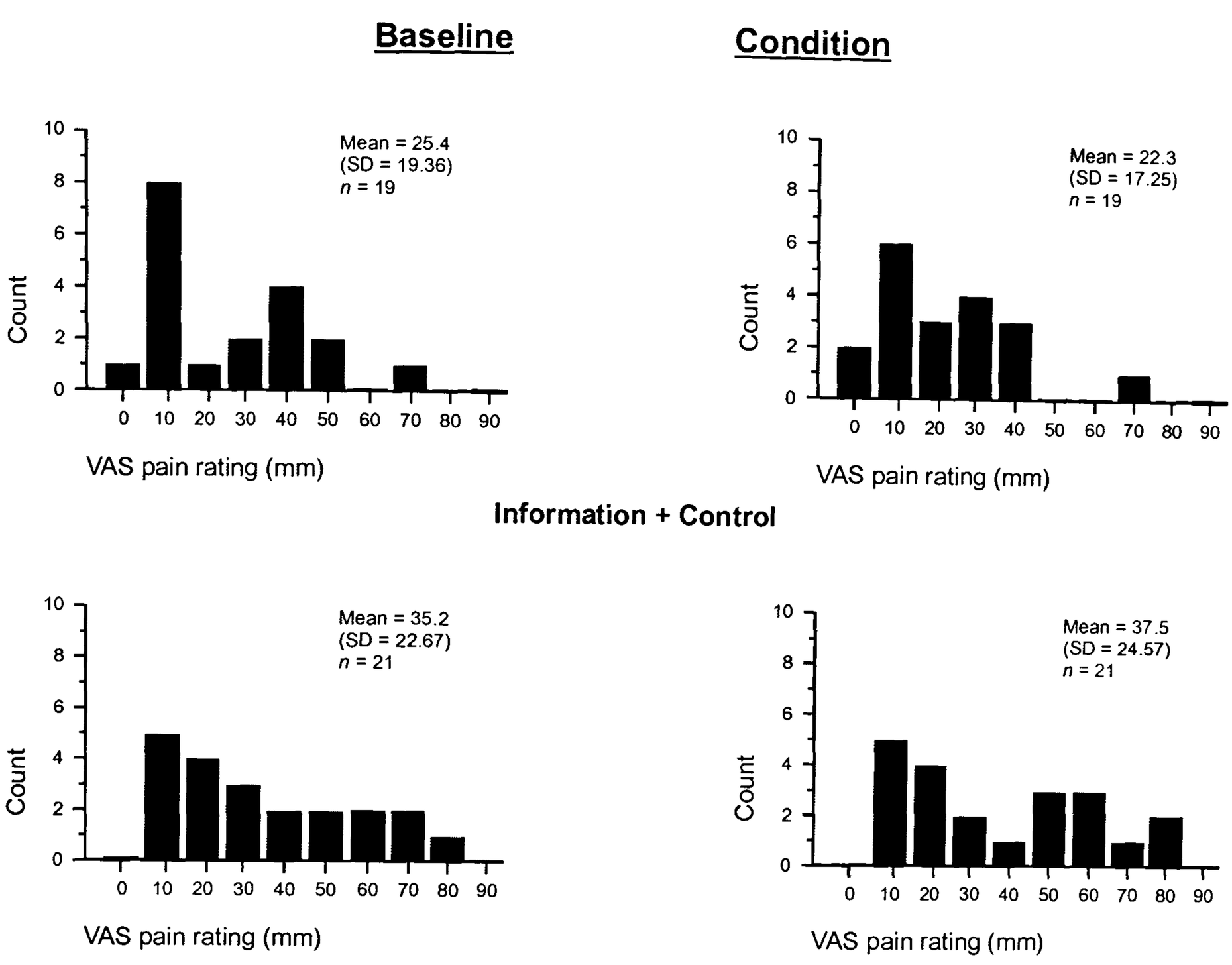

Figure 11 VAS Pain rating distributions for each group across baseline and condition measures

Changes in distribution can be seen across measures, particularly for the NI-NC group. However, the distributions also show a marked positive skew. To test for this, a diagnostic plot of the pain rating (VAS) data was carried out (Figure 11). The plot revealed a systematic relationship between log (SD) and log (Mean) across the experimental conditions. The slope of the regression line for predicting log SD from log mean indicated that a square-root (Sqrt) transformation of the data was appropriate (Box & Cox, 1964) (see Figure 12, also Appendix IV).

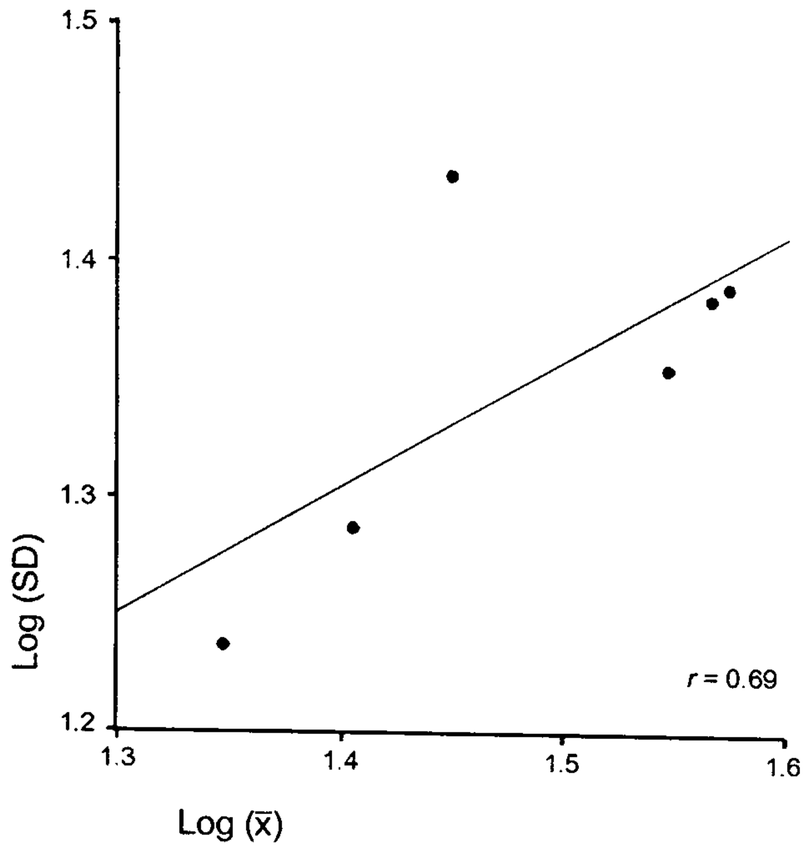

Figure 12 Log Standard deviations by Log Means for each of the six cells in the design (3x2).

Figure 13 shows the changes in overall distribution of VAS data as a result of square-root correction for the baseline and condition VAS data.

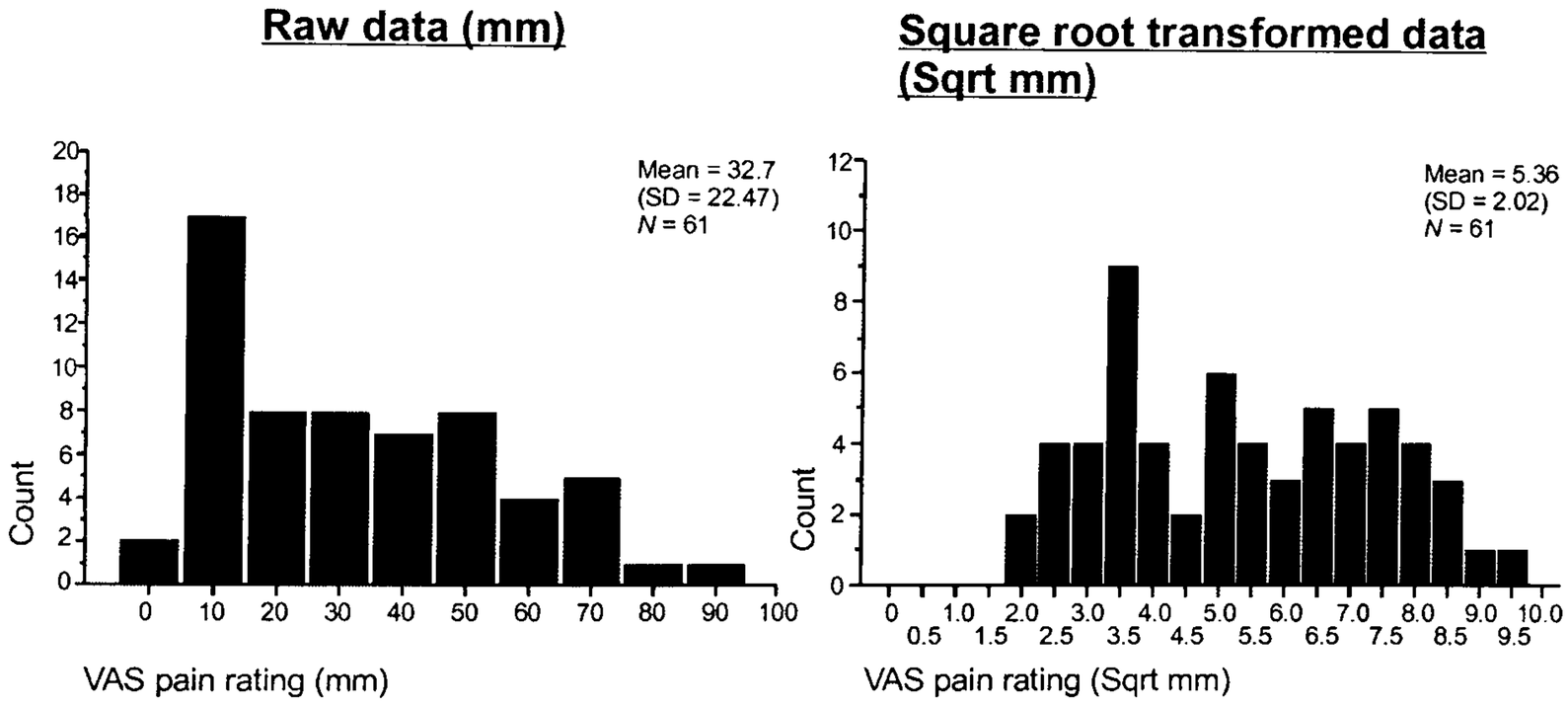

Figure 13 Baseline and condition VAS distributions (totalled for condition) before and after square-root correction.

Results

A mixed 3 x 2 ANOVA revealed a significant main effect for VAS pain rating across measures ($F_{1,58} = 5.364, p = 0.024$). There was a significant interaction between VAS pain rating and condition (see Figure 14). Participants whose briefing contained neither preparatory information nor perceived control reported a significant reduction in pain rating across trials compared to participants whose briefings provided both preparatory information and perceived control, or preparatory information but no perceived control ($F_{2,58} = 4.257, p = 0.019$).

Participants in the control group (I+C) reported slightly lower pain for the condition trial compared to the baseline, whilst participants in the I-NC group reported slightly higher pain for the condition trial compared to the baseline, although neither difference was significant. Whilst the plot of the estimated marginal means in Figure 14 appears to show that participants in the I+C group provided lower baseline VAS ratings than participants in the I-NC and the NI-NC groups, analysis using One-Way ANOVA showed no significant difference between groups for the baseline VAS pain rating ($F_{2,58} = 1.50, p = 0.23$).

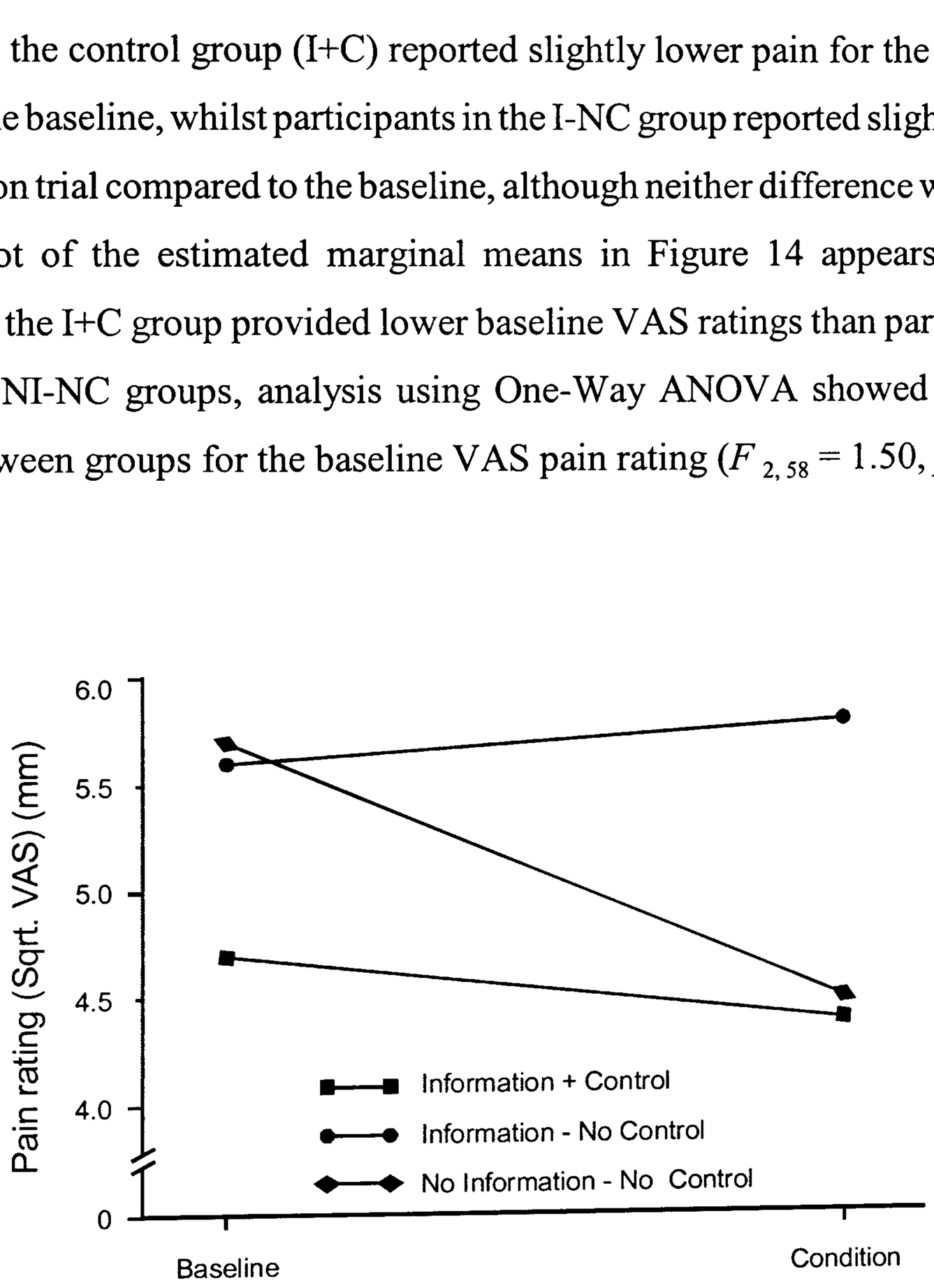

Figure 14 Estimated marginal means of the transformed pain rating (Sqrt. VAS) for I+C, I-NC and NI-NC conditions over baseline and condition measures.

Participants were asked to compare their second pain experience with their first using a five point scale (1 = *much less* to 5 = *much more*). Figure 15 presents the response distributions for the comparison scale data.

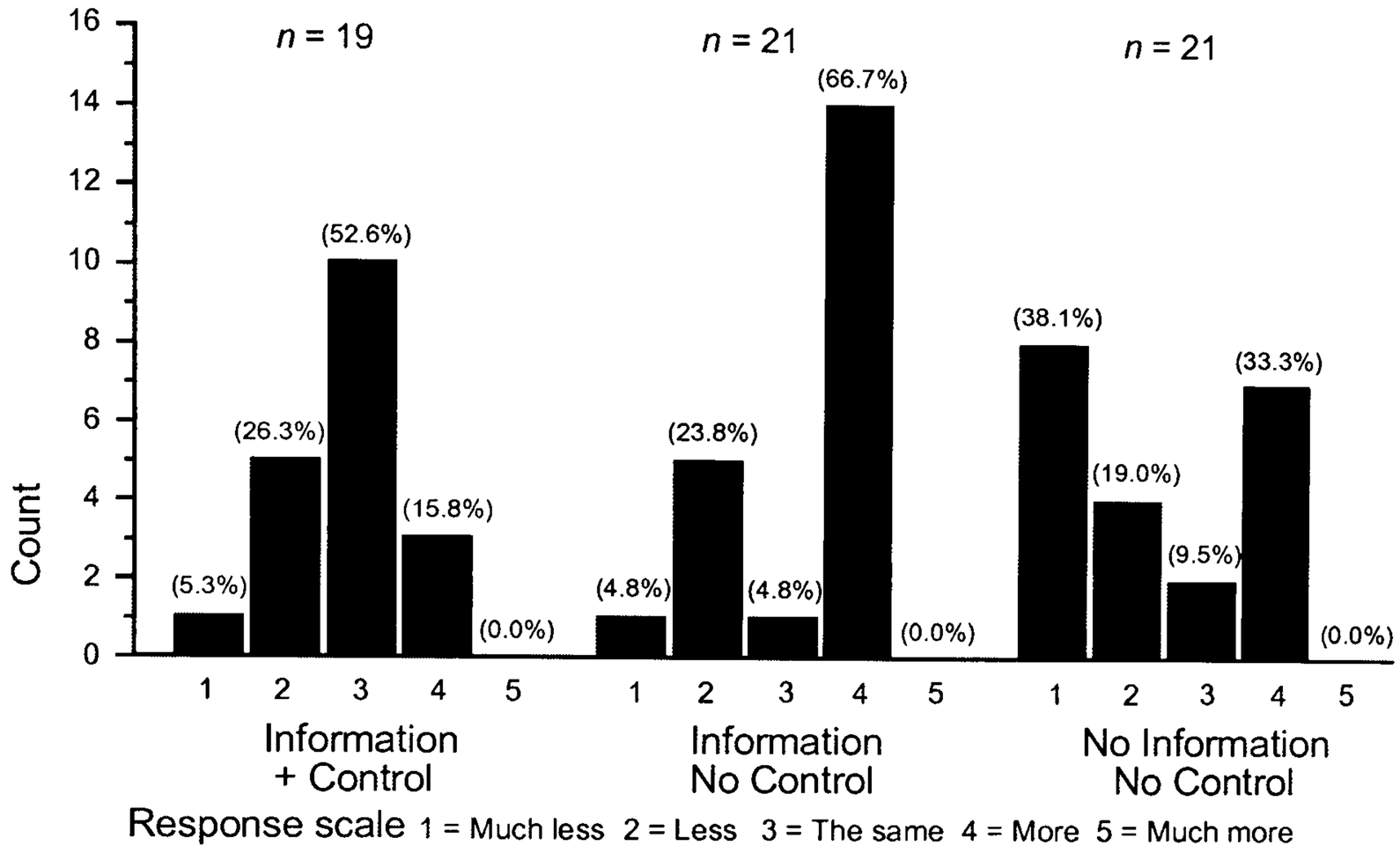

Figure 15 Response distributions for comparison scale; participants rating the second pain stimulus compared to the first.

Analysis using Kruskal-Wallis H revealed a significant difference between groups (χ^2 = 7.55, $df = 2, p = 0.023$). Participants in the control group (I+C) rated their second trial the same as their first, while participants in the I-NC group rated their second trial as more painful than their first compared to the control group. Participants in the NI-NC group rated their second trial as less painful than their first compared to the control group although responses in the NI-NC group show a bimodal distribution. Table 5 shows the mean ranks for each group.

Table 5. Mean ranks for I+C, I-NC and NINC conditions

CONDITION	MEAN RANK	*n*
Information + Control	29.03	19
Information - No Control	38.90	21
No Information - No Control	24.88	21

Analysis using Spearman's Rho correlation revealed that both the experimental condition VAS pain rating and comparison scale responses are strongly correlated ($N = 61, r_s = 0.54, p < 0.0005$). However, analysis within groups show no significant correlation between comparison scale and VAS pain rating for the I+C condition ($n = 19, r_s = -0.09, p = 0.71$), but a significant positive correlation between VAS pain rating and comparison scale responses for both the I-NC condition ($n = 21, r_s = 0.53, p = 0.01$) and for the NI-NC condition ($n = 21, r_s = 0.69, p < 0.0005$) (Figures 16 & 17 respectively).

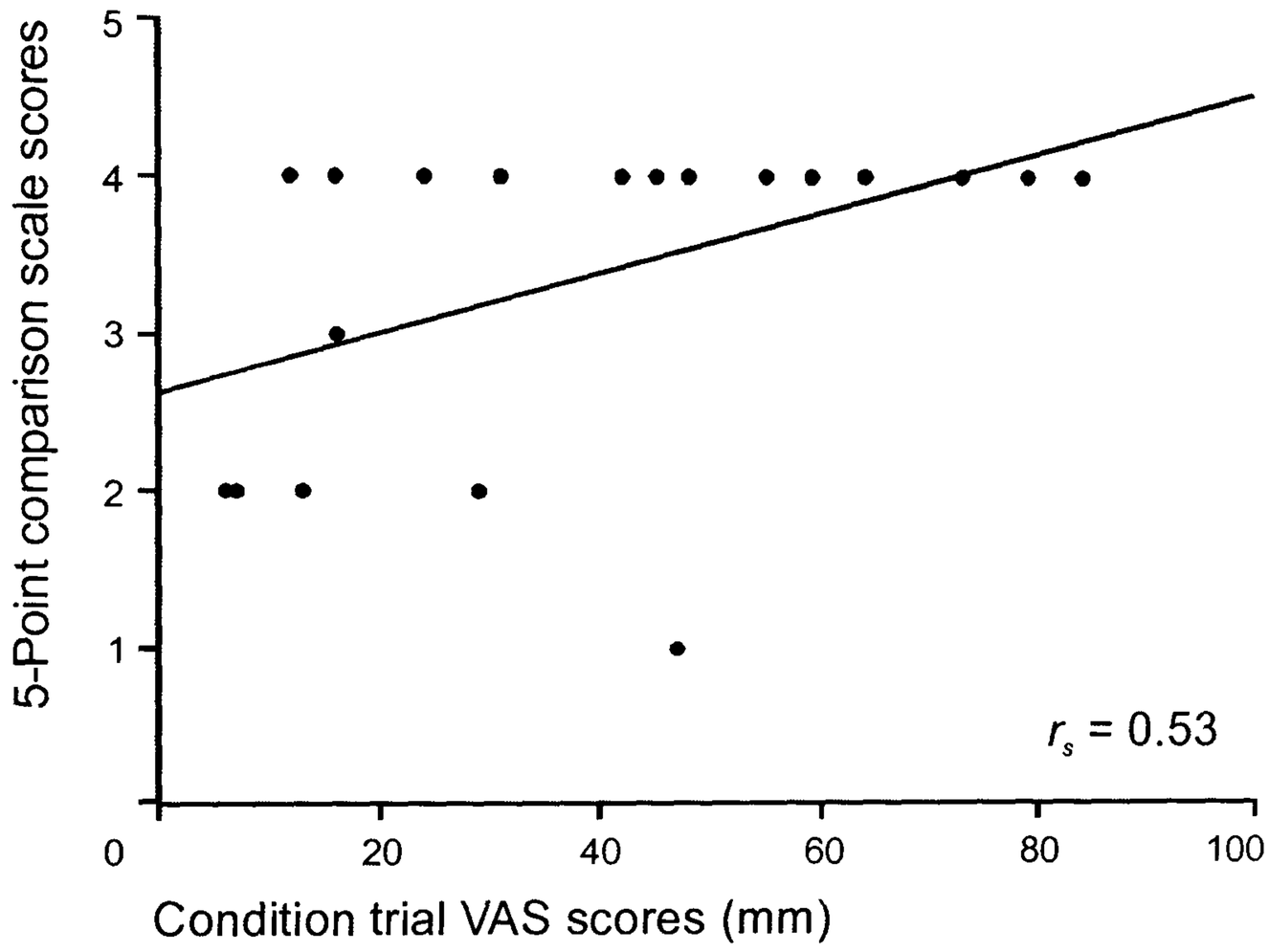

Figure 16 Condition trial VAS pain ratings by comparison scale responses for the I-NC group.

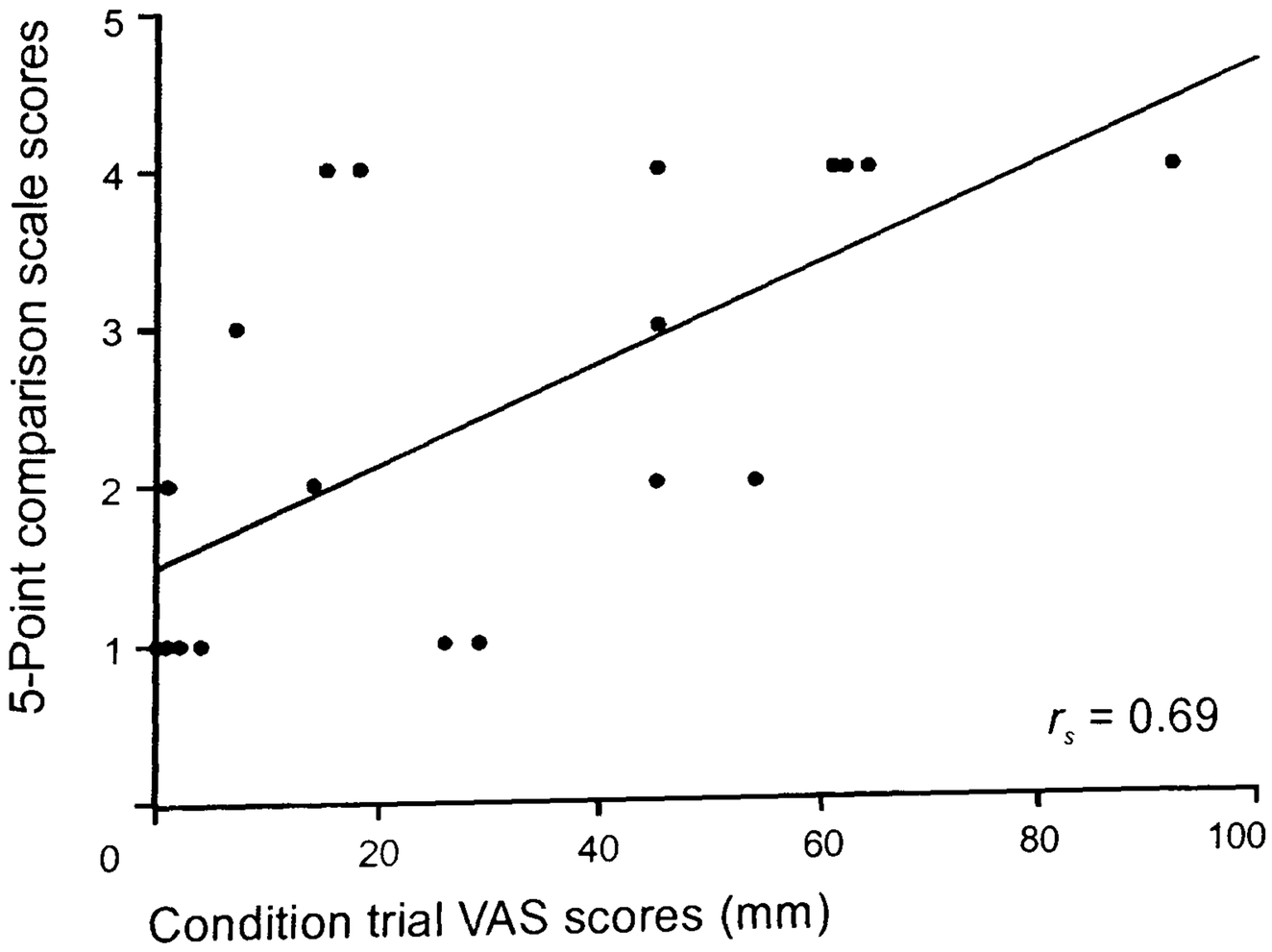

Figure 17 Condition trial VAS pain ratings by comparison scale responses for the NI-NC group.

Analysis using Pearson product-moment correlation revealed a significant overall correlation between LOC and pain rating for the condition trial ($N = 61, r = 0.26, p = 0.04$). However, analysis within groups showed no correlation between LOC and pain rating for the I+C group ($n = 19, r = 0.03, p = 0.91$), nor for the I-NC group ($n = 21, r = 0.05, p = 0.80$), but a strong positive correlation between LOC and pain rating for the NI-NC group ($n = 21, r = 0.53, p = 0.01$). Participants with a more internal LOC style generally reported less pain than participants with a more external LOC style (Figure 18).

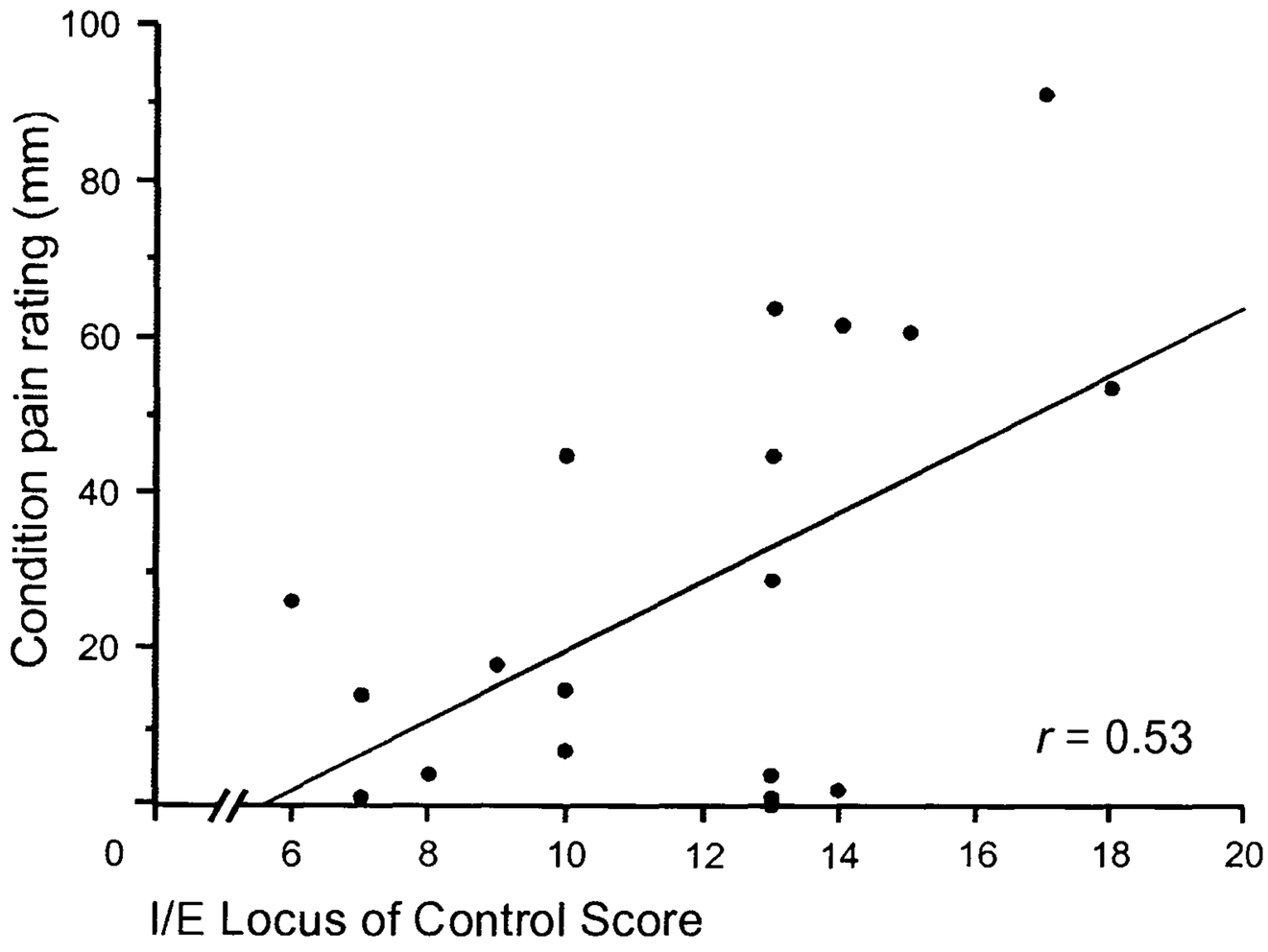

Figure 18 VAS pain rating (mm) by LOC score for the NI-NC condition.

Discussion

The results show that differences in the content of pre-procedure briefings had a significant effect on the perception of the second of two identical stimuli. In effect, that participants experienced as more or less painful, a pain stimulus of an intensity identical to their own pre-measured pain threshold level.

Participants presented with the briefing containing both preparatory information and explicitly granting perceived control (I+C) reported slightly (though not-significantly) lower VAS pain ratings for the condition trial compared to the baseline trial, and rated the condition trial as the same or less painful in comparison to the baseline trial. There was no correlation between VAS pain rating and comparison scale response in this condition.

Participants in the I-NC group who were presented with the briefing providing preparatory information (high predictability) but placing perceived control in the hands of the experimenter (low control) reported slightly (though not significantly) higher VAS pain ratings for the condition trial. However, in comparing the second stimulus with the first, a significant proportion (66%) of participants in this condition rated the second pain stimulus as being more painful than the first. There is a strong, positive correlation between VAS pain rating and comparison scale responses in this condition.

Participants in the NI-NC group who were presented with the briefing which neither provided preparatory information nor explicitly granted perceived control (low predictability, low control) reported significantly lower VAS pain ratings for the second trial. VAS pain rating from the second (condition) trial is strongly related to LOC style in the NI-NC group (Figure 16). A more internal LOC style related to lower pain rating and a more external LOC style related to higher pain rating. Also, comparison scale data from this group show a bimodal response distribution (33% found it more painful and 38.7% found it less painful). As with the I-NC condition, VAS pain ratings and comparison scale responses from the NI-NC condition show a strong, positive correlation.

It is possible that participants' expectations had some influence on the results. Thus, an alternative explanation for the results may be simply that the briefings for the second trial for the I-NC and NI-NC groups were *different* to the first. It may be that the simple fact that the second briefing was different resulted in an overall higher level of attention in the I-NC and NI-NC groups, as participants in those groups were alerted to the possibility of other unexpected changes in procedure.

However, whilst this alternative may account for differences between the I-NC and NI-NC groups and the control (I+C) group, it does not account for the systematic differences in pain rating between the I-NC and NI-NC groups (i.e. the difference in the *direction* of changes in pain rating between those groups). Therefore it is more likely that the *content* of the second trial briefings had more of an influence than the fact that the second trial briefings were different to the first.

The effects of manipulating the content of pre-procedure briefings, as shown by Experiment 3, suggests that the provision of preparatory information concerning a potentially painful event results in a more negative appraisal of the event, irrespective of LOC, when a perceived means of influencing the event is unavailable. This supports the suggestions that information can act as a stressor if an individual has no perceived means of influencing the event (e.g. Miller & Mangan, 1983; Thompson, 1981; Weisenberg et al., 1985). However, withholding preparatory information (in the absence of perceived control) resulted in a pain response that is strongly related to LOC. Pain rating was lower from those with a more internal LOC, and higher in those with a more external LOC. In other words, for participants who had little perceived control over events, withholding information concerning the impending stimulus intensity resulted in different evaluations of the situation, based upon differences in their individual LOC style.

It is worthy of note that upon debriefing, participants in the NI-NC group expressed surprise that the second stimulus was identical to the first, and reported spontaneously that the second stimulus had 'genuinely felt different' (less or more painful according to their experience).

The change reflected in VAS rating across trials for the NI-NC condition also supports the suggestion that VASs are sensitive to more than just the intensity of the pain stimulus. As the stimulus intensities for the second trial were identical to those in the first trial, it is clear that changes in VAS pain rating cannot have been related to changes in stimulus intensity. Therefore any differences must be due to changes in evaluation and subsequent differences in affective-motivational components of the experience. In other words, the VAS ratings, rather than reflecting changes in the intensity of the pain stimulus, reflected changes in the degree of unpleasantness associated with the event.

As shown, there is a positive correlation between the VAS data and the comparison scale data for the I-NC and NI-NC groups. However, the trends shown in the VAS data appear to have been magnified by the comparison scale. For example (and in particular), participants in the I-NC condition, when asked to compare the second pain stimulus with the first, and having to make a deliberate choice between explicit options, showed a more pronounced (and statistically significant) effect than that detected by the VAS.

This suggests the possibility that whilst the second stimulus may not have been immediately *felt* as significantly more painful by participants in the I-NC condition (as rated using the VASs), the stimulus was *remembered* as being more painful in comparison to the first. In other words, participants asked to recall and compare their experiences appear to have significantly more 'unpleasantness' associated with their memory of the second stimulus. This in turn suggests that the higher level of processing required to recall and compare experiences allowed a greater opportunity for pre-conscious changes in affective motivational state to influence subsequent judgements.

It is apparent that differences in chronic trait accessibility relating to individual LOC style produced differences in the way the situation was interpreted by participants, and that this in turn, was brought about by differences in the content of pre-test briefings and not differences in stimulus intensities. Therefore, as a salient determinant of evaluation of context, differences in what is said within a researcher-participant (or clinician-patient) dyad relating to predictability and control, has been shown to have a significant influence of its own. However, one may expect patients and participants to pay direct attention to and be aware of what is explicitly said within the dyad. On another level, what may be obvious, but not necessarily deliberately attended to, are the characteristics of who is saying it. Experiment 4 investigated the effects of the sex of the experimenter on the interpretation of a painful event.

CHAPTER 8

EXPERIMENT 4: THE EFFECT OF EXPERIMENTER SEX ON PRESSURE-PAIN THRESHOLD AND SUBJECTIVE PAIN RATING.

Introduction

There have been very few studies investigating directly the effects of experimenter sex on pain perception and rating. Those that have been done tend to focus on the effect as a function of participant gender-role. For example, Levine and De Simone (1991) found that males reported significantly less pain to a member of the opposite sex than to another male during a cold-pressor test. They suggest that "This result is congruent with the standard gender-role requirement of males appearing macho and not allowing females to know they are weak." (Levine & De Simone, 1991, p.71). Otto & Dougher (1985), suggest that in measures of pain threshold, delaying the report of pain would provide an advantage to men wishing to appear macho, with no appreciable cost. Further, it has been suggested that males are socially conditioned to suppress, or consider as a sign of weakness, outward signs of pain (Fillingim & Maixner, 1995; Riley III et al., 1998).

Whilst participant gender-role no doubt has some influence, the suggestion that delaying reports of pain threshold given to an opposite sex assessor may advantage males wishing to appear macho implies that males (if not females) consciously censor pain report according to what they consider appropriate to their gender-role. However, as shown in Chapter Four, there is compelling evidence that the automatic evaluation of a situation and activation of stereotypes are very basic events that can occur independently of cognitive process. In light of that evidence, it is suggested that the mere presence of a member of the opposite sex results in activation of stereotype trait constructs (e.g. Bargh, 1988, 1996; Bargh, 2001; Dijksterhuis, Aarts et al., 2000; Todorov & Bargh, 2002).

As discussed in Chapter Two, appropriate gender-roles are acquired through social learning. But it is not just one's own gender identity that is acquired. A part of the process of the acquisition of gender identity is sex typing; the learning of stereotypes (sets of culturally designated traits) associated with maleness and femaleness.

Examples of gender traits associated with females are eagerness to soothe hurt feelings, gentleness, sensitivity to the needs of others, sympathy, tenderness, understanding and warmth. On the other hand, examples of gender traits associated with males are aggression, assertiveness, dominance, forcefulness and competitiveness (From the Bem Sex-Role Inventory. See for example Baron & Byrne, 2000, Chapter Five). Thus, whilst the acquisition of gender-roles will undoubtedly influence the behaviour of individuals, limiting them to some degree to behaviours 'appropriate' to their particular gender role, it will also influence their expectancy with regard to behaviours from members of the opposite sex. That is to say, people will be less likely to *expect* females to inflict pain than males, as this runs contrary to their gender traits of gentleness, sensitivity and understanding.

Therefore, in potentially painful clinical and experimental situations, the presence of a female clinician or researcher as a part of the dyad is likely to result in a less negative evaluation of the situation and a lower avoidance motivation in the patient or participant than the presence of a male. In other words, under these circumstances, males reporting less pain to a female assessor may not be doing so deliberately or in a conscious attempt to impress, or conform to their gender-role. Instead, differences in pain ratings may reflect differences in affective-motivational state occurring as a result of gender-stereotype activation, resulting in participants forming different expectancies concerning probable outcomes.

If participants are influenced in their pain reporting principally by their own gender-role expectation, then the effect previously shown of males reporting higher pain threshold to female assessors, should not be apparent in female participants. To delay reports of pain in order to 'impress' runs contrary to the female gender-role stereotype (e.g. as being 'passive' and non-competitive), and would have no benefit when reporting to a same sex assessor. Conversely, should a bias in pain report between male and female assessors be principally a result of gender-stereotype activation influencing expectancies in the participants, then the less negative evaluation of a potentially painful event resulting from the activation of female stereotype traits should result in higher reports of pain threshold to a female assessor from both male and female participants.

Further, as shown in Experiment 2, the subjective experience of pain threshold is the same regardless of the stimulus intensity required to achieve it. Therefore, across two measures in which participants have explicit control to stop at pain threshold, there are no grounds to expect changes in VAS pain rating. Therefore, if the preconscious activation of female stereotype traits results in a less negative evaluation of the situation, then one would expect this to be reflected in a lower propensity to avoid the pain stimulus (indicated by a higher pain threshold), but no difference in the subjective experience because the subjective experience of pain at pain threshold intensity remains the same.

On the other hand, if a reporting bias in males reporting to a female experimenter was a result of conscious 'censoring' of pain report, then it would be reasonable to expect higher PPTs to be accompanied by lower VAS pain ratings from male participants. There would be little benefit to males wishing to appear macho in provide an 'impressively' high report of pain threshold (look how much I can take!), if it were to be accompanied by a high pain rating (but it really hurt!). Therefore, it was hypothesised that participants (male and female) would report higher PPTs to a female experimenter than to a male experimenter. In line with the results of Experiment 2, no differences in VAS pain ratings were expected.

Methods

Design

Using a mixed 4 (groups) x 2 (participant sex) x 2 (measures) crossover design, participants were randomly allocated to one of four groups determined by the order of the sex of the experimenter across two trials; male-female, female-male, male-male and female-female.

Participants

Participants were 40 (20 male and 20 female) healthy first-year student volunteers (mean age 25.94 years, SD 7.97 years, range 18-51 years) who had responded to advertisements placed on the University of Westminster research participation scheme notice board. Participants were naive as to the true purpose of the Experiment.

Experimenters

The male and female experimenters were matched for age (male 40 years, female 42 years). The experimenters dressed similarly (casual dress, jeans and shirt) and no attempt was made to enhance their stereotypical gender characteristics. Experimenter-participant interaction was controlled through the use of standardised, scripted instructions (Appendix VI).

Procedure

To eliminate the possibility of competition, participants were not informed that they had been allocated to different groups. The two trials took place in the same room, one week apart. Participants were greeted by either the male or the female experimenter and asked to make themselves comfortable. Participants were told that the purpose of the experiment was to assess the reliability of measures of pain threshold over repeated measures. Instructions on the general procedure and the use of VAS were read to each participant. If participants had any questions, the appropriate section of the script was paraphrased.

Before measures of PPT and VAS pain rating were taken, participants were asked to score their pre-test anxiety using a 10cm VAS from '*Not at all anxious*' to '*As anxious as I could possibly be*'. As soon as participants indicated they were ready to proceed, PPT and VAS pain ratings were taken.

For the second trial (one week later), fresh consent was obtained from each participant, and their rights to halt or withdraw at any time were re-stated. Participants in the crossover conditions (male - female, female - male) were told, if they enquired, that due to unforseen circumstances, the original experimenter could not make it on time and had asked the new experimenter to stand in.

After the final experimental trial, each participant was fully debriefed and the true objectives of the experiment were explained. Participants were given the opportunity to discuss their responses to the debriefing and any issues arising from the manipulation.

Results

The data took the form of three measures (PPT and VAS pain and pre-test anxiety ratings), taken from four groups, determined by the order of the sex of the experimenter (male-female, female-male, male-male and female-female) over two trials. Tables 6, 7 and 8 present summaries of these data. As with the previous experiments, the data reflect a wide distribution of PPT and VAS pain ratings between participants, as shown by the comparatively large standard deviations recorded for these measures.

Table 6. Mean PPT (g) (± SD) for each of the four conditions over two trials.

	TRIAL 1	TRIAL 2	
CONDITION	MEAN PPT (SD)	MEAN PPT (SD)	*n*
MALE - FEMALE	1253.0 (451.2)	1880.5 (591.4)	10
FEMALE - MALE	1337.0 (381.1)	904.5 (295.5)	10
MALE - MALE	1171.0 (378.3)	1091.5 (467.1)	10
FEMALE - FEMALE	1442.0 (634.5)	1427.0 (696.2)	10

Table 7. Mean VAS pain ratings (mm) (± SD) for each of the four conditions over two trials.

	TRIAL 1	TRIAL 2	
CONDITION	MEAN VAS (SD)	MEAN VAS (SD)	*n*
MALE - FEMALE	28.60 (15.37)	33.30 (19.08)	10
FEMALE - MALE	30.90 (18.21)	37.00 (24.95)	10
MALE - MALE	33.00 (21.00)	28.60 (16.67)	10
FEMALE - FEMALE	26.70 (14.68)	27.80 (21.44)	10

Table 8. Mean VAS anxiety ratings (mm) (± SD) for each of the four conditions over two trials.

	TRIAL 1	TRIAL 2	
CONDITION	MEAN VAS (SD)	MEAN VAS (SD)	*n*
MALE - FEMALE	20.90 (18.14)	6.50 (7.99)	10
FEMALE - MALE	34.50 (28.50)	23.60 (18.81)	10
MALE -MALE	23.40 (20.94)	14.70 (15.43)	10
FEMALE - FEMALE	16.50 (25.10)	21.90 (30.67)	10

The data were analysed using a mixed 4 x 2 x 2 ANOVA. The results show no main effect for PPT across trials ($F_{1,32} = 0.316, p = 0.58$), but a highly significant interaction between experimental condition and PPT. Participants in the male-female condition reported higher PPTs on the second trial and participants in the female-male condition reported lower PPTs on the second trial ($F_{3,32} = 24.37, p < 0.0005$) (Figure 19).

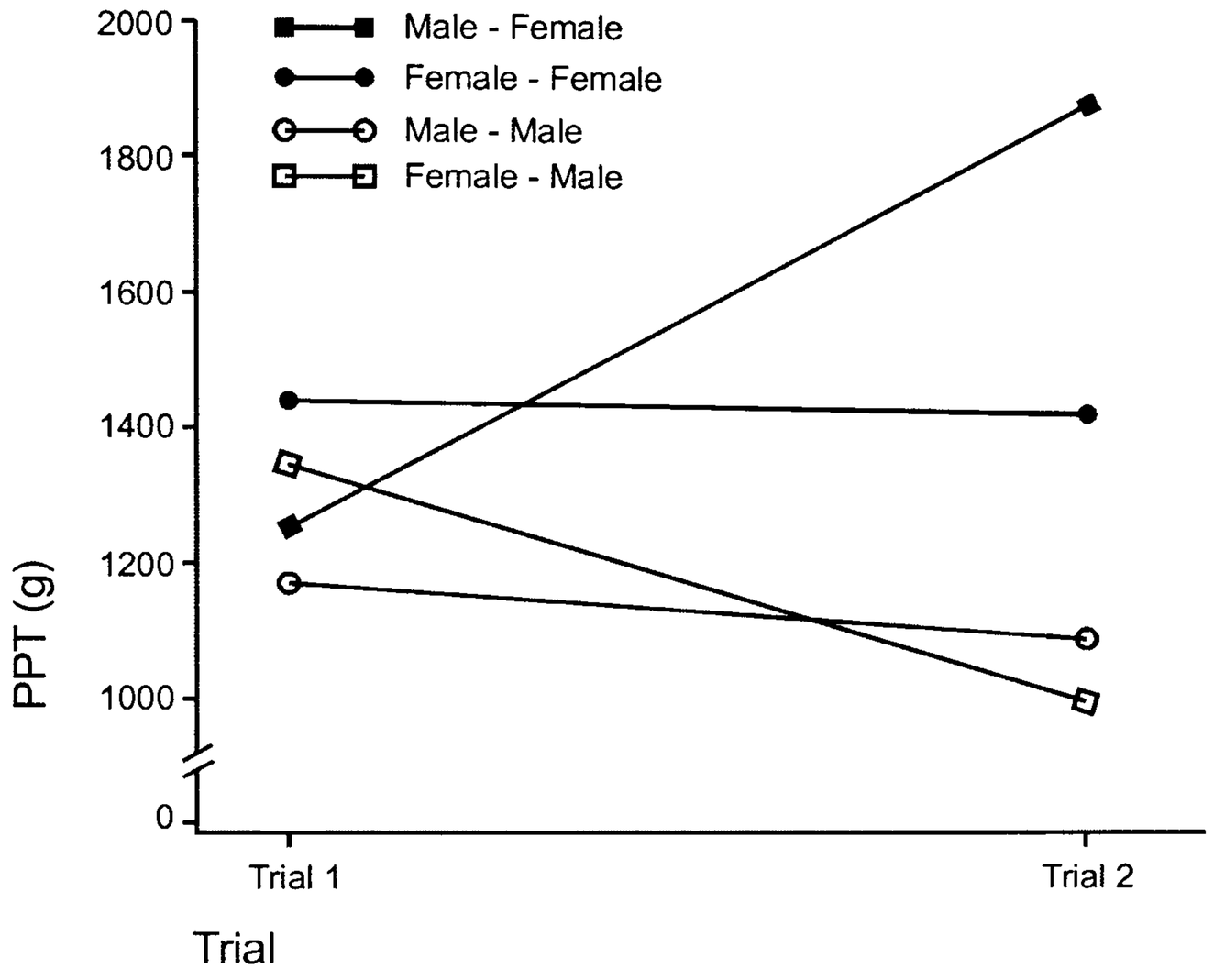

Figure 19 Estimated marginal means of PPT for female-female, male-male, female-male and male-female conditions.

There was a significant between groups main effect for PPT, participants reported higher threshold levels to the female than to the male experimenter ($F_{3,32} = 3.198, p = 0.036$). There was also a significant between participant main effect for participant sex. Male participants reported significantly higher PPTs than female participants. ($F_{1,32} = 14.76, p = 0.001$), however, there was no interaction between participant sex and experimental condition ($F_{1,32} = 2.410, p = 0.09$).

The data presented in Figure 19 appear to show that participants in the male-female experimenter condition reported higher PPTs than participants in the female-female control condition for the second trial. Likewise that participants in the female-male experimenter condition reporting lower PPTs than participants in the male-male control condition for the second trial. However, post-hoc analysis of trial 2 PPT data using Tukey's test of honestly significant difference (HSD) revealed that these differences were not significant ($p = 0.25$ and 0.85 respectively).

Analysis of VAS pain ratings revealed no main effect for VAS pain rating ($F_{1,32} = 0.445$, $p = 0.51$), participant sex ($F_{1,32} = 1.345, p = 0.25$) or experimental condition ($F_{3,32} = 0.283$, $p = 0.84$). Nor are there any interactions between experimental condition and VAS pain ratings ($F_{3,32} = 0.694, p = 0.56$), or participant sex and VAS pain rating ($F_{1,32} = 1.527, p = 0.23$). However, there was a significant main effect for pre-test anxiety ratings. Pre-test anxiety was lower for the second of the two trials ($F_{1,32} = 5.52, p = 0.025$) (Figure 20). There was no interaction between anxiety ratings and condition ($F_{3,32} = 2.040, p = 0.13$), nor any main effect for participant sex on pre-test anxiety rating ($F_{1,32} = 0.070, p = 0.79$).

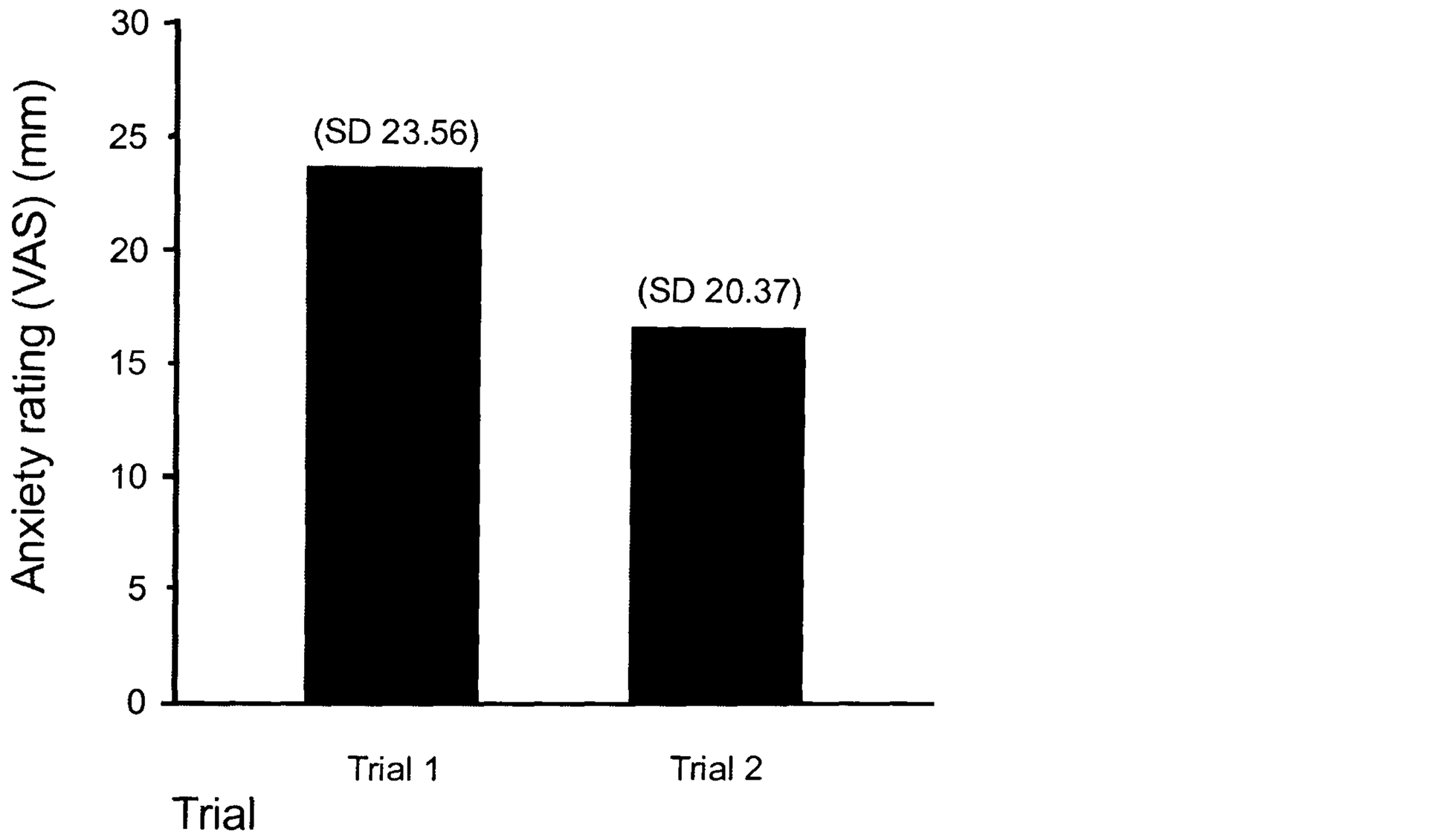

Figure 20 Mean pre-test anxiety rating for first and second trial.

Discussion

The results show overall that male participants reported higher PPTs than female participants. This is in line with previous research (e.g. Brennum et al., 1989; Fischer, 1986, 1987; Mersky & Spear, 1964). The results also show that both male and female participants reported higher PPTs to a female experimenter than to a male experimenter. Moreover, the results show a change in PPT resulting from a change of experimenter, from male to female, and from female to male across trials. Participants tested by a male experimenter in the first trial reported significantly higher PPTs when tested by a female experimenter in the second trial, and those tested by a female experimenter in the first trial reported significantly lower PPTs when tested by a male experimenter in the second trial. As in Experiment 2, there were no significant differences in VAS pain rating.

Whilst the higher PPTs reported to the female experimenter conditions agree with previous research (e.g. Levine & De Simone, 1991), the previous 'participant oriented' gender-role behaviour explanation of the effect (i.e. males wishing to appear macho) does not account for the result that female participants showed the same effect. As noted previously, it is highly unlikely that females would benefit from delaying reports of pain threshold to another female.

The suggestion that differences in pain rating from males reporting to a female assessor is the product of a conscious and controlled process is further confounded by the absence of differences in pain ratings shown in this study. As previously suggested, should males have been consciously attempting either to conform to their beliefs concerning their own gender-role, or (by extension) to impress the female assessor, it would have been reasonable to expect a significant reduction in VAS pain rating from males reporting to a female, compared to males reporting to another male.

Further, the results show a reduction in anxiety over the two trials (most probably due to familiarity with the procedure by the second trial). However, the results show no differences in pre-test levels of anxiety *between* conditions. In other words, participants did not report greater anxiety when confronted with a male experimenter, or less anxiety when confronted with a female experimenter. This suggests that whilst there was a change in affective-motivational state sufficient to significantly influence measures of PPT, participants were not aware of it on a conscious level.

However, as with Experiment 3, the results could be interpreted in terms of participant expectation. The participants, having been tested by either a male or a female experimenter in the first trial, may have entered the second trial *expecting* to be tested by the same experimenter. Thus it might be argued that the simple fact that the experimenter was different (i.e. not the person who was expected) was sufficient to alert the participants to the possibility of further unexpected changes and result in a difference in their evaluation of the situation.

In fact, this alternative may go some way towards accounting for the 'overshoot' of participants in the male-female experimenter condition, who reported higher PPTs (though not significantly so) on their second measure than participants in the female-female experimenter (control) condition, and likewise for the similar overshoot of participants in the female-male experimenter condition, who reported lower PPTs (though not significantly so) on the second trial than participants in the male-male experimenter (control) condition (see Figure 19). However, as with Experiment 3, whilst participant expectation may have to some degree amplified the changes in PPT observed across trials, this alternative does not account for the systematic difference in the *direction* of changes in PPT observed between experimental conditions.

So far, it has been shown that differences in information provided to participants in the form of pre-procedure briefings, influences the interpretation of a painful event so as to produce differences in the subjective rating of the second of two identical pain stimuli. Further, it has been shown that the presence of different sex experimenters results in significant differences in PPT. It is suggested that these occur as a result of differences in basic affective-motivational state due to activation of sex-stereotypes within the participant. It is suggested that the activation of sex-stereotypes influenced the expectancies held by the participants concerning the situation, and resulted in a more negative evaluation of an impending pain stimulus when delivered by a male experimenter, than when delivered by a female experimenter.

The factors investigated in Experiments 3 and 4 are features of the social context (one explicit and the other implicit) which exists within research and clinical situations. The purpose of the final Experiment was to test the effect on PPT of an emotionally valenced non-social feature of the environment in which a potentially painful procedure takes place.

CHAPTER 9

EXPERIMENT 5: MANIPULATION OF MECHANICAL PAIN THRESHOLD USING A VISUAL PRIME.

Introduction

It is no great surprise that most clinical procedures tend to take place in clinical environments. Clinical environments are known to produce certain effects on different people, for example, the white coat effect[5] (e.g. Pickering & Friedman, 1991), though in this case, patients usually have an existing underlying pathology (chronic hypertension). But what defines a clinical environment? Many people, when talking about hospitals, cite the odour as one of the most unpleasant factors. Odour has been shown to act as a contextual cue (e.g. Smith, Standing, & de Man, 1992), but this effect depends upon prior exposure to the context. The smell peculiar to hospitals could not evoke a memory of a hospital experience in an individual who has never has such an experience.

It is more likely that in reality it is a combination of factors; sounds, smells and sights that serve to form the overall 'clinic' environment. As noted in Chapters Three and Four, all incoming information is evaluated for valence and classification of features in the environment as either 'good' or 'bad' occurs within 250 ms (Bargh, 2001; Bargh & Ferguson, 2000; Giner-Sorolla et al., 1999). Further, that this classification has been shown to directly affect the tendency to either approach or avoid the stimulus (Chen & Bargh, 1999). Clinics and hospitals are full of 'clinically oriented' information pertaining to health and well being that is strongly valenced. For example leaflets stating that "Smoking Kills!" and "Drinking when pregnant can harm your baby!" or posters promoting HIV awareness, or requesting that people "Do Something Special: Give Blood".

As noted previously, continual evaluation of features of the environment serves to signal the overall safety or potential for harm within the current environment. It is suggested that the prevalence of negatively valenced information within the clinical situation produces an

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5 The white coat effect describes the tendency for some individuals to show significantly higher measures of blood pressure when taken by a doctor in a clinical environment, than when taken at the patient's home using a 24 hour ambulatory BP recording system.

overall negative evaluation and an increased avoidance motivation. This is likely to result in a more negative interpretation of a potentially painful stimulus, which in the case of non-scalable pain stimuli, such as acutely painful, minor surgical procedures, would manifest as the procedure being perceived as more unpleasant (e.g. as shown by Experiment 3). In the case of scalable pain stimuli in which intensity is variable and under the control of the experimenter, greater negative affect and avoidance motivation is likely to manifest as a reduction in pain threshold. Therefore, it was hypothesised that the presence of a negatively valenced feature in the environment will result in lower pain thresholds. Under the principle that the experience of pain threshold remains the same, regardless of the stimulus intensity required to reach it, no differences in VAS pain rating were expected.

Methods

Design

An independent groups design was employed. Whilst it could be argued that repeated measures would be a better design for this study, the nature of automatic evaluation makes a repeated measures design hard to control. For example, a properly controlled repeated measures experiment needs to be counterbalanced with respect to stimulus presentation, one group tested under neutral versus stimulus conditions, and the other tested under stimulus versus neutral conditions. However, whilst the valenced environmental feature in this case was the wound classification chart, the automatic evaluation effect has been shown to be pervasive (e.g. Bargh et al., 1992; Chen & Bargh, 1999), thus the ultimate evaluation applies to the particular situation as a whole.

Having formed an association between the evaluation and the situation, subsequent exposure to the same situation, even in the absence of the stimulus material, would evoke the previously formed evaluation (e.g. Bargh, 1989; Bargh & Chartrand, 2000; Higgins & Bargh, 1987). Thus, whilst no change in PPT for the neutral versus experimental condition would support the Null Hypothesis, the same result for the experimental versus neutral condition could indicate either no effect, or the carry-over of a previously formed evaluation into the neutral condition, thus increasing the probability of a type II error.

Participants

Participants were 40 healthy, first-year student volunteers who had responded to advertisements placed on the University research participation scheme notice board (33 females, 7 males; mean age 22.48years, SD 5.54 years). Participants were randomly assigned to one of two groups, either the experimental or neutral condition.

Materials

The experimental condition was induced through the presence of a hospital wound-classification and dressings reference poster[6,7] (Figure 21) pinned to the wall behind the experimenter. For the neutral condition, the poster was absent.

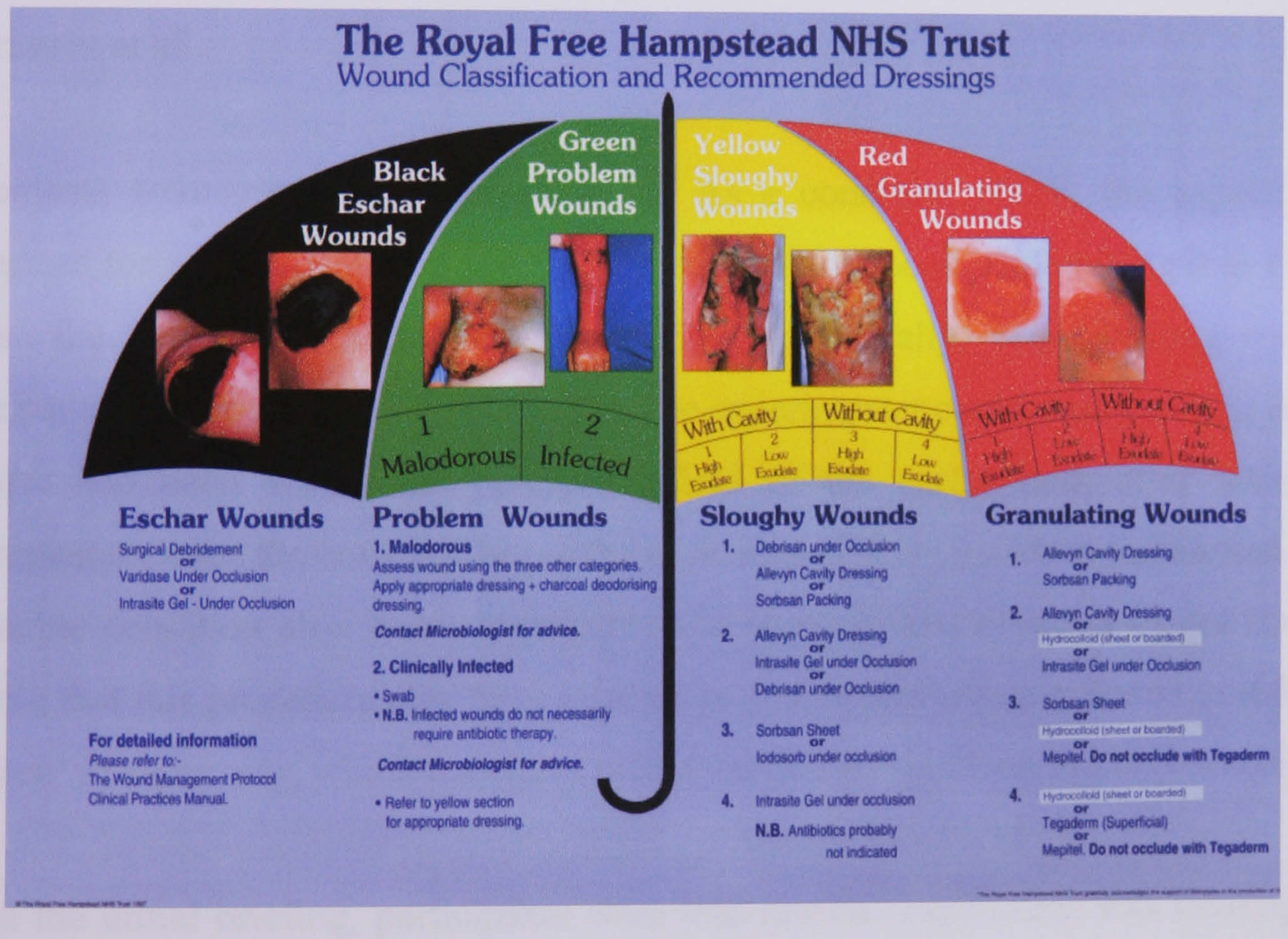

Figure 21 Wound classification and dressings reference chart. Produced with permission from the Royal Free Hampstead NHS Trust.

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6 Posters such as the one shown are common in clinical areas of hospitals and are frequently displayed in patient areas such as treatment and dressings rooms.

7 It should be noted that the Royal Free Hampstead NHS Trust has recently ruled that all such posters be removed from all areas where patients are likely to come into contact with them.

Pain stimulus was applied using the nail-bed pressure algometer. Pain ratings were taken using the standard 10cm VASs. Measures of pre-test anxiety were also taken using a 10 cm VAS from "*Not at all anxious*" to "*As anxious as I could possibly be*" (see Appendix II). Participant-experimenter interaction during briefing and de-briefing (probing) was controlled through the use of a script (Appendix VII) which the experimenter had rehearsed.

Procedure

The Experiment took place in the University of Westminster, in a 2 x 2.5 m cubicle labelled 'Health Laboratory Annex'. The purpose of the labelling was so that the presence of an educational clinical poster in the room would not seem incongruous. This particular poster was chosen because it is an educational tool, and so would not appear out of place in a University health psychology laboratory. Thus it was thought less likely that participants would perceive the chart as an experimental manipulation, or would associate it with the experiment at all.

Participants were greeted and asked to sit. As a condition check, the experimenter apologised for not being quite prepared, picked up a note book, and holding it in front of him so the face of the participant was visible peripherally, began writing until the participants gaze switched to the poster (i.e. the experimenter could safely assume that the stimulus had been within the perceptual field of the participant), after which the experimenter closed the book and began the experiment. This procedure was carried out in the neutral condition also, to avoid possible systematic effects between groups (i.e. it is possible that this procedure may have resulted in those participants exposed to it feeling 'slighted' in some way, which may have influenced their evaluation of the proceedings).

Before the initial briefing, participants were told that the experiment was investigating factors influencing pain threshold, and that the objective of the experiment was to collect a number of pain threshold measures to use as a baseline. Participants were read the standard briefing concerning the procedure and asked to complete the first section of the score sheet asking their sex, age and handedness. At no point before the debriefing did the experimenter refer to, or in any other way acknowledge the poster. Measures of pre-test anxiety were taken. Following the usual protocol (general methods), a non-dominant hand familiarisation measure of PPT was taken, after which dominant hand measures of PPT and VAS pain rating were taken.

Prior to a complete de-briefing, participants were probed (in the course of 'casual conversation') in order to ascertain what, in their own opinions, they assumed to be the purpose and objectives of the experiment, whether they worked or had been patients in hospitals or surgeries recently and, for participants in the experimental condition, whether they had ever seen charts like the one present and whether or not they had associated the chart with the experiment in any way.

Awareness of the nature or true objectives of the experiment, familiarity with or recent exposure to the stimulus material or evidence that the participants had associated the stimulus material with the experiment were considered exclusion criteria. However, no participants admitted to associating the chart with the Experiment, nor to ever having seen the stimulus material or anything similar, thus no data were excluded. Finally, the true objectives of the study were explained and participants in the experimental group were given the opportunity to comment on the experiment, and in particular the chart, and to discuss their responses to it.

Results

The data took the form of three measures (PPT, VAS pain rating and VAS pre-test anxiety rating) taken from two independent groups. Table 9 presents a summary of those data.

Table 9. Means (± SD) of PPT (g) and VAS (mm) pain and pre-test anxiety ratings for the two groups.

	Experimental condition	Neutral condition	
Condition	Mean (SD)	Mean (SD)	*N*
PPT (g)	1036.00 (645.08)	1629.75 (874.19)	40
VAS pain rating (mm)	37.40 (17.60)	35.60 (19.93)	40
VAS pre-test anxiety rating (mm)	36.00 (26.93)	29.60 (20.71)	40

Trials on the nail-bed pressure algometer revealed that the first measure taken from a naive participant is usually lower than the second (which increases slightly, probably due to familiarity). Due to this, in all Experiments, participants undergo a familiarisation trial (as mentioned in general methods), which generally produces higher values and more 'noisy' data than subsequent measures. However, in this case, the familiarisation data were

included in analysis as, if the effect of automatic evaluation is universal and pervasive, then it should produce a general effect on both familiarisation and test measures.

Whilst the increased noise and unreliability of measures taken under the familiarisation trial reduce the probability of any effect achieving statistical significance, it was thought nonetheless to be of interest to include these data. Figure 22 shows the mean PPTs for both the familiarisation and test trials for each of the two conditions.

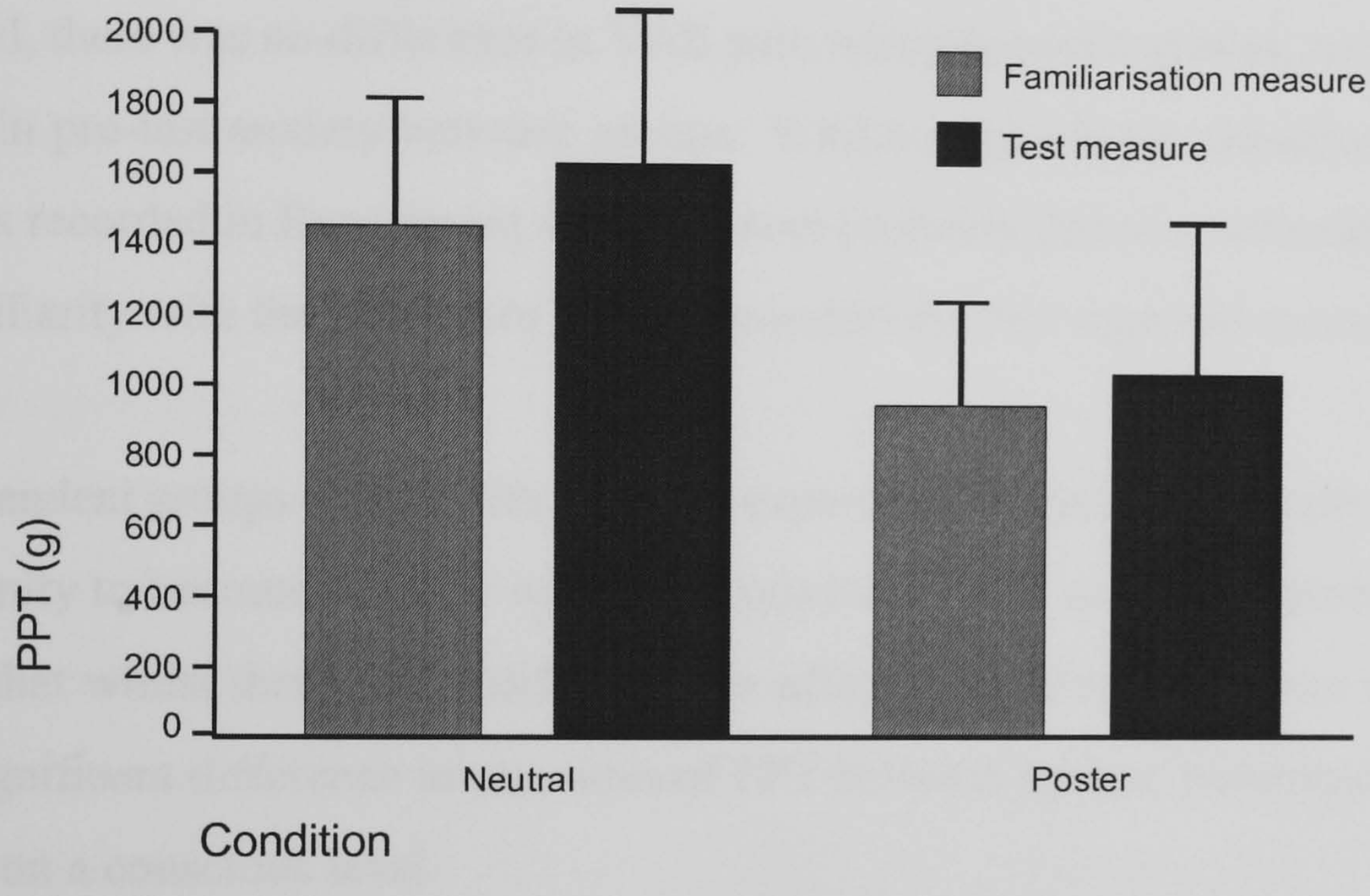

Figure 22 Mean PPTs for familiarization and test measures for neutral and experimental condition. Error bars represent ± 1standard deviation.

Analysis using independent samples T-tests revealed a significant difference between groups for both familiarisation and test measures of PPT. Participants in the experimental condition reported significantly lower PPTs for both the non-dominant hand familiarisation trial (t = -2.442, df = 38, p = 0.019; 2-tailed) and for the dominant hand test trial (t = -2.444, df = 38, p = 0.019; 2-tailed). There were no significant differences between groups for VAS pain rating (t = 0.303, df = 38, p = 0.76; 2-tailed) or pre-test anxiety (t = 0.843, df = 38, p = 0.40; 2-tailed).

Discussion

The results show that the presence of a negatively valenced object in the form of a clinical reference chart resulted in significantly lower PPTs recorded for the experimental group compared to the neutral condition group. This result is in line with data showing increased avoidance motivation in response to a negative prime (Chen & Bargh, 1999), and moreover, shows the influence of the automatic evaluation effect in an ecologically valid (quasi-clinical) context.

As expected, there was no difference in VAS pain rating between groups, nor was there a difference in pre-test anxiety between groups. Whilst a significant reduction in pre-test anxiety was recorded in Experiment 4, this is most probably due to a reduction in anxiety due to familiarity with the procedure by the second of the two repeated measures.

In an independent groups design with only one experimental trial, participants would have no opportunity to become familiar with the procedure. Thus, as with Experiment 4, it is suggested that whilst there was a difference in affective-motivational state sufficient to induce a significant difference in measures of PPT between groups, participants were not aware of it on a conscious level.

Automatic evaluation is said to be a continuous process that has been described as universal and unconditional. The effects of the process are pervasive and the balance of the evaluation of features in a given context serves to signal the overall safety, or potential for harm within the current environment. The results of Experiment 5 demonstrate the pervasive nature of the effect, insofar as the mere presence of an educational reference poster containing negatively valenced information was sufficient to influence perception of the pain stimulus significantly, even though for all intents and purposes (as far as the participants were concerned), the chart itself had nothing to do with the situation.

A possible weakness in this study is that the experimenter was aware of the conditions in which the measures were taken. Having just stated that the automatic evaluation effect is universal and unconditional, it is possible that the experimenter may have been subject to a similar effect. Although the experimental procedures and experimenter-participant

interactions were controlled through the use of scripts (Appendix VII), it could be argued that the awareness of the condition was sufficient to alter, in some subtle manner, the behaviour of the experimenter. In this case, rather than there being the possibility of participant expectation effects (as each participant underwent only one trial, there was no opportunity for participants to generate particular expectations), there was the possibility of experimenter expectation effects. Whilst the controls in this Experiment, and the experimenters' awareness of the possibility of such effects, no doubt limited the influence any such effect might have had (in light of these controls, it seems unlikely that experimenter expectation effects alone would have been capable of producing the results shown), it is suggested (with the benefit of hindsight) that any replication of this Experiment ensure that the experimenter is blind to the conditions, perhaps through a confederate directing participants to neutral or valenced waiting areas prior to the trial.

Nonetheless, the results of Experiment 5 are in line with the evidence that the presence of emotionally salient features and objects in the environment serve as significant elements in the formation of the context and its significance as perceived by a participant. Negatively valenced objects that may have nothing to do with the situation at hand, nonetheless influence evaluation of the overall context resulting in an overall more negative interpretation of a pain stimulus. It is reasonable to assume that had the stimulus not been scalable (as in minor, acutely painful procedures such as venipuncture), then the results would have shown more negative subjective pain rating (i.e. the stimulus rated as more painful, as shown in Experiment 3).

As noted, clinical situations such as surgery waiting rooms, outpatient clinics and many public areas of hospitals contain large amounts of strongly valenced information, as in the example given above "Smoking **Kills**!", "Drinking when pregnant can **harm your baby**!", or requesting that people "Do Something Special. Give **Blood**". The results of Experiment 5 suggest that whilst health related information presented in clinical situations may be of long-term benefit to individuals who choose to heed the messages, the mere presence of the information may in fact be detrimental in the short-term to individuals awaiting treatment involving an acutely painful procedure. Individuals exposed to negatively valenced information prior to a painful event may, in effect, be 'primed' for pain.

CHAPTER 10

GENERAL DISCUSSION

Précis of Results

Experiments 1 and 2 were conducted as validation studies for the prototype nail-bed pressure algometer. These experiments were designed to assess test-retest reliability and the effect of an intervention of known efficacy (intra-segmental vibration stimulation) respectively.

The results of Experiment 1 show no significant changes in measures of PPT or VAS pain rating taken under stable conditions over five consecutive trials conducted at one week intervals. In Experiment 2, measures of PPT and VAS pain rating were taken at three time-points: Baseline, at 30 minutes during vibration and 15 minutes post-vibration. The results show a significant elevation in PPT at 30 minutes vibration. Pain thresholds returned to baseline at 15 minutes post-vibration. There were no significant changes in VAS pain rating over three measures.

Experiment 3 tested the effects of differences in preparatory information relating to predictability (with respect to the intensity of the impending pain stimulus), and locus of perceived control, on the second of two pain stimuli of identical intensities. Participants in the control condition who were provided with both preparatory information and perceived control (I+C) showed no significant differences in VAS pain rating across measures, and rated the second stimulus 'the same' in comparison to the first (using the 5-point comparison scale from 1 = *Much less* to 5 = *Much more*).

By contrast, participants provided with full information, but denied perceived control (I-NC) rated the second stimulus as significantly more painful in comparison to the first. This rating was accompanied by a slight (though non-significant) elevation in VAS pain rating. Comparison scale response and VAS pain rating are strongly correlated in this condition. Conversely, participants provided with neither information nor perceived control (NI-NC) rated the second stimulus as being significantly less painful than the first using the VAS.

Comparison scale responses show a bimodal distribution in the NI-NC condition, and there is a significant positive correlation between VAS pain rating and LOC score for the NI-NC condition which does not exist for the I+C and I-NC conditions. Participants with a more internal LOC style recorded lower pain ratings, and participants with a more external LOC style recorded higher pain ratings. Also, as with the I-NC condition, there is a strong, positive correlation between comparison scale response and VAS pain rating for the NI-NC condition.

Experiment 4 tested the effect of the sex of the experimenter on measures of PPT. The results show that both male and female participants reported significantly higher PPTs to a female experimenter than to a male experimenter. Moreover, changing experimenter (from male to female or from female to male) between trials resulted in changes in measures of PPT concordant with that result (a significant elevation and reduction, respectively). There was also a significant main effect for participant sex. Male participants reported higher PPTs than female participants. There was a significant reduction in pre-test anxiety for the second of the two trials, but no effect on pre-test anxiety of either experimenter sex or participant sex. There were no significant differences in VAS pain rating between male and female experimenter conditions.

The results of Experiment 5 show that the presence of a negatively valenced feature in the environment, that ostensibly had nothing to do with the experiment, resulted in significantly lower measures of PPT for both familiarisation and test trials, compared to the control condition in which the feature was absent. There were no significant differences between groups for pre-test anxiety or VAS pain ratings.

Examination of results, and principal findings

The overall aim of this investigation was to investigate the roles of social, contextual and environmental factors as mediators of within-individual variation in the perception and reporting of acute pain. The studies reported in this thesis have demonstrated that manipulation of contextual factors unrelated to the pain stimulus results in changes in the perception of a pain stimulus and concomitant changes in stimulus intensity required to achieve pain threshold. Significant changes in the subjective experience of the second of two identical pain stimuli were also shown.

Three factors common to clinical and experimental situations were investigated: Differences in a pre-procedure briefing, altering the degree of preparatory information (providing predictability) and the locus of perceived control provided within the situation, the influence of personal characteristics inherent within the situation (the sex of the experimenter) and features of the environment in which the procedure takes place.

The subjective experience of pain threshold is stable within individuals, and remains the same regardless of the stimulus intensity required to achieve it.

Experiments 1 and 2 were conducted in order to assess the test - retest validity of the nail-bed pressure algometer and to assess its sensitivity to an intervention of known efficacy. These experiments show that the nail-bed pressure algometer provides reliable and valid measures of pain threshold (stimulus intensity at the advent of pain).

Experiment 1 showed that whilst there is a very broad range of pain threshold between participants, measures of PPT using the nail-bed pressure algometer were highly reliable within participants over repeated measures. This suggests that all else being equal, pain thresholds within participants are stable over time. The same principle was found for VAS pain rating. For as long as the situation within each trial was uniform (location, experimenter and experimental briefing), the subjective experience of pain threshold within participants was also stable.

The results of Experiment 2 show that the nail-bed pressure algometer is sensitive to an intervention known to be effective in the mediation of deep-tonic pain. In line with previous research, the application of intra-segmental vibratory stimulation resulted in significant elevation of stimulus intensities required to achieve pain threshold (e.g. Kakigi et al., 1993 64; Kakigi & Shibasaki, 1992 67; Kosek & Hansson, 1997 59; Sherer et al., 1986). This result is concordant with the Gate Control Theory of Pain (Melzack & Wall, 1965; Wall, 1978). However, there was no concomitant change in subjective pain rating. This suggests that within participants, the subjective experience of the advent of pain remains the same regardless of the stimulus intensity required to achieve it. The results of the validation studies taken in combination with the results of the three principal studies demonstrate that the prototype nail-bed pressure algometer used in conjunction with VAS pain rating is sensitive to both a physical intervention known to be effective in ameliorating deep, tonic pain of the kind induced by mechanical pain stimuli, and psychological manipulations. The use of combined measures has been shown here to provide a greater degree of information than either measure alone.

The provision of information can influence the evaluation of a potentially painful procedure

Experiment 3 showed that the nature of preparatory information provided within a dyad significantly affects the perception of a pain stimulus. As suggested, within experimental and clinical dyads, pre-procedure instructions or briefings provided by the researcher or clinician are the most explicit environmental elements upon which patient or participant expectancies concerning the situation can be based.

It was suggested that the content of such briefings may vary in at least two ways; preparatory information allowing predictability, and the locus of perceived control within the dyad (the degree to which the participants believe they can influence events within the situation). It was also suggested that the effects of elements of the briefings pertaining to control would depend upon the chronic accessibility of cognitive traits related to control within the participants.

The results of Experiment 3 show that when comparing the second of two identical stimuli to the first, participants rated the second stimulus as more painful when explicit control to halt the trial was perceived as being in the hands of the experimenter (low perceived control). It is of significance that this occurred even though the participants were informed that the experimenter knew their pain threshold stimulus intensity from the first (baseline) measure and that the intensity of the impending stimulus would be exactly the same (high predictability). This suggests that although participants were aware of what to expect in respect of stimulus intensity (high predictability), the absence of a perceived means of influencing the event (low control) led to a more negative evaluation of the situation, resulting in a more negative affective-motivational state than participants in the control (I+C) condition, who had been given explicit control over events.

Therefore, the second stimulus, although no more intense than the first, was perceived more negatively, in effect, increasing the 'unpleasant' component of the experience. To extend the flat tyre analogy (p 30), this represents the difference, in the event of a flat tyre, between knowing one has access to a jack and a wheel brace, and knowing one does not. Although the immediate situation is no worse; the flat tyre is no flatter, the situation is perceived as generally more unpleasant overall, as nothing can be done about it.

The group provided with preparatory information but no control (I-NC), rated the second stimulus as more painful in comparison to the first. This occurred irrespective of LOC styles of the participants in that group. On the other hand, participants in the NI-NC condition who were not provided with preparatory information (low predictability), and who perceived control as being in the hands of the experimenter (low control) showed a significant reduction in VAS pain rating for the second stimulus. Moreover, VAS Pain rating and LOC score were strongly related in this condition (a more internal LOC style related to lower pain rating and a more external LOC style related to higher pain rating). Comparison scale responses from participants in the NI-NC condition showed a bimodal distribution that is strongly correlated with VAS pain rating, and concordant with the relationship between LOC style and VAS pain rating.

It appears that in the NI-NC condition, withholding preparatory information concerning the intensity of the impending pain stimulus resulted in different evaluations of the situation between participants. That is, participants responded differently to the lack of predictability. These differences may be a result of the activation of different control related chronically accessible trait constructs within each participant. As stated previously, people are more sensitive to information in the environment that is relevant to their individual long-term trait constructs (e.g. Bargh, 1990; Bargh & Pratto, 1986). Thus, it appears likely that explicitly placing perceived control in the hands of the experimenter activated trait constructs pertaining to control within the participants, but that the activated representations are different, depending on the LOC style of the participants. In other words, withholding explicit control activated different representations in individuals with a more external LOC style and who believe already that control lies in the hands of luck, fate, or powerful others (i.e. that they have little direct control themselves), than in individuals with a more internal LOC style, who believe that events within their personal environment are under their own control.

The provision of preparatory information in the I-NC condition (high predictability - low control) appears to have suppressed these differences. Participants knew exactly what was going to happen with respect to the intensity of the impending stimulus, but having no control over it increased the general unpleasantness associated with the event (as suggested above).

However, withholding preparatory information in the NI-NC condition (low predictability - low control) appears to have allowed expression of the differences in activated trait constructs between participants. Although participants in the NI-NC condition perceived control as being in the hands of the experimenter, there was now an element of ambiguity concerning the outcome. It seems likely that differences in activated control-related trait constructs between participants influenced the interpretation and ultimate significance of the ambiguous element to the participants. To those with a more internal style, the ambiguity may have represented an opportunity. Where the outcome is not explicitly stated, and thus not 'fixed', there may exist the possibility of influencing it.

To those with a more external LOC style however, the reduced tendency to look for, or act upon such a possibility to begin with, means that the element of ambiguity simply represented greater uncertainty. This is in line with previous research showing that information can act as a stressor and exacerbate distress during a potentially painful event if the person is denied any apparent means of controlling that event (Law et al., 1994; Miller, 1980; Miller & Mangan, 1983; Weisenberg et al., 1985).

Differences in activation of chronically accessible traits relating to personal control may provide an explanation for the unpredictable effects of information on the perception of pain shown in previous research. It has been noted that due to the diversity in the types of information used in research, no straightforward relationship has been found between the receipt of information about an event and the reactions to the event (Thompson, 1981).

However, if individual differences in socially acquired, long-term trait constructs are taken into account, it appears that the effects of information become more predictable. For example, Miller and Mangan (1983) suggest that preparatory information may exacerbate patient distress and that variations in coping style interact with and determine the impact of information. They suggest that patients are generally less aroused when the information with which they are presented is consonant with their coping styles.

Evidence for that suggestion comes from an earlier study by Thompson (1981), who reported that the provision of information before a painful event (surgery) gave mixed results dependent upon the cognitive coping strategy employed by the patients. Patients who employed avoidant cognitive strategies experience less preoperative anxiety, but also had less favourable postoperative attitudes. Thompson suggests that the use of an avoidant strategy depends on the situation. If vigilance (information seeking) is likely to be effective in reducing or avoiding pain, it is useful. If not, it would only result in increased anxiety. The results of Experiment 3 showing that participants in the I-NC condition rated the second stimulus as more painful than the first (in the absence of perceived control) are in line with that suggestion, and support the idea that the activation of long-term trait constructs relating to control, influences the ultimate impact of information.

Thompson goes on to suggest that the effects of a warning signal may depend on the strategies and goals it evokes in the recipient. It is suggested here that those strategies in turn, depend upon individual differences in chronic trait availability.

Law et al. (1994), found that information in the form of stress inoculation training resulted in higher levels of reported pain for those participants with low desire for and feelings of control. Similarly, in a study by Weisenberg et al. (1985) the provision of information allowing predictability resulted in high Trait Anxiety participants reporting more pain than low Trait Anxiety participants. In these studies two different types of information; information on dealing with stress and information allowing predictability respectively, have a similar effect on the perception of pain as the information concerning the impending stimulus intensity used in Experiment 3. Therefore, it seems probable that information does have a predictable effect, but that effect is dependant upon chronically accessible trait availability within participants.

The results of Experiment 3 are in line also with the suggestion that information allowing predictability is likely to act as another ingredient in control (Weisenberg et al., 1985). When an individual feels capable of acting upon the information provided (internal LOC style or high perceived control), then that information is helpful. However, the same information may be seen as simply more pressure by somebody who already doubts their ability to manage (e.g. the I-NC condition in which information was provided, but control was withheld). Weisenberg et al. note also that many psychological techniques for the regulation of pain depend upon the willingness of the individual to accept control.

Miller (1980) suggested that under circumstances where a person doubts their own ability to exercise behavioural control, or when the correct necessary action is unclear, that person may be willing to hand over control to another. This would especially be the case should the other person be seen to have greater expertise or skill to deal with the threat. It seems likely that this is how clinicians and researchers are perceived.

In the NI-NC condition of Experiment 3 it would have been reasonable to expect that participants with a more external LOC style would be more ready to yield control to a 'competent other' than participants with a more internal LOC style who, in turn, would be reasonably expected to respond less well to having control taken from them. It could be argued then, that withholding control should have resulted in those with a more internal LOC style evaluating the situation more negatively than those with a more external LOC style. However, it should be noted that all participants had been informed at the beginning of the experiment of their rights to halt or withdraw from the experiment at *any* time, as required under ethical guidelines. Thus, under the experimental condition, it is possible that participants with chronically accessible traits relating to a more internal LOC style (e.g. higher self-efficacy and confidence in their ability to control events), were generally more confident of their own judgement concerning the situation. Therefore, should it have come to it, in the absence of an explicitly stated outcome they felt sufficient personal control or sense of self-efficacy to prevent events from progressing beyond their limits, in spite of new instructions from the experimenter. On the other hand, participants with chronically accessible traits relating to a more external LOC style (e.g. lower self-efficacy and lack of confidence in their ability to control events), may have lacked confidence in their ability to exert or regain personal control should events threaten to exceed their limits. Thus, evaluation of the situation by participants with a more external LOC style would be more negative overall compared to evaluations by participants with a more internal LOC style.

Experiment 3 shows that qualities of a pre-procedure briefing can influence the interpretation of a pain stimulus and suggests that the interpretation depends to a degree upon individual differences in long-term cognitive structures that are activated by elements of the briefing. A situation in which control is in the hands of the experimenter and which has an explicitly stated (and thus 'fixed') outcome results in an overall more negative evaluation and a concomitant increase in unpleasantness associated with the pain stimulus. On the other hand, the evaluation of a situation in which control is in the hands of the experimenter but in which the outcome is ambiguous, appears to result in different interpretations depending upon differences in chronic control-related trait accessibility between participants. The activation of traits associated with a more internal LOC style

leads to a more positive evaluation of the situation and lower levels of unpleasantness associated with the pain stimulus. Conversely, the activation of traits associated with a more external LOC style leads to a more negative evaluation of the situation, and greater unpleasantness associated with the pain stimulus.

Socially acquired gender-role expectations can influence the evaluation of a potentially painful procedure

In contrast to the explicit and variable nature of pre-procedure briefings, Experiment 4 examined the effects of the sex of the experimenter (a social factor inherent to researcher-participant and clinician-patient dyads) on the perception of a pain stimulus. The results of Experiment 4 show a main effect for participant sex. Males reported higher pain thresholds overall. This is in line with previous research using mechanical pain stimuli (pressure algometry) (e.g. Brennum et al., 1989; Fillingim & Maixner, 1995; Fischer, 1986, 1987; Mersky & Spear, 1964; Riley III et al., 1998). The results also show that both male and female participants reported significantly higher PPTs to a female experimenter than to a male experimenter.

The higher pain thresholds recorded for the female experimenter group agree with previous research (Levine & De Simone, 1991), and the suggestion that gender-role behaviour may be an important determinant of individual responses to pain (Otto & Dougher, 1985). However, these results cannot be explained fully by the stereotypical gender-role motive of males trying to appear macho to a female.

Firstly, if the male participants were fulfilling stereotypical gender-role requirements of appearing macho and hiding their weakness from females (Levine & De Simone, 1991), it is reasonable to suppose that male participants would have attempted to demonstrate this by delaying reports of pain threshold (as suggested by Otto & Dougher, 1985), but reporting lower levels of pain (lower VAS pain ratings). That is, there should have been a divergence between measures of pain threshold and pain rating for male participants reporting to a female experimenter compared to the same males reporting to a male experimenter. As

noted previously, there would be little benefit in providing an 'impressively' high pain threshold if it is accompanied by an equivalently high pain rating. Secondly, if the difference in reports of PPT between male experimenter and female experimenter groups was a function of the desire by males to impress a member of the opposite sex, why should the same pattern of pain threshold reporting be observed in female participants?

The key may lie in the fact that the cold pressor test, as used by Levine and De Simone, is self-administered by participants (under instruction from the experimenter). In the case of mechanical pain stimulus, the stimulus is delivered by another (as indeed, are most acutely painful clinical procedures). In light of this, the simplest explanation of the results is that when the stimulus was delivered by a female, participants required greater stimulus intensity to achieve the degree of unpleasantness signalling pain threshold than when the stimulus was delivered by a male. In other words, the presence of an opposite sex assessor activated gender stereotype trait constructs within the participants (in line with Bargh, Chen et al., 1996; Chen & Bargh, 1997), and the activation of these trait constructs influenced subsequent dyadic interaction (e.g. Snyder et al., 1977). As noted, examples of traits associated with the female stereotype are sensitivity, understanding, gentleness and caring. As the delivery of painful stimuli runs contrary to these traits, it is most likely that participants confronted with a female experimenter formed different expectancies concerning the situation and possible outcomes (e.g. Higgins & Bargh, 1987) than participant confronted by a male experimenter.

Evaluation of the situation and short-term hypotheses concerning probable outcomes based upon the activated female stereotype trait constructs of gentleness, caring and sensitivity were likely to be more positive overall. In effect, participants in the female experimenter conditions *expected* less pain than participants confronted with a male experimenter, as a result of an overall less negative evaluation of the situation and its potential for harm. In short, the activation of female stereotype trait constructs appears to have resulted in a less negative evaluation of the situation and a less negative affective-motivational response compared to the activation of the male stereotype trait constructs. Thus, in the presence of a female, the entire situation, including the pain stimulus, was perceived less negatively (as

presenting less potential for harm) and so as less unpleasant. Therefore, it took greater stimulus intensity from a female experimenter than from a male experimenter to achieve the same level of unpleasantness signalling the subjective experience of pain threshold.

In light of this, the influential factor in experimenter sex effects is less likely to be the conscious 'censoring' of behaviour by the participants according to their socially acquired ideals of gender-role behaviour (i.e. a participant oriented effect). Rather, it is more likely to be the result of differences in the evaluation of the situation by participants influenced by the activation of stereotypical traits associated with the experimenter, and subsequent differences in expectancies concerning the outcome (i.e. an experimenter/context oriented effect).

This interpretation fits with the evidence reviewed in Chapters Three and Four, insofar as the evaluation of the environment for the likelihood of potential harm is less likely to depend to a major degree upon the characteristics of the individual than on the characteristics of the features evaluated. Environmental features signalling possible danger will have a similar meaning to both males and females, as what is potentially harmful to a female is also potentially harmful to a male and visa-versa.

Features of the immediate environment can influence evaluation of events within that environment

Within the experimental dyad, both what is said and characteristics of who says it have been shown to influence the perception of a painful stimulus, most likely through the effects of these factors on the evaluation of the situation by the participants. Experiment 5 tested the effect of a non-social feature of the environment which signals the nature of the situation and its significance to the individual. In this case, a negatively valenced object in the form of a wound classification and dressings reference chart of a type commonly found in clinical environments.

The results of Experiment 5 showed that the mere presence of the clinical reference chart resulted in significantly lower measures of PPT for the group exposed to it, compared to the control group who were not exposed to it. This result is in line with the principles of the automatic evaluation effect discussed in Chapter Four. The work of Chen and Bargh (1999) demonstrates a direct link between the automatic process of evaluation of environmental objects as either positive or negative, and affective-motivational state and subsequent behavioural propensity. Experiment 5 extends these results by demonstrating the effect of these automatic processes on the perception of a potentially painful procedure in an ecologically valid research (and quasi-clinical) situation.

The automatic evaluation effect, as noted previously, has been described as a continuous process that is universal and unconditional and requires neither awareness nor intent (Bargh, 2001; Bargh, Chaiken et al., 1996; Bargh & Chartrand, 1999). Its effects are pervasive, and can influence subsequent evaluations and higher cognitive processes (e.g. Bargh & Ferguson, 2000; Bargh & Pietromonaco, 1982). The images on the reference chart were only two dimensional images, and as noted by Giner-Sorolla (1999), the immediate appraisal may be modified by later perceptions. In the case of Experiment 5 for example, the immediate impact of the images may have been mitigated by the fact that the stimuli were just pictures on a chart and not real wounds, thus reducing subsequent emotional response. But even so, the fact that an effect was shown for images, both by Giner-Sorolla and in Experiment 5, supports the contention that automatic evaluation is a basic and unavoidable process with pervasive effects, and is indicative of the implicit and inherent nature of the process.

The results of Experiment 5 support the idea that the automatic evaluation of a negatively valenced feature of the environment, which for all practical purposes in the minds of the participants (as determined by post trial probing) had nothing at all to do with the experiment at hand, triggered an overall more negative evaluation of the situation (by signalling that the environment held a greater potential for harm) and an increased negative affective-motivational state, resulting in reduced pain thresholds for that group.

Extending the principle

The automatic evaluation effect may also go some way to explaining the aversion to hospitals that many people express. When asking a person who expresses an aversion to the hospital environment, why they dislike hospitals (as the author has done frequently), the responses are usually ambiguous. Usually, the person cannot present a single precise reason for their aversion, rather they present a generalised and ambiguous expression of dislike. One of the most frequent explanations given is 'the hospital smell'. In light of the principles of automatic evaluation, it seems more likely that the actual aversion stems from the increase in negative affective-motivational state generated by the prevalence of negatively valenced information present within the clinical environment.

As the evaluation of environmental information occurs at a very low (pre-conscious) level, the resulting change in affective-motivational state and increase in arousal would appear as a general, non-specific sense of 'unease' or 'disquiet' which could not be attributed to any particular factor, but which would be accompanied by an urge (motivation) to avoid or remove one's self from the cause of the unease. As the specific cause of the feeling of unease may not have been consciously identified or attributed to any one thing in particular, the general sense of disquiet and increased arousal and avoidance motivation would most likely be generalised to the situation as a whole. Thus, with respect to the frequently expressed rationale of 'the hospital smell', whilst the odour itself is innocuous (at worst, Hycolin or some other general surface disinfectant), and often barely noticeable, it seems most likely that the odour serves as a signal, triggering the learned association between the smell and the situation (e.g. Smith et al., 1992).

As noted by Bargh (1982), awareness of a source of environmental information is not necessary for it to affect conscious judgements. Indeed, it has been shown that awareness of a priming stimulus and its potential effects prevents the effects from occurring (Dijksterhuis, Bargh et al., 2000). As people are not aware of the pre-conscious evaluation of features of the environment, or in many cases even the presence of the stimulus (Bargh & Pietromonaco, 1982), it follows that the resulting affective-motivational state applies to the entire context rather than the particular stimulus *per se*, (as suggested above) and in this way the presence of such valenced stimuli serves to signal the safety or danger of the immediate environment

as a whole (Bargh & Chartrand, 1999; Chen & Bargh, 1999). In light of this, and the often overwhelming predominance of such valenced stimuli in clinical environments, it is reasonable to suppose that exposure to such environments will result in an increased negative affective-motivational state in people attending hospitals, regardless of whether they are attending as patients who may be expecting some unpleasant procedure, or simply as visitors. Moreover, an association between the environment and the affective-motivational response to it (the sense of 'unease') will begin to be laid down and will influence expectations on subsequent exposure to that environment.

What does *a measure of pain threshold measure?*

The results of Experiment 5 suggest that people exposed to such environments and awaiting an acutely painful procedure (e.g. venipuncture) will have a significantly increased motivation to avoid potentially painful stimuli, and a significantly increased negative affective response to the administration of such stimuli. In other words, such individuals will in effect, be 'primed' for pain. Thus, pain stimuli of intensities that in other situations may not be perceived as being painful (or at least, not *as* painful), may be experienced as painful (or more painful), due simply to the environment in which the procedure takes place, rather than qualities or the intensity of the pain stimulus itself.

However, it should be remembered that, as stated by the IASP, pain stimulus is not pain *per se*, and in experiments which rely upon measures of pain threshold, what is being measured is only the stimulus intensity at which participants report the advent of pain. Therefore, it must be acknowledged that in experiments (such as Experiment 5) where the presence of a negatively valenced feature of the environment is shown to result in a significant reduction in pain threshold, the evaluation of the participants which results in an increase in negative affective-motivational state, also increases the motivation and behavioural propensity to avoid the stimulus (as stated above). It is possible therefore, that participants in Experiment 5 could have been reporting pain threshold at sub-threshold stimulus intensities, in order to avoid the experience of pain altogether. Due to the entirely subjective nature of pain, and the fact that pain itself is a non-observable phenomenon, this possibility exists in all studies which rely on measures of pain threshold.

However, participants were not overtly aware of the experimental manipulation, and as noted previously, conscious awareness of 'primes' and their effects tends to nullify their effect. Moreover, participants are unlikely to have been consciously aware of the increase in negative affective-motivational state or propensity to avoid the stimulus within the time-frame of the Experiment (around 5 minutes per trial), and all participants were acting under the explicit instructions to stop the trial as soon as they felt the pressure had become *painful*. It is most likely that participants were responding 'honestly', but that under the experimental condition, the general increase in negative affect resulted in the pain stimulus being perceived as being more 'unpleasant' (as opposed to more intense), thus lower stimulus intensities were required to achieve pain threshold in the experimental condition.

That being said, in light of the evidence that stimulus intensities at pain threshold are stable within individuals over time (e.g. Experiment 1), and further, that the experience of pain threshold remains the same within individuals, regardless of the stimulus intensity required to achieve it (e.g. Experiments 2 and 4), those experiments showing differences in stimulus intensity required to achieve pain threshold resulting from psychological interventions raise questions concerning the nature of pain threshold: What does a measure of pain threshold (or to be precise, a measure of stimulus intensity at the advent of pain) reflect? Further, in situations showing significant elevation or reduction in pain threshold as a result of psychological manipulation over repeated measures or between groups, what accounts for the differences? The following section discusses the nature of pain threshold and proposes an integrated biopsychosocial model which provides answers to these questions.

The Nature of Pain Threshold

> "*When the right thing can only be measured poorly, it tends to cause the wrong thing to be measured only because it can be measured well. And it is often much worse to have good measurement of the wrong thing - especially when, as is so often the case, the wrong thing will IN FACT be used as an indicator of the right thing - than to have poor measurement of the right thing.*" (Tukey, 1979).

The intensity-unpleasantness equilibrium

Taken together, the results of the experiments presented in this thesis suggest that measures of pain threshold reflect an equilibrium between the sensory and affective-motivational components of pain. In other words, the experience of pain threshold; the subjective psychological event that signals the advent of pain, appears to be stable within participants, and to be a result of a 'tonic balance' between the sensory component (signalling stimulus intensity) and the degree of unpleasantness associated with the situation, as determined by the influence of preattentive limbic processes on affective-motivational state.

The results of Experiment 1 show that under stable conditions across measures (no experimental intervention or changes in environmental conditions), repeated measures of pain threshold and subjective pain rating are stable for each participant over time. The results of Experiment 2 showed that subjective pain rating remained unaltered even though a significant elevation in pain stimulus intensity was required to achieve pain threshold. As mentioned, this suggests that the experience of pain threshold remains the same, regardless of the stimulus intensity required to achieve it.

Experiment 4 showed that differences in appraisal of the situation due to the presence of a male or female experimenter resulted in differences in stimulus intensities requires to achieve pain threshold (higher in the presence of a female and lower in the presence of a male). However, as with Experiment 2, there were no differences in subjective pain rating across measures. In the same vein, Experiment 5 showed that differences in evaluation due to the presence of negatively valenced stimuli in the environment resulted in a lower stimulus intensity required to achieve pain threshold for the group exposed to the manipulation. Again, there was no difference in subjective pain rating between groups.

By contrast, the results of Experiment 3, in which participants rated the second of two pain stimuli of identical intensities (i.e. previously recorded pain threshold intensity), showed that differences in evaluation due to manipulation of preparatory information and locus of perceived control resulted in participants perceiving the second of two identical stimuli as either more or less painful compared to the first. In this case, whilst the intensity of the pain stimulus remained fixed for each participant, their perception of the stimulus changed significantly.

Whilst at face value it might seem pointless to ask participants to quantify their pain experience at pain threshold stimulus intensity, as intuitively it might be expected that as pain threshold signals the advent of pain, subsequent subjective measures of pain intensity would be just above "*no pain*". However, the experience of pain, by definition, must contain all the elements that make it 'painful'. This includes both the sensory component signalling intensity and the affective motivational component that makes a painful experience 'unpleasant', and constitutes the drive to remove it (or remove one's self from it). As shown in Chapter Three, where a component is removed (e.g. the sensory component, as in the case of the cardioembolic stroke patient reported by Ploner et al., 1999), the experience resulting from administration of a pain stimulus could not be classified by the patient as 'pain', but merely as 'unpleasant'.

In this, discussion of the components of the pain experience is rather like discussing the ingredients of a cake. Whilst the ingredients of a cake are eggs, butter, flour and sugar, once baked, the cake is something other than the sum of its ingredients. Thus, whilst it may be possible to state, for example, that the contributing elements of any given slice are flour, sugar, eggs and butter, in reality, the 'experience' of cake is none of those, it is just cake. In the same way, whilst the elements contributing to the experience of pain have been differentiated into sensory-discriminatory, cognitive-evaluative and affective-motivational components, the subjective experience of pain is a synergistic psychological event which is entirely subjective and unique to the individual. It is something other than the sum of its components, yet it requires *all* the components.

It is suggested that any subjective measure of pain intensity will also be influenced to some degree by the degree to which the participant perceives it as unpleasant. In other words, measures of intensity reflect not just stimulus intensity, but (at least partly) unpleasantness, as determined by the current affective-motivational state and significance of the situation as a whole, as perceived by the participant. This is supported by studies that have attempted to use independent measures of intensity and unpleasantness but have found them to be related (e.g. Dahlgren et al., 1995).

Measures of pain threshold are subject to the same principle. Whilst in themselves, measures of pain threshold measure only stimulus intensity at the advent of pain, it is suggested that the advent of pain within individuals is determined by a balance between the intensity of the stimulus and the affective-motivational state of the individual. Whilst the inherent qualities of pain stimuli vary, depending on the nature of the stimulus (e.g. electrical, chemical, thermal or mechanical), for any given stimulus, the subjective experience of the *advent* of pain, almost by definition must be the same within individuals.

However, previous research and the experiments presented in this thesis show that the advent of pain can occur within the same individual at different stimulus intensities. This begs the question, what exactly does a measure of pain threshold reflect? If an intervention is shown to result in a reduction in pain threshold, it cannot be said that the experience was more painful, as that would be a supra-threshold measure of pain (it is not likely that any participant exposed to a stimulus of increasing intensity would continue beyond the advent of pain after being instructed to 'say stop as soon as it becomes painful').

Similarly, if an intervention is shown to result in elevation of pain threshold, it cannot be said that the experience was less painful, as, by definition, any experience preceding the advent of pain, is not pain threshold. So, if the same experience is being achieved under different stimulus intensities, what accounts for the differences? In other words, when the advent of pain occurs at a lower stimulus intensity across repeated measures, what 'makes up the difference' in subjective experience between the previously recorded threshold intensity and the lower intensity? Conversely, when the advent of pain occurs at a higher stimulus intensity across repeated measures, what is removed?

It is suggested that whilst measures of pain threshold show simply stimulus intensity at the advent of pain, measures showing changes in stimulus intensity required to achieve pain threshold within the same individual are reflecting a shift in the balance between the relative contributions of the intensity of the stimulus and the degree of unpleasantness associated with it, as determined by preattentive emotional processing and the resulting degree and valence of affective-motivational state.

A reduction in recorded pain threshold across measures represents the advent of pain at a lower stimulus intensity. But why should a pain stimulus at lower intensity than previously recorded threshold levels achieve pain threshold? As noted, it could be said that in instances where a significant reduction in pain thresholds are recorded, participants are simply attempting to avoid the experience of pain altogether. Whilst this is not impossible, it does imply intent. Preconscious evaluation has been shown to occur immediately on perception of a stimulus and without intent (Bargh, 1996). Moreover, classification of environmental stimuli as good or bad (the basic affective-motivational response to the stimulus) has been shown to occur within 250ms (Bargh, 2001), thus it cannot be said that participants are necessarily *aware* of an increased motivation to avoid pain. As noted in Chapter Four, at the level of preattentive evaluation, affect and motivation are indivisible. Changes in both affect and motivation occurring as a result of automatic evaluation are collateral. In other words, an increase in the behavioural propensity to avoid a stimulus or situation is accompanied in parallel by an increase in negative affect; the psychological 'drive' to avoid the situation or stimulus. Therefore, it is more likely that participants are reporting the advent of pain as instructed, but that the stimulus is perceived as more unpleasant (due to the increased contribution to the experience of a negative affective-motivational state), and thus painful at a lower stimulus intensity.

Similarly, elevations in pain threshold across measures beg the question, why does the administration of stimulus intensities greater than previously recorded pain threshold, not result in a higher subjective pain rating? Most probably because the same physical stimulus was perceived in light of a less negative affective-motivational state (lower negative affect and less motivation to avoid the stimulus), and so was perceived as less unpleasant, whilst the sum of the subjective experience at the advent of pain remains the same.

Figure 23 presents an integrated biopsychosocial model representing a possible explanation for the way in which stimulus intensity and automatic evaluation processes contribute to the experience of pain threshold. The model works within the parameters of what is known of the underlying neural bases of the sensory and affective divisions of pain (the pain matrix). The model acknowledges also the roles of automatic processes; the preattentive detection and processing of emotionally salient information in the environment, and the influences upon these processes of socially acquired, chronically accessible cognitive structures relating to individual traits.

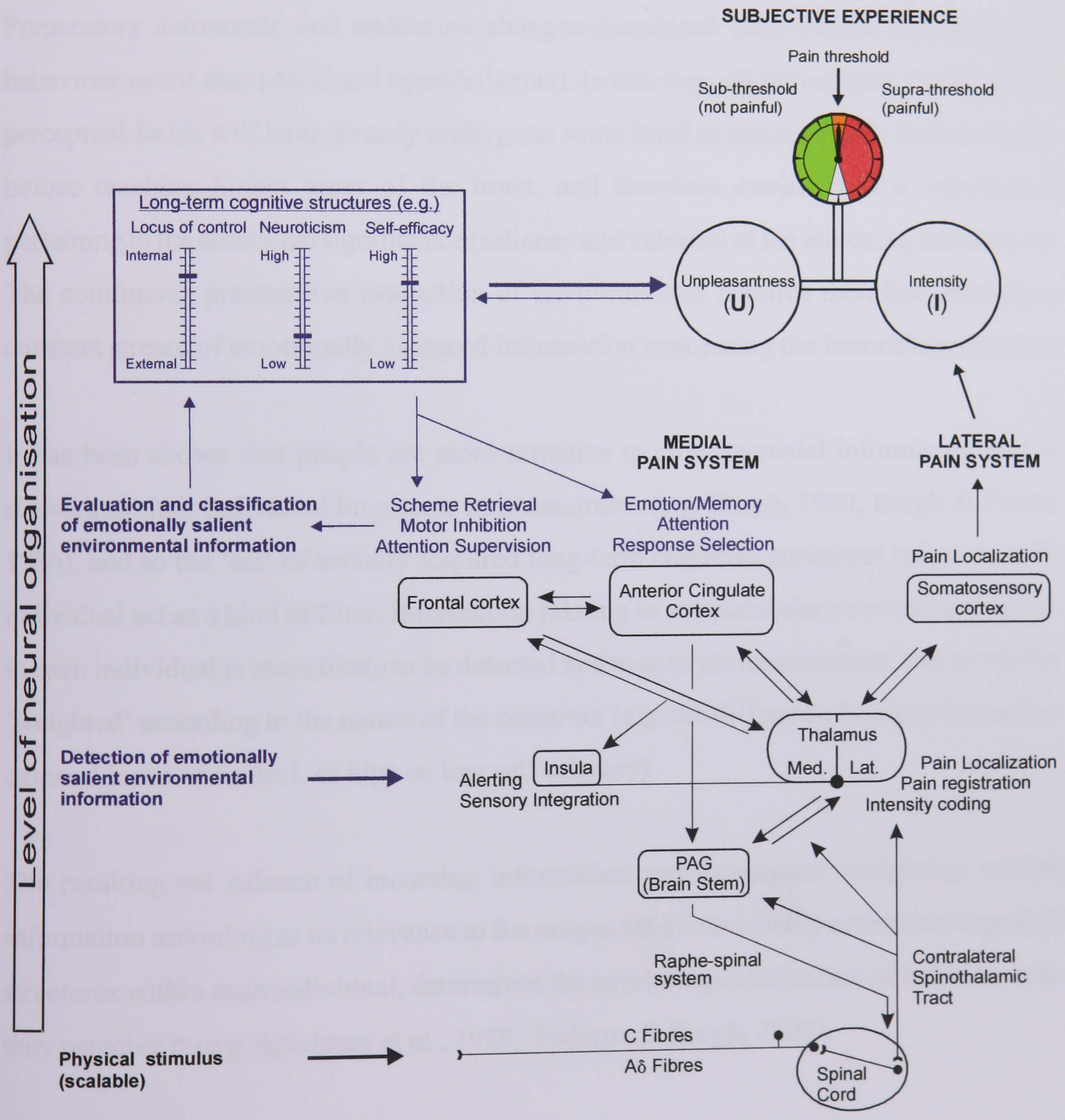

Figure 23 Model representing the equilibrium between unpleasantness and intensity determining the advent of pain (automatic processes in blue). The roles of the amygdala and other structures associated with the detection and evaluation of emotionally salient environmental information are accepted as givens at those levels of the model.

The biopsychosocial model and individual differences in pain threshold

At the detection, evaluation and classification levels of the model (as shown previously in Chapter Three), all incoming information is checked for novelty or persistence (reticular formation and locus coeruleus). The emotional significance of novel stimuli is recalled (amygdala) and determinations concerning its salience are made (ACC). Affective-motivational changes in response to the information are initiated (amygdala and ACC), and the appropriate behavioural response is selected (ACC).

Preparatory autonomic and endocrine changes associated with arousal and motivated behaviour occur also (ACC and hypothalamus). In this way, all information falling within perceptual fields will have already undergone some level of processing in limbic regions before reaching higher areas of the brain, and therefore carries with it information pertaining to the emotional significance (salience and valence) of the incoming information. The continuous preattentive evaluation of environmental features therefore provides a constant stream of emotionally valenced information concerning the immediate situation.

It has been shown that people are more sensitive to environmental information that is relevant to their individual long-term trait constructs (e.g. Bargh, 1990; Bargh & Pratto, 1986), and so the 'set' of socially acquired long-term cognitive structures unique to each individual act as a kind of filter. Information relating to any particular construct accessible in each individual is more likely to be detected and to activate the construct, and so will be 'weighted' according to the nature of the construct (e.g. the difference between internal or external locus of control, or high or low self-efficacy).

The resulting net valence of incoming information and subsequent 'weighting' of that information according to its relevance to the unique set of chronically accessible cognitive structures within each individual, determines the psychological situation of individuals as they perceive it (e.g. Spielman et al., 1988; Todorov & Bargh, 2002).

The situation as perceived by an individual in light of the valence and strength of their affective-motivational state influences the way in which subsequent information is interpreted, forming a kind of feedback loop. Thus, detection of negatively valenced stimuli in the environment results in elevated levels of arousal and alertness and an increased sensitivity to other negatively valenced stimuli in the environment.

The increased negativity of affective-motivational state results also in ambiguous or ambivalent stimuli being interpreted in a way that is congruent with the valence of previously detected stimuli (e.g. Bargh & Ferguson, 2000), and influences further 'downstream' processes such as emotion, mood and judgement (e.g. Bargh & Pietromonaco, 1982). It follows that the more negatively the situation is perceived by the individual, the more negatively (unpleasant) any noxious stimulus delivered in that situation is likely to be perceived.

In short, automatic evaluation provides a stream of emotionally valenced information that has been is filtered and weighted by the set of socially acquired, chronically accessible trait constructs unique to each individual. This information is fed back into the system and influences subsequent evaluations. The set of chronically accessible constructs peculiar to each individual acts as a 'template' influencing sensitivity to, and evaluation of salient stimuli. Therefore, information in any given environment is likely to be evaluated differently according to its relevance to long-term constructs within each individual, and so will result in different affective-emotional states between individuals in the same environment.

This accounts for individual differences in response to pain stimuli in the same environment, as shown by the wide range of PPT and VAS pain ratings recorded in Experiment 1. The stable PPT and VAS pain ratings recorded in Experiment 1 over five consecutive measures reflect the relative stability of pain threshold *within* individuals, when measured under stable conditions.

The biopsychosocial model and individual variance in pain threshold

Whilst the above accounts for between-individual differences in pain threshold, the experiments presented in this thesis show within-individual variation in the perception and reporting of pain resulting from manipulation of social, contextual and environmental factors. Figure 24 illustrates the way in which these manipulations influence individual pain thresholds in terms of the model presented in Figure 23.

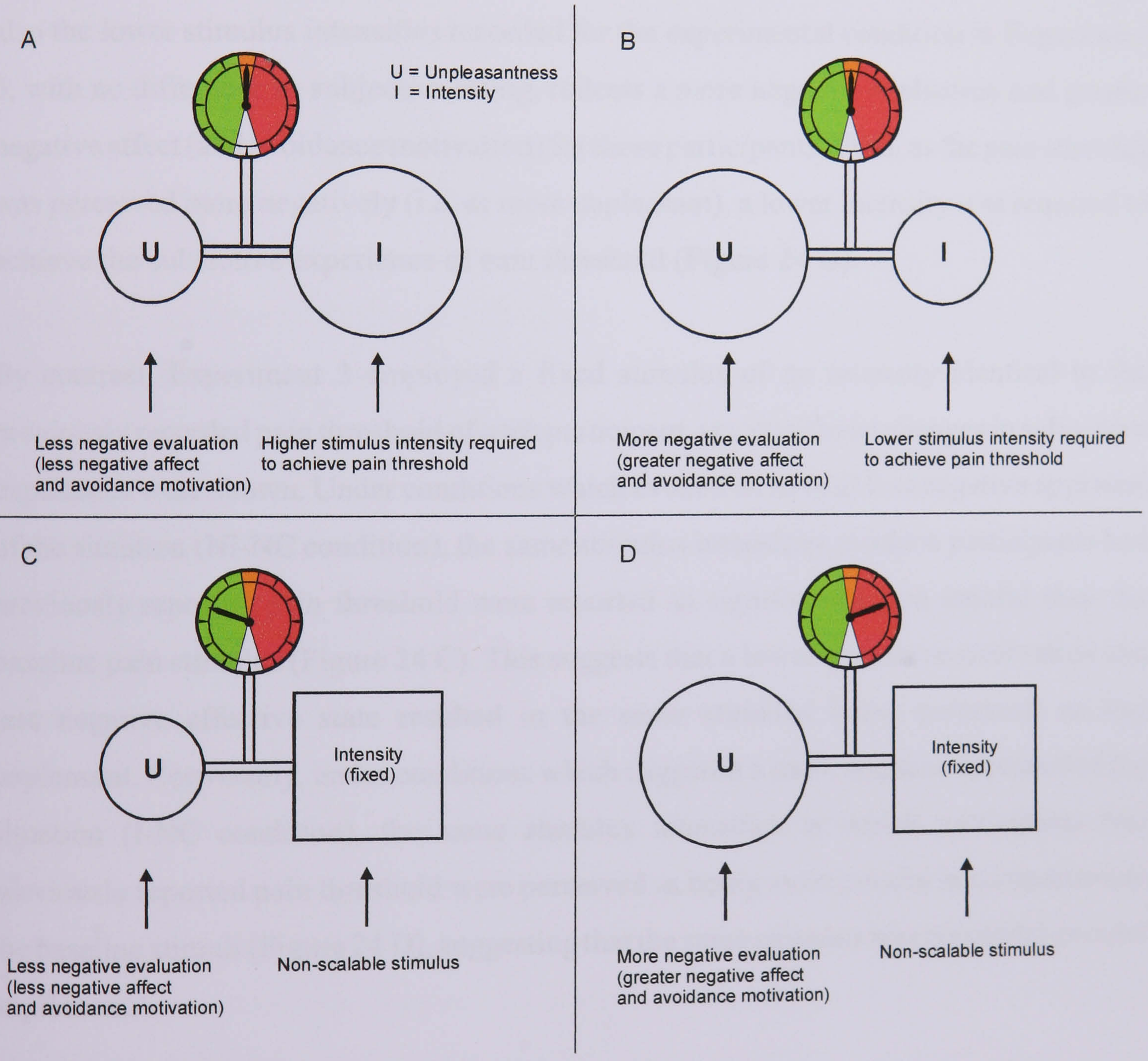

Figure 24 Examples of the effects of experimental manipulations on the pain threshold equilibrium.

The elevation in pain stimulus intensity required to achieve pain threshold with no change in subjective pain rating shown in the male-female experimenter condition in Experiment 3, reflect overall less negative evaluation of the situation and (thus) less negative expectancies by members of that group. Therefore the stimulus was perceived less negatively, and accompanied by a lower motivation to avoid it (i.e. as being less unpleasant), and so greater intensity was required to achieve the subjective experience of pain threshold (Figure 24 A).

Conversely, the reduction in pain stimulus required to achieve pain threshold with no change in subjective pain rating recorded from the female-male experimenter condition, and also the lower stimulus intensities recorded for the experimental condition in Experiment 5, with no difference in subjective rating, reflects a more negative evaluation and greater negative affect (and avoidance motivation) for those participants. Thus, as the pain stimulus was perceived more negatively (i.e. as more unpleasant), a lower intensity was required to achieve the subjective experience of pain threshold (Figure 24 B).

By contrast, Experiment 3 employed a fixed stimulus of an intensity identical to the previously recorded pain threshold of each participant, yet significant changes in subjective experience were shown. Under conditions which evoked an overall less negative appraisal of the situation (NI-NC condition), the same stimulus intensities at which participants had previously reported pain threshold were reported as significantly less painful than the baseline pain stimulus (Figure 24 C). This suggests that a lower avoidance motivation and less negative affective state resulted in the same stimulus being perceived as less unpleasant. Conversely, under conditions which triggered a more negative appraisal of the situation (I-NC condition), the same stimulus intensities at which participants had previously reported pain threshold were perceived as being more painful in comparison to the baseline stimuli (Figure 24 D), suggesting that the same stimulus was perceived as more unpleasant.

In short, whilst the stimulus is scalable, changes in evaluation result in significant changes in stimulus intensity required to achieve pain threshold, but no significant alteration in the 'sum' of the subjective experience (Figure 24 A & B). On the other hand, when the stimulus is of a fixed intensity, changes in stimulus intensity are not a contributing factor, but differences in evaluation result in significant differences in the subjective experience

(Figure 24 C & D). This latter example is important, as it suggests that under conditions in which a non-scalable, acutely painful stimulus[8] is to be applied, the ultimate pain experience is, to a degree, controllable through the manipulation of social and environmental factors not related to the pain stimulus.

Experiment 2 is different in that it involved the application of a physical intervention (vibration) which is known to influence the sensory component in line with the principles of the Gate Control Theory of Pain (Melzack & Wall, 1965). In this case, the intervention influenced the perceived *intensity* of the stimulus through modulation of the sensory nociceptive system (i.e. the lateral division of the pain matrix). Nonetheless, the results of Experiment 2 support arguments for both the existence and stability of pain thresholds within participants, especially when viewed in conjunction with the results of Experiment 1.

Experiment 1 showed that participants reported pain threshold at the same stimulus intensities over 5 repeated measures, each a week apart. It was suggested that this would be difficult for participants to achieve in the absence of some kind of cue, and that in the presence of a stimulus of increasing intensity, the advent of pain was the most likely cue. Experiment 2 involved the application of an intervention known to mediate perception of the *intensity* of noxious stimuli. The result of this was that a significant elevation in stimulus intensity was required in order to provide participants with the same cue. Once this cue had been provided, participant reported pain threshold, but did not report any significant difference in the subjective experience of pain.

Whilst the experience of acute pain is (normally) dependent upon contributions from both the sensory-discriminative division (signalling the intensity, quality and location of the stimulus) and the affective-motivational division of the pain matrix, the results of the experiments presented here suggest that activity in the affective-motivational division evoked by factors other than the nature (intensity and qualities) of a physical pain stimulus, nonetheless modulate the overall perception of the stimulus. Where sensory, cognitive and affective-motivational factors all contribute to the experience of pain, the experiments

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To clarify, it should be noted that to term a stimulus 'painful' is inaccurate insofar as it suggests that pain is a quality of the stimulus. Clearly, this is not the case. What is meant here by the term 'painful stimulus' is a stimulus of an intensity that one may reasonably expect to be perceived as painful by most individuals.

conducted for this thesis have shown that the contribution of the affective-motivational component is not necessarily dependant upon, nor a direct result of the pain stimulus or the experience of pain. Pre-existing affective-motivational states, or changes in state due to environmental influences are also determinants of the experience.

There is no evidence to suggest that the medial (affective-motivational) division of the pain matrix is exclusive to pain, rather it shares components with the central system associated with the processing of emotionally salient information and the production of affect. Changes in this system evoked by factors that have nothing to do with a pain stimulus, will nonetheless influence the overall experience of a painful event, by weighting the degree of 'unpleasantness' (i.e. the degree of negative affect and avoidance motivation) associated with it.

Implications

To what degree can changes in affective-motivational state influence the perception of pain stimuli? The results of the experiments conducted in this thesis have shown that differences in affective-motivational state induced prior to a painful stimulus is a significant modifier of the perception of the stimulus and as such, can influence the stimulus intensity required to achieve pain threshold. The fairly simple and straightforward manipulations employed have also been shown to result in the stimulus being perceived as 'less painful' in comparison to the same stimulus at an identical intensity. It is not extending the principle too far to suppose that similar processes could result in a comparatively intense stimulus being perceived as 'not painful'. Thus it is quite possible that affective-motivational state not only influences the perceived severity of a pain experience, but is a determining factor in whether the experience is perceived as painful or not.

As shown in Chapter One, there are situations in which the presence of an undeniably intense physical stimuli do not result in pain. For example, the Indian hook-swinging ceremony, which involves the celebrant undergoing what by western standards would be considered an immensely painful procedure; having steel hooks inserted under the skin and muscle on each side of his spine and then being suspended from these hooks by ropes attached to a cart. Yet this occurs in the absence of any apparent signs of suffering (Melzack & Wall, 1982). What could account for the apparent absence of pain in this situation?

To the objective observer, the act of inserting the hooks 'looks' painful. However, as mentioned in Chapter One, the pain a person feels cannot be known to an observer, but the observer can relate the situation to his or her own experience and draw inferences from it. This is adaptive as observing harm in another acts as a strong signal for the potential for harm in the current environment. However, it seems highly probable that the situation as perceived by the celebrant was completely different to what might reasonable be inferred by an objective observer. The insertion of the hooks is not seen as 'harm' by the celebrant, but rather as the culmination of a long term of ritual preparation in his honourable role as 'the chosen one'.

Similarly, the example of the 9 year-old boy reported by Chapman (1984), who had undergone a comparatively major surgical procedure (a nephrectomy) and yet, in the absence of any post-operative analgesia showed no signs of suffering until he was given 'proof' that the procedure had occurred (the author worked on a renal-transplant unit for 4 years and can report that the post-operative pain following a nephrectomy is generally rated by patients as quite severe). Again, to objective observers, the existence of the surgical wound, and the knowledge that the boy was not prescribed post-operative analgesia might suggest that the boy should have been in some pain. However, the situation as perceived by the boy (prior to the nurse 'proving' to him that the operation had been performed), was completely different. As far as he was concerned, the operation had not yet taken place.

The common denominator in each of these examples appears to be the beliefs held by the individuals involved concerning the nature of their situation; their evaluation of the situation based upon those beliefs, and the subjective perception of its meaning and emotional significance which determines the 'reality' in which a person exists (e.g. Spielman et al., 1988; Todorov & Bargh, 2002). Suggestive evidence in support of this has been provided by research into hypnosis. Whilst the precise nature and mechanism of function of hypnosis is not fully understood, there is some evidence to indicate that one of its principal actions is to allow the participant to 'reinterpret' incoming information, which would have a direct impact on the reality of the situation as experienced by the person under hypnosis.

Hypnosis has been shown to affect anterior brain function and the ACC in particular (Kropotov et al., 1997). Further evidence has supported the suggestion that hypnosis interferes with normal anterior brain function involving a high order attentional system (Croft et al., 2002). As shown in Chapter Three, the affective subdivision of the ACC is primarily involved in assessing the salience of emotional information and the regulation of emotional and motivational responses (Bush et al., 2000; Davidson & Irwin, 1999), and as noted, the cognitive subdivision of the ACC is a part of an attentional network distributed throughout the limbic system, and among the functions ascribed to this subdivision are selective attention and response selection.

Kiernan et al. (1995) reported several mechanisms which may explain hypnotic analgesia. Hypnosis may block transmission of nociceptive volleys to associative areas of the brain, possibly at the spinal and supraspinal levels. Moreover, they found (in line with previous research) that hypnosis resulted in a greater reduction in the unpleasantness of pain than in the intensity. They suggest that "...in addition to the reduction in unpleasantness directly related to reduction in pain sensation, a separate mechanism, perhaps related to reinterpreting the meaning of the painful sensation, is specifically related to a reduction in unpleasantness beyond that provided by reduction in sensation intensity" (p45).

Faymonville et al. (1998), report that hypnosis resulted in patients experiencing significantly higher impressions of control during surgery. They suggest that hypnosis allows the transition from a passive suffering state, to an active and independent state, and that it completely changes the subjective experience and perceptions of the patient. Faymonville et al. suggest that consequently, analgesia will result not only from preventing awareness of pain, but also from a selective reduction in its affective dimension through reinterpretation of the meanings associated with the painful sensation.

Faymonville et al. (1998) also found that in patients undergoing elective plastic surgery, hypnosis resulted in significantly more stable autonomic functions (heart-rate, systolic and diastolic arterial pressures and respiration rate) compared to patients in the control group who were provided with continuous stress-reducing strategies. This is consistent with the evidence reviewed in Chapter Three demonstrating the involvement of the anterior cingulate cortex in autonomic function, including respiration, heart-rate and blood pressure,

and further supports the idea of ACC involvement in the hypnotic mediation of pain. It is possible therefore, that the rituals observed by the celebrant prior to the insertion of the hooks in the hook-swinging ceremony (for example), and the 'ritual' of hypnotic induction may be different paths to the same state. A state which allows the individual to reinterpret the meaning and significance of the situation and thus modify its emotional impact.

In all, this suggests that the 'reality' of the situation as perceived by the individual (its meaning and significance) and the affective-motivational state concomitant with that reality is the determining factor in the perception of acute pain within participants. That is to say, differences in affective-motivational state may determine the difference between an intense experience and a painful one.

CONCLUSIONS

> *"If you are distressed by anything external, the pain is not due to the thing itself, but to your estimate of it; and this you have the power to revoke at any moment."* Marcus Aurelius Antoninus (121 AD - 180 AD). Meditations 167 A.C.E.

This thesis investigated the roles of social, contextual and environmental factors on the perception of acute pain. The results show that these factors are significant modifiers of the perception of a pain stimulus and of the experience of pain. The results further suggest that principles generated by research into automaticity and preattentive (automatic) processing are applicable in pain research, and provide a framework within which individual variation in the perception of pain may be conceptualised.

Using these principles, this thesis has shown that it is not only post-hoc emotional response to pain or qualities of pain stimulus which influences the ultimate experience. A priori perceptions concerning the nature of the situation in its entirety are also significant modifiers of the experience. These perceptions are (at least partly) driven by social, contextual and environmental cues, which serve to signal the relative potential for harm (pain) within a given situation. From this principle, several conclusions may be drawn.

Within-individual variation in response to pain may be explained in terms of preattentive processes.

The model presented above (Figure 23) illustrates a possible mechanism by which a balance between the intensity of a given stimulus and affective-motivational state determines the experience of a pain stimulus. It serves as a possible example of the way in which both between individual differences and within-individual variation in pain threshold may be understood.

Between-individual differences in the perception of pain have been studied extensively. Factors such as sex, ethnicity and cultural affiliation and personality (as discussed in Chapter Two) have long been known to be relatively reliable predictors of traits in the

perception and reporting of pain. It was suggested that these factors, rather than constituting direct influences *per se*, are simply terms describing socially (and partly biologically in the case of sex) acquired differences in long-term cognitive structures related to constructs such as locus of control, self-efficacy and gender-role stereotypes. Evidence was reviewed showing that the repeated laying down of associations between a painful event and socially appropriate response (according to gender, familial and cultural norms within a given society) can result in long-term changes in limbic structures associated with emotional processing (e.g. Bates et al., 1993; Davidson et al., 2000).

It is suggested that the socially acquired differences in long-term cognitive structures serve as 'trait-determinants' in the perception and response to pain or potentially painful situations. That is, these stable combinations of chronically accessible trait constructs exert a stable influence on the way in which an individual interprets their situation. In this way, they act as 'templates' for the affective-motivational response of each individual to a painful event, and thus influence their response to a painful event in predictable ways.

By contrast, this thesis has shown that the perception of pain by the same individual over repeated measures can be influenced through the manipulation of social, contextual and environmental features. That is to say, where the same pain stimulus is used (i.e. where differences in the qualities of a stimulus are not a factor), differences in the situation as perceived by the participants are sufficient to influence significantly their perception of, and response to the pain stimulus.

As noted previously, automatic evaluation is a significant modifier not just of behavioural propensity, but of the way in which a person experiences and interprets their reality (e.g. Spielman et al., 1988; Todorov & Bargh, 2002). This thesis has shown that differences in the content of pre-procedure briefings relating to predictability and locus of perceived control, differences in stereotype activation depending on the sex of the experimenter and features of the environment in which procedures take place are all significant factors influencing the way in which individuals perceive a painful event.

It is suggested therefore, that where between-individual differences demonstrated in stable conditions are attributable to differences in combinations of socially acquired traits, within-individual variation is principally a function of automatic evaluation processes which effect changes in affective-motivational state and thus the significance of a given situation as perceived by each individual.

People can be 'primed' for pain by their environment.

The influence that social, contextual and environmental factors have been shown to exert suggests that in many cases, people suffer more than necessary (if any suffering can be considered necessary). As suggested by Cardinal et al. (2002), emotions probably evolved from simple mechanisms mediating basic approach-avoidance behaviours which provided the capacity for organisms to seek physiologically valuable resources and to avoid harm. They suggest that simple and evolutionarily old brain systems may serve fundamental aspects of emotional processing. As noted by Dijksterhuis (2000), the structures involved are still present and still serve the purposes for which they evolved.

It has been shown that the left amygdala is particularly responsive to environmental cues for threat or danger (e.g. Davidson et al., 2000) and is involved in the evaluation of negatively valenced environmental information across a range of different modalities (e.g. Cuthbert et al., 2000; Lane et al., 1999; Lane et al., 1997; Morris et al., 1999; Tabert et al., 2001). The ACC also has been strongly implicated in the emotional processing of environmental information (e.g. Cardinal et al., 2002; Lane et al., 1997), and also in approach/avoidance behaviours (e.g. Davidson et al., 2000). Moreover, cells in the ACC have been identified which respond specifically to pain related environmental cues and to the *anticipation* of a pain stimulus (Hutchison et al., 1999).

As discussed in Chapter Three, these structures are phylogenetically ancient, and evolved to fulfill an evolutionarily critical function; to enable an organism to detect and avoid potentially harmful stimuli quickly, and without the need for the time-consuming conscious processes of identification and classification. Activity in these structures associated with the automatic and continuous processing of environmental information (which as noted, has been described as universal and unconditional) requires neither conscious awareness nor intent.

The affective-motivational responses to the net valence of incoming information is also automatic, occurring within 250 ms (e.g. Bargh, 2001; Bargh & Ferguson, 2000; Giner-Sorolla et al., 1999) as is the behavioural propensity consonant with that response (Chen & Bargh, 1999). Therefore it is reasonable to expect that an individual entering an environment containing large amounts of negatively valenced information, will automatically undergo affective-motivational changes in response to the information in that environment.

Thus in many cases, and particularly in clinical environments which often contain large amounts of negatively valenced information (e.g. the chart used in Experiment 5), individuals may be 'primed' for the experience of pain. This is to say, that the prevalence of negatively valenced information in the environment will elicit a negative affective-motivational (avoidance) response, which will influence the expectancies and short-term hypotheses formed by an individual concerning the probable outcomes of the situation.

The already negative affective-motivational state is likely to be compounded by the fact that subsequent behaviour of an individual in clinical situations often directly contradicts their motivational state. For example, presenting an arm for venipuncture (an approach behaviour in the presence of an avoidance state). In short, where cues in the environment signal a high potential for harm and result in an increase in negativity of affective-motivational state and concomitant arousal, any noxious stimulus will be perceived as more unpleasant. Therefore relatively innocuous physical stimuli may be perceived as painful (and painful stimuli as even more painful) than they would be under different environmental conditions (e.g. Experiment 5).

Social, contextual and environmental factors may impact on pain assessment and measurement.

The control of acute (e.g. post-operative) pain is known to be most effective when the pain is treated prophylactically. Earlier pain control regimen (e.g. strictly controlled 4-hourly doses of analgesia) often resulted in 'wind-up'[9]. Put simply, wind-up manifests as follows: The first dose of analgesia is effective, but the pain returns before the second dose is administered 4 hours later. Thus, the second dose would reduce, but not fully control the pain, and so the pain would return to non-controlled levels yet more quickly and would increase in intensity. Therefore, the third dose had even less of an effect, and the pain-onset-pain-treatment cycle would shift out of phase and the pain would quickly spiral out of control.

In practical terms, wind-up is the result of poor pain-control practice. More recent pain control methods addresses this by using smaller doses more frequently, and administered *before* the pain becomes intense. This requires frequent pain assessment, and the efficacy of the system is dependent upon the validity and reliability of the assessment.

This thesis has shown that the perception and reporting of pain can be influenced by social and environmental factors. The author has often observed practical examples of this in the form of disparities in pain report from the same patient responding to enquiries from different assessors. This was particularly pronounced when there was a large difference (as perceived by the patient) between the assessors. For example, the difference between a consultant on bi-weekly rounds, surrounded by their entourage, or a familiar nurse on the morning drug-rounds.

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9 Wind-up occurs in the substantia gelatinosa, and is caused when N-methyl-D-aspartate (NMDA) receptors open. During normal transmission, glutamate acts upon NMDA and non-NMDA receptors, however, Na^+ does not flow through NMDA receptors, due to the Mg^{2+} blockade of NMDA receptors at resting potential. During high frequency transmission at the synapse, temporal summation results in depolarisation of the post-synaptic membrane to a threshold that releases the Mg^{2+} blockade, allowing an influx of Na^+, and Ca^{2+}. Nitric Oxide (NO) is produced in neurons in response to Ca^{2+}. NO readily passes through cell membranes and acts as a retrograde messenger to the presynaptic membrane causing more transmitter release, even without stimulus, thus reinforcing the pathway. In short, an increase in wind-up results in an increase in sensitivity.

The results of this thesis suggest that a way to increase the validity and reliability of pain assessment would be to ensure the conditions under which pain assessment takes place remain the same. For example, by ensuring that the same assessor is used at each occasion (e.g. Experiment 4) and that the patient is not assessed in a novel or more threatening environment, such as a treatment room (e.g. Experiment 5).

The same principle applies to research situations. Where the conditions are stable, the researcher may be reasonably confident of reliable and valid measures of pain (as shown by Experiment 1). Where the conditions between measures vary, the researcher cannot be certain of the degree to which the participant is responding to their experimental manipulation, or (non-experimental) differences in the conditions, thus raising questions of validity.

Whilst this sounds obvious as any researcher worth their salt would understand the principles of experimental controls, the results of this thesis suggests that factors that some pain researchers might consider irrelevant, may nonetheless have a systematic effect. For example the differences between different researchers collaborating on the same experiment (e.g. Experiment 4), differences in the wording of pre-test briefings (e.g. Experiment 3) or simply differences in environment, for example, where the original laboratory may be double booked and unavailable, 'so we have to use the anatomy lab for this session' (e.g. Experiment 5).

Principles of automaticity may be useful in controlling acute pain.

It has been noted that effective pain control often involves altering the affective-motivational components of pain (Weisenberg, 1989; 1998). However, this generally refers to altering the affective-motivational response to existing pain. The results of the experiments conducted in this thesis suggests that changes in affective-motivational state *prior* to a potentially painful event can significantly alter the perception of that event. It is possible therefore, that controlled manipulations of context and environment designed to reduce negative evaluation and reinforce positive evaluation and expectancies within an individual, may ameliorate the experience of an acutely painful event.

Encouraging a more positive evaluation of the situation would result in a lower (negative) affective-motivational contribution to the experience, so that a greater pain stimulus intensity could be accepted before the advent of pain. Also, in the event of pain, this would result in lower levels of unpleasantness being attributed to the pain stimulus and lower levels of negative emotional response to it (suffering).

This has practical applications in clinical situations. For example, as shown by Experiment 3, the provision of information about an event can have a negative influence on the perception of a painful event if not presented concomitant with some means of influencing that event. As suggested by Miller and Mangan (1983), in clinical situations in which patients are entitled to as much information as is available, although the right to information is laudable, it is possible to predict circumstances in which there is a conflict between the rights of the patient to full disclosure of information, and the duty of the clinician to minimize patient distress. However, whilst it would probably benefit patients to ensure that the provision of information was consonant with their coping style, providing information only to those who utilize an information seeking coping strategy (i.e. those who request it), in reality, it would be impractical to assess the coping style of every patient about to undergo an acutely painful procedure. Moreover, in cases requiring informed consent from the patient, it is an obvious prerequisite that all relevant information is presented.

Nonetheless, under such circumstances, generating the perception of control in the patient, may change their perception of an event from one that is potentially unendurable, to one that is manageable (as suggested by Thompson, 1981). As stated previously, control does not actually have to be provided, it simply needs to be *perceived* to be available. It is suggested therefore (as withholding information is out of the question), that promoting the perception of control by encouraging the patient in an active participant role could help avoid the conflict predicted by Miller and Mangan. Developing the perception of control within patients through active participation in their own treatment could help to alter their perception of the situation as a whole, and thereby alter the affective-motivational state associated with it.

A practical example

Providing the perception of control can be achieved very easily, and does not require a significant change in practice. As a practical example, this was employed as a technique by the author in his role as a phlebotomist on a renal transplant unit. Patients with renal problems often require blood tests on a daily basis. Occasionally, patients would be admitted who expressed greater than usual, and in some cases extreme, fear of venipuncture, and (thus) greater levels of suffering during the procedure (expressed both verbally, and behaviourally by wincing, grimacing and flinching).

In such cases, the author would encourage active participation by the patient, by giving them the power to influence events. Firstly, the importance of the tests to the patient were highlighted. The patient would be informed of the reasons underlying the necessity of taking blood every day, with emphasis on the fact that diagnosis and subsequent treatment (and thus the potential for recovery) depended upon the results of those tests. After this, the patients would be given as much control over events as possible. The patient would be informed that the phlebotomist would be on the unit for the next two hours, and the patient should call him when he or she was ready for their blood test. When the patients called, they would be encouraged to select the needle they wished to be used from a choice of 'long' (38mm) needles, or 'short' (19.5mm) 'butterfly®' needles of different gauges. The patients were also encouraged to choose their own preferred site for venipuncture, and once the phlebotomist was ready, to give the signal for the phlebotomist to insert the needle (having been told that the needle would not be inserted until they gave the signal).

Whilst some clinicians may hold the opinion that giving so much leeway to patients can only result in greater inefficiency (i.e. the need to spend more time with each patient), the end result did not support this. None of the decisions given to the patients made any significant, practical difference to the procedure, but they appeared to make a great difference to the patients. Within a short period of time (usually within a week), the patients appeared less anxious, more relaxed and ceased showing overt signs of pain or suffering in response to venipuncture. As a result, the phlebotomist no longer had to spend time coaxing reluctant and frightened patients to accept venipuncture, and the time taken to

cover two wards and outlying patients actually dropped. Perhaps more important, as diagnosis and subsequent treatment, including dialysis (i.e. duration of dialysis and concentration of dialysis solution) depended upon the results of the blood tests, was the fact that instances of outright refusal dropped to zero for the renal unit.

Although this is anecdotal evidence only, it is reasonable to suppose that the evaluation of the situation by the patient was altered by the shift in the perceived locus of instrumental control within the patient-clinician dyad. The phlebotomist was no longer the controlling party, but was willing to accept instructions from the patient. It is likely that the perspective of the patient changed from that of helplessness; as an individual to whom inevitable and uncontrollable things happen, to one of control, as an active participant in their own treatment, with the power to influence and (to a degree) direct events. In any event, changing the terms of the patient-clinician relationship in the manner described appeared to reduce the unpleasantness of the experience to a great extent, for both the patients[10] and (not unimportantly) the phlebotomist (sticking a large needle into a terrified person or a screaming child is an *extremely* unpleasant experience).

Attenuation of the unpleasantness associated with a painful event is likely to have further 'downstream' effects. The less unpleasant an experience, the weaker the association between the event and the context is likely to be. Therefore, it is less likely that subsequent exposure to the same or similar environments will result in a pronounced negative evaluation and a strong affective-motivational response. In other words, it would serve to inhibit the formation of (or at least weaken) the association between a particular environment or context, and a strong affective-motivational response. Subsequent meetings with the patients described above support this. After discharge, patients would often have to attend the outpatient clinic for blood tests in order to monitor their progress (often for months). None of the patients showed any resurgent signs of their original anxiety or pain response to venipuncture.

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10 One unfortunate side effect was that these patients appeared to associate the author with pain-free phlebotomy (as one patient put it) and so would always insist he be called to take their blood (in fact two of these patients refused venipuncture from anybody else). Consequently, the author's workload increased dramatically.

Future aims and objectives

Great progress has been made in the understanding of the nature of pain and the pain experience, from both physiological and psychological perspectives, and there is a growing body of evidence to suggest that the experience of pain can be manipulated through psychological interventions. Similar progress has been made in the understanding of automaticity, preattentive processes and their influence on affective-motivational state and subsequent behaviour. This thesis provides evidence that the experience of pain can be modulated through manipulation of social, contextual and environmental features. This indicates that the subjective perception and (preattentive) emotional evaluation of the situation as a whole is a significant modifier of the pain experience.

Whilst for the moment, the degree to which these processes may influence the pain experience can only be surmised, as shown, there are examples of a complete dissociation between intense stimulation (including actual tissue damage) and the emotional and psychological response normally associated with it. In other words, pain and suffering are not necessarily a direct result of physical insult. This suggests at least the possibility that the experience of pain is entirely dependent upon the evaluation, perception and emotional significance of the situation.

Whilst pain is a necessary and adaptive feature which restricts and alters behaviour in ways that promotes healing, the suffering associated with human pain can often be maladaptive and debilitating. Could it be that humans suffer so much *because* (as noted by Cytowic, 1993a) humans are unique among animals in being advanced in both limbic and cortical dimensions, and that in humans, it is the limbic system that reaches its greatest development? In other words, could there be a correspondence between emotional (limbic) development and the suffering associated with intense physical stimuli?

As discussed, there are recorded instances of individuals suffering pain in the absence of any discernable physical cause. Pain can be experienced in conversion hysteria and hallucinations (e.g. Weisenberg, 1977), and can be induced psychologically (e.g. Bayer et al., 1991). The pain experienced in these conditions is without physical cause, but it is nonetheless real. This suggests that genuine suffering can result from states of intense

emotional arousal, in the absence of any input from peripheral nociceptive systems (i.e. from limbic activity alone). The opposite, that is, the apparent absence of pain in the presence of significant physical trauma, has also been observed (e.g. the Indian hook-swinging ceremony and surgery under hypnotic analgesia). Taken together, these opposing extremes would seem to suggest two things: Firstly, suffering is the result of limbic activity and not exposure to noxious physical stimuli. Secondly, whether or not suffering occurs as a result of physical trauma in the first place, is dependent more upon qualities of limbic activity than the qualities, intensity (or even presence) of physical stimulation.

As discussed previously, work in Experimental Social Psychology has provided evidence that automatic evaluation processes influence affective-motivational state and behavioural propensity. These processes have further 'downstream' effects on explicit emotional experience and evaluation of subsequent environmental stimuli. Further, that the result of automatic processes has a direct influence on autonomic function, resulting in autonomic changes consonant with the affective-motivational state (in preparation for the appropriate approach or avoidance behaviour). The work presented in this thesis has extended this to show that automatic evaluation processes can influence the perception and experience of a physical stimulus. Taken together, the implication is that automatic processes have a significant role in the way in which people experience and interact with their environment, at *all* levels, not just at the emotional level.

This thesis focussed on pain as one index of the effects of preattentive processes. It showed that the effects of these processes were not limited to preconscious affective-motivational responses, but (as a function of those responses) extended into the milieu of physical (tactile) experience. In addition, evidence was presented in Chapter Two that there are relationships between personality factors and immunological function and endogenous opioid production (e.g. Bandura, 1987; Wiedenfeld, 1990). In light of this, the results of this thesis raise broader questions. Are there measurable effects of preattentive processes on other indexes? If negatively valenced environmental features have a negative influence on the perception of a potentially painful stimulus by stimulating a negative affective state accompanied by an avoidance motivation, is the same environmental information causing other (negative) effects through the same mechanism?

For example, the triggering of a particular affective-motivational state is accompanied by autonomic changes associated with the appropriate (approach or avoidance) behaviour; the physical 'readiness' to behave in a way consonant with the motivational state. If automatic evaluation processes trigger a negative affective state (and avoidance motivation), but the individual is not in a position to avoid the situation, then it would be reasonable to expect the conflict between motivation and behaviour to result in dissonance and a degree of stress. This may be reflected in (for example) elevated levels of the stress hormone cortisol or a reduction in levels of secretory IgA (or indeed, both).

Therefore, a logical progression of the work presented here would be to replicate the research in a clinical situation in order to test whether the principles shown here generalize to both genuine (as opposed to experimental) conditions, and other pain stimuli (particularly those involved in acutely painful clinical procedures). Moreover, it is suggested that the experimental measures are extended to include stress and immune function indexes, in order to assess the possible impact of automatic evaluation processes on stress and immune system competence. It may be that clinical environments, built for the purpose of treating injury and illness, not only have the effect of compounding the experience of painful events, but have the collateral effect of impairing the ability of people to fight illness for themselves.

Pain is inevitable: Suffering is optional

(Unknown)

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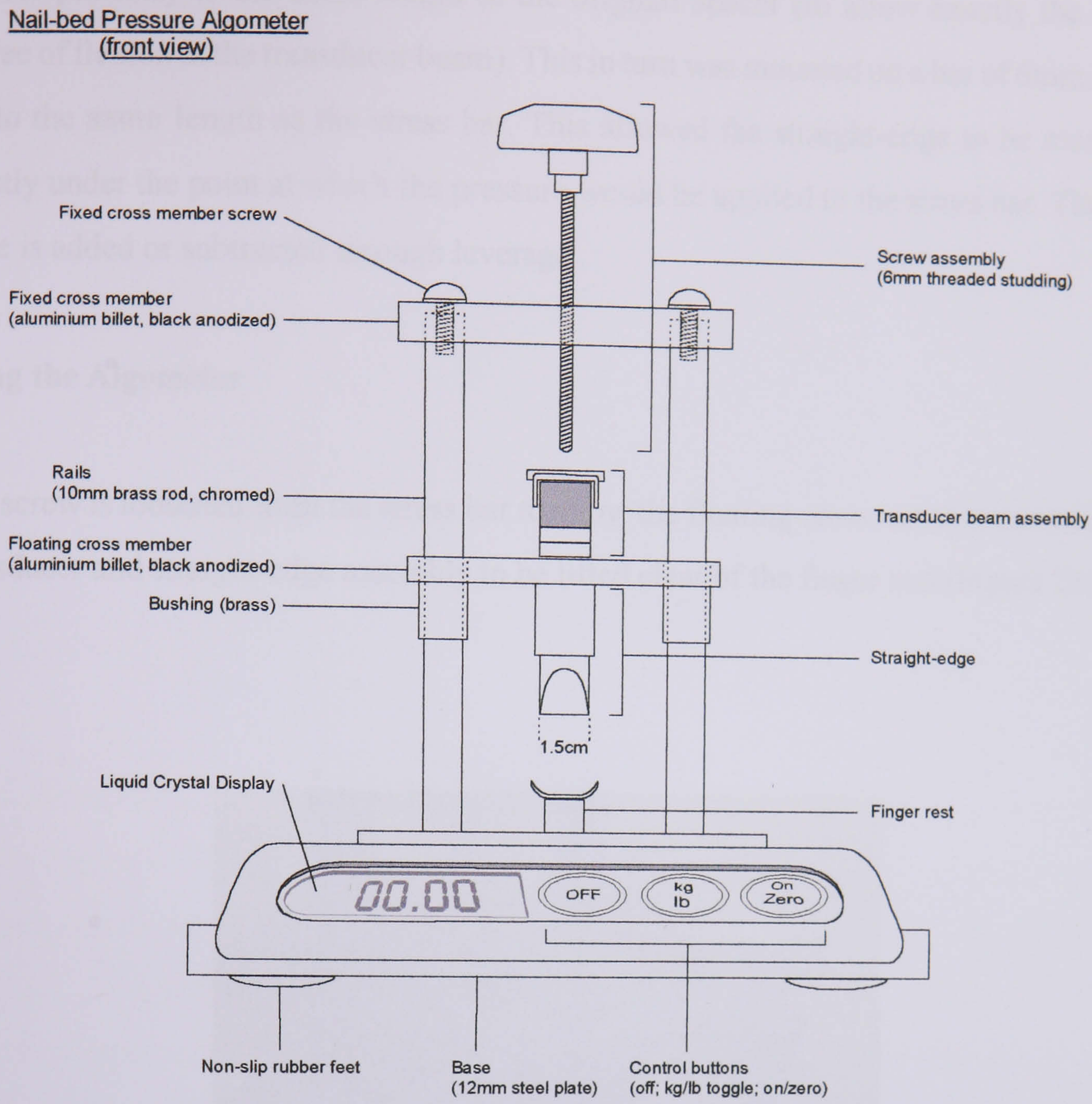
APPENDICES

APPENDIX I

NOTES ON THE NAIL-BED PRESSURE ALGOMETER

The nail-bed pressure algometer (Figure 25) was designed to fulfil a need for a portable tool that could be used to administer a scalable mechanical pain stimulus without any risk of bruising or inflammatory response. To avoid applying force to soft tissue sites, the nail-bed pressure algometer is designed to apply scalable mechanical force to the lunula of the nail. The application of nail-bed pressure is common custom and practice on hospital wards by nurses checking pain response in order to assess level of consciousness during neurological observations on unconscious patients. When applying nail bed pressure, nurses will often use a pen, however, during trials it was found that when applying pressure through an area approximating that of a pen (between 7mm and 10mm diameter), considerably more than 5kg pressure was required to achieve pain threshold in most participants. The optimal edge diameter that would reliably elicit pain sensation at less than 5kg pressure (usually around 1.5 - 2kg) was found to be 1mm. This edge was polished and chromed, and is blunt enough to ensure that there is no danger of scratching or splitting the nail or causing other damage.

The measuring components of the machine came from a set of domestic electronic kitchen scales, made by Avery Berkel (Salter Weigh-Tronix). This type of electronic scales use Strain Gauge technology. The transducer beam (load cell) is designed to bend in proportion to the load placed on the scales platform. A strain gauge is mounted on the beam. The electrical resistance of the strain gauge changes when stressed by the bending of the beam. The change in the strain gauge resistance is proportional to the bend of the beam. An Analog to Digital (A/D) converter located on the circuit board transforms the varying analog signals from the strain gauge into digital signals that are then sent to, and read by a microcontroller (comparator). The microcontroller compares the digital data to stored calibration data, and then processes the digital signals into electronic data and sends them to the Liquid Crystal Display (LCD). The LCD shows the data from the microprocessor as a standard number (ie 100.00). Domestic kitchen scales of this type commonly have a maximum readout of 5kg, and are accurate to ± 0.01% (5g).



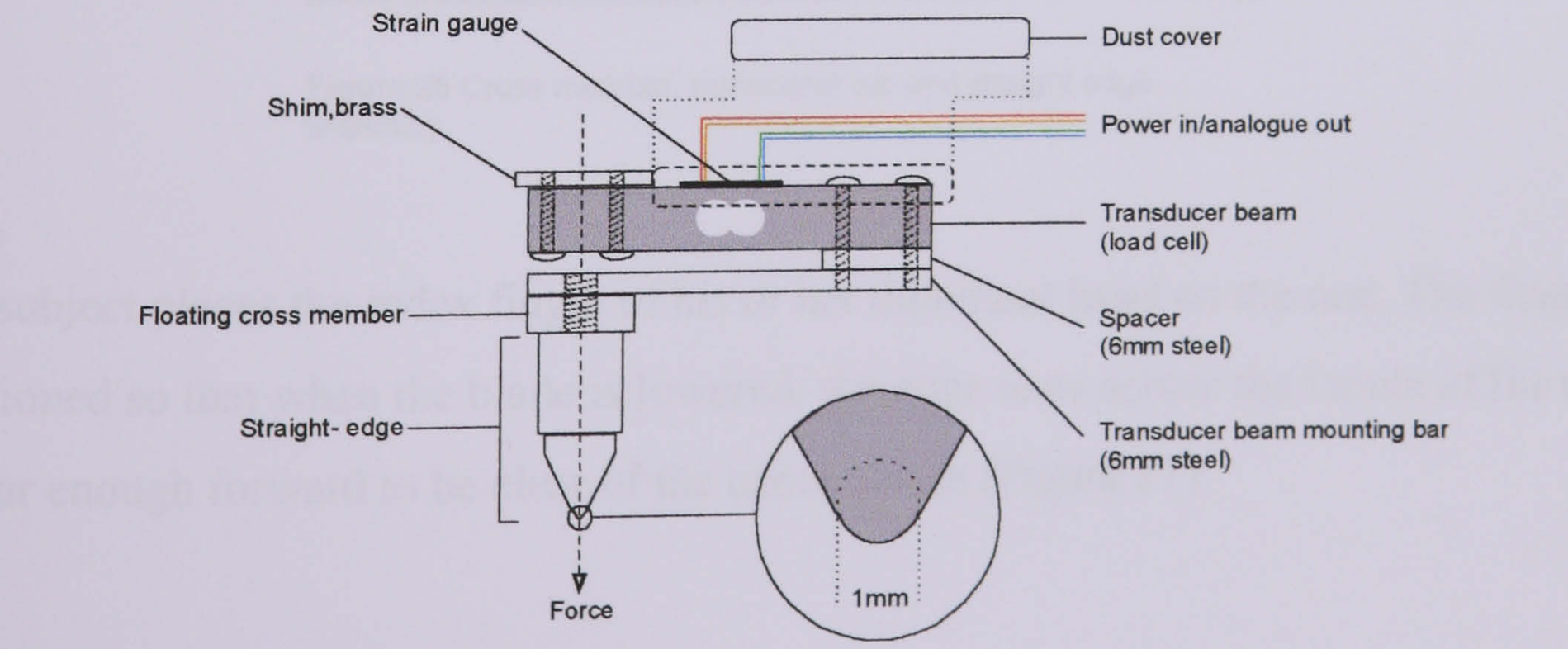


Figure 25 Drawing of the prototype nail-bed pressure algometer, front view (top) and the floating cross member transducer beam and straight edge assembly, side view (bottom).

The transducer beam was mounted on a spacer of 6mm steel, which had been measured and cut precisely to the same length as the original spacer (to allow exactly the same degree of flexion in the transducer beam). This in turn was mounted on a bar of 6mm steel, cut to the same length as the stress bar. This allowed the straight-edge to be mounted exactly under the point at which the pressure would be applied to the stress bar. Thus no force is added or subtracted through leverage.

Using the Algometer

The screw is loosened from the stress bar to allow the floating cross member carrying the transducer and straight-edge assembly to be lifted clear of the finger rest (Figure 26).

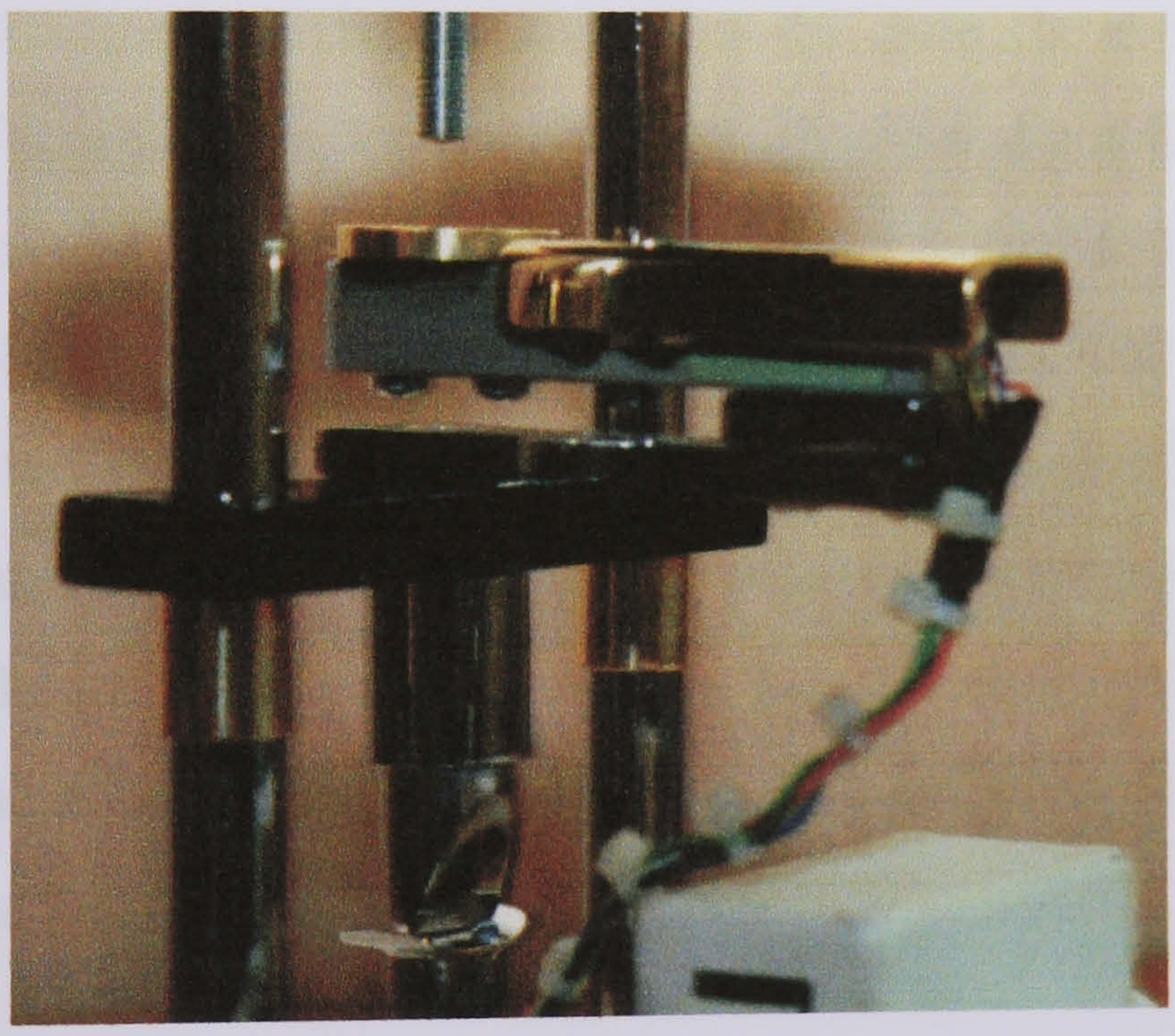


Figure 26 Cross member, transducer bar and straight edge assembly

The subject places the index finger of his or her dominant hand on the rest. The finger is positioned so that when the blade is lowered, the edge rests across the lunula of the nail, but far enough forward to be clear of the eponychium (Figure 27).

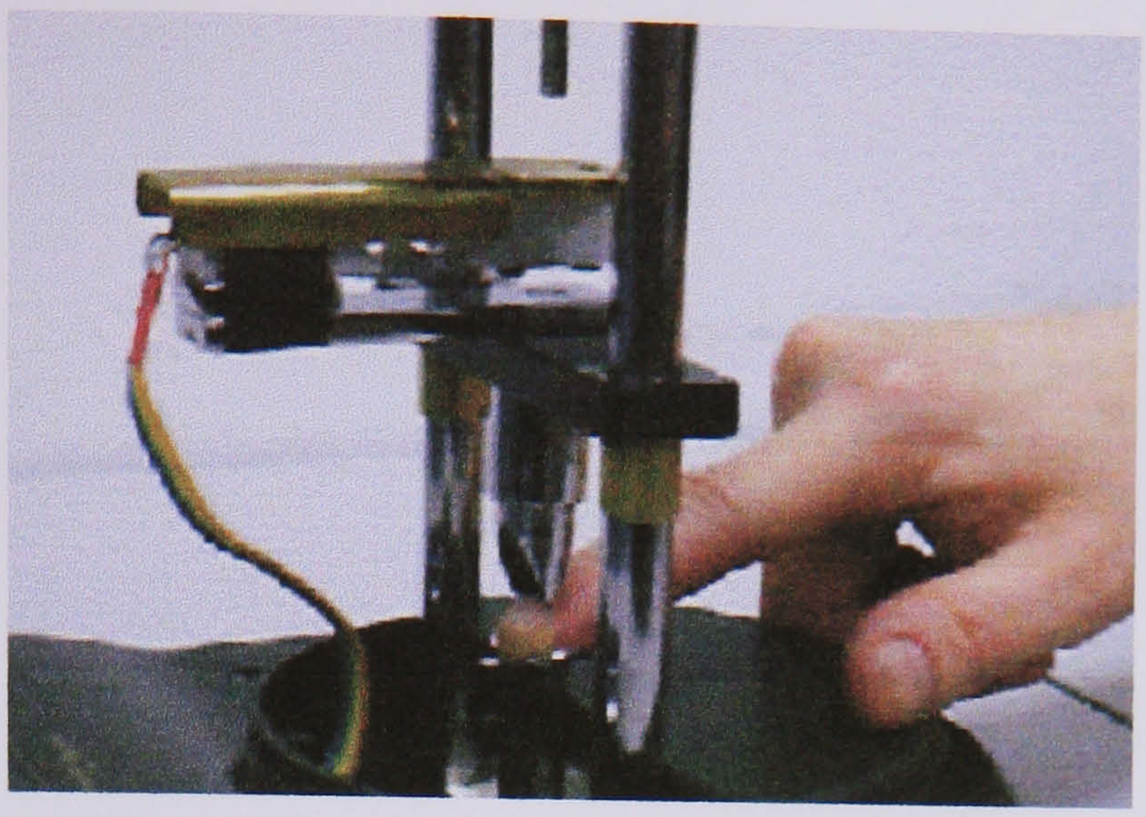


Figure 27 Straight edge in start position on the lunula of the dominant hand index fingernail

Once the machine has been switched on and allowed to zero, the experimenter begins to tighten the screw. This should be done smoothly. With minimal practice a constant rate of increase can be achieved. During trials it was found that around $100g/S^{-1}$ is a reasonable rate, as it generated the most consistent pain threshold reports. The volunteers used on these trial reported that the point at which the pressure became painful was "obvious" at that rate of increase. The pressure applied to the nail bed is read from the liquid crystal display which may be toggled to display grammes (kilograms) or pounds. From trials and during the Experiment, this machine proved to be an efficient and accurate tool for the delivery of safe, scalable mechanical pain stimulus.

APPENDIX II

Standard Participant Score Sheets

You have the right not to participate in this Experiment. Should you choose to continue, you have the right to withdraw at any time, you do not need to provide an explanation.

Code:.....

Your age last birthday (Years):..... Your sex (m/f): .....
Are you: Left handed..... Right handed..... (please tick)

SCORE SHEETS

INSTRUCTIONS

This score sheet contains two Visual Analogue Scales. These scales are 10 centimetre lines. At each end there is a verbal anchor describing two extremes. To use the scales, place a vertical mark at a position along the line which you feel best describes your experience.

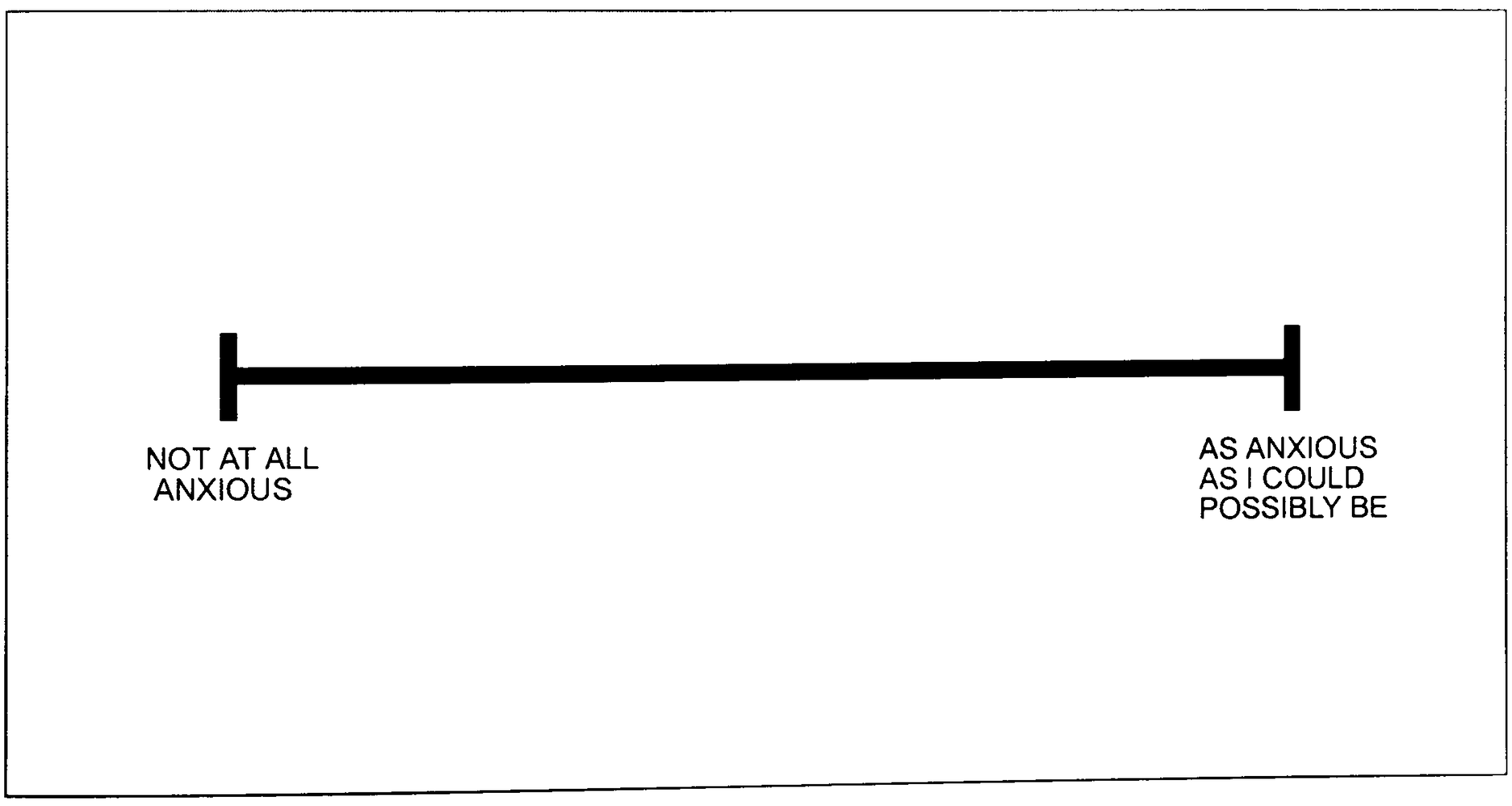
IMPORTANT!

This study and its results are anonymous. This sheet identifies you using a code, and is evidence of your participation. The researcher will sign this sheet at each session. Please keep it safe and return it to the researcher at the second session at which point your participation sheet can be signed. Be sure to bring your participation sheet to the second session so it can be signed.

BEFORE THE TEST, PLEASE COMPLETE THIS SCALE

Use this scale to score how *nervous* you are about this test.

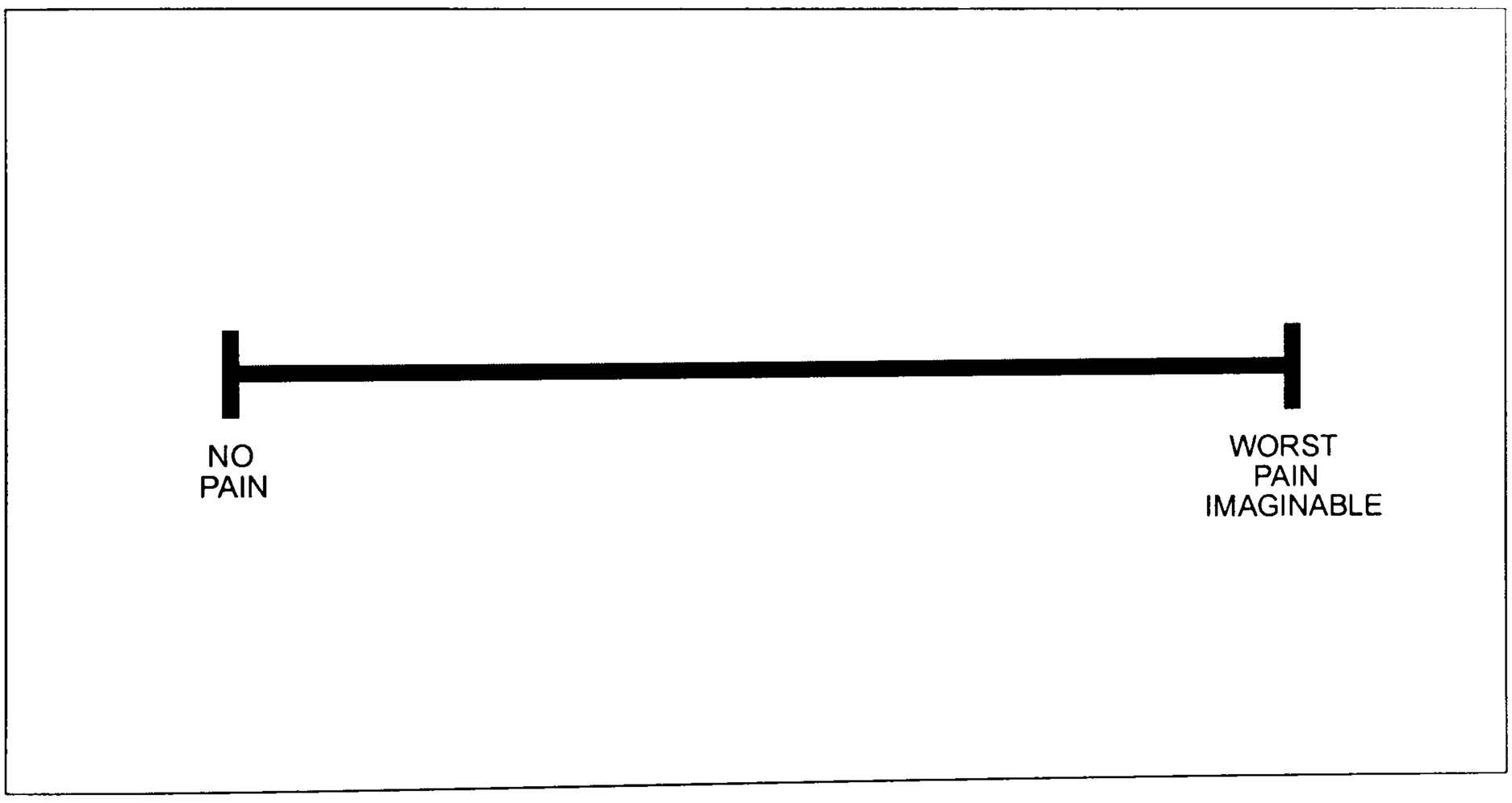
Place a vertical line through the scale at a point you feel best indicates how anxious you are feeling about doing this test



AFTER THE TEST, PLEASE COMPLETE THIS SCALE

Use this scale to score the *amount* of pain you felt.

Place a vertical line through the scale at a point you feel best indicates how much pain you felt.



1	2

(For experimenter use)

APPENDIX III

ETHICAL REQUIREMENTS FOR STUDIES CONDUCTED OUTSIDE OF THE UNIVERSITY OF WESTMINSTER

Pages x-xi: Participant information sheet as required by the Ethics Committee of Great Ormond Street Hospital for Sick Children (Experiment II)

Pages xii-xvii: Letter of application for ethical clearance to the Ethics Committee of The Royal Free Hampstead NHS Trust (Experiment III)

Pages xviii-xx: Participant information sheet and consent form as required by the Royal Free Hampstead NHS Trust (Experiment III)

SUBJECT INFORMATION SHEET

Project title.

THE EFFECT OF VIBRATION ON PRESSURE PAIN THRESHOLD AND PAIN REPORT

1) The aim of the study.

The aim of this study is to investigate the effect of vibration on pressure pain threshold (PPT) and pain report. Pressure pain threshold is defined as the point at which an increasing pressure becomes painful.

2) Why is the study being done?

The method used to measure PPTs in this study is new. For this method to be used it needs to be validated, that is, we need to be sure that it measures the same thing as other methods that have been tried and tested. One way to do this is to repeat an experiment that has been done using a tried and tested method to see if we get similar results.

3) How is the study to be done?

a) General. This type of study is called a repeated measures study. This means that the factors we are interested in (in this case, PPTs and pain report) are measured several times. Between measures, we apply something we think will have some effect (in this case vibration). The measures are then compared with each other to see if our intervention made any difference.

b) Measures. The method we use to measure pressure pain threshold is to apply a slowly increasing pressure to the nail-bed of your index finger. The moment you decide the pressure has become painful, you say stop, and the pressure is released. The amount of pressure applied (measured in grams) at the point you say stop is your pressure pain threshold. Immediately after this, you score the amount of pain you felt using a Visual Analogue Scale (VAS). The VAS is a 10cm line with the words "no pain" and one end, and "worst pain imaginable" at the other. All you do is place a mark at some point along the scale that you feel best matches the amount of pain you felt.

Procedure. The measures described above will be taken three times. The first is called a baseline measure. This tells us what your normal PPT and VAS score is. After the first measure, you rest your finger on a vibrating bar for 30 minutes. At 30 minutes the second measure is taken. Finally, after 15 minutes rest, the last measure is taken. The whole procedure takes around 50 minutes.

4) What are the risks and discomfort?

There are no foreseeable risks. The pressure is only applied until it begins to hurt. By definition there will be some discomfort. As long as you are honest and do not try to see how much pressure you can take, or try to take more pressure than other subjects, the force involved is much less than required to cause any damage.

5) What are the potential benefits?

There are no immediate benefits to people taking part in this study. However, if the method used in this study is validated, it may provide a useful new tool that can be used in the study of pain and more specifically, factors that affect the perception of pain.

6) Who will have access to the research records?

Only the researcher, his immediate supervisors and a representative of the Research Ethics Committee will have access to the data collected during this study.

7) What are the arrangements for compensation?

This research has been approved by an independent Research Ethics Committee who believe that it is of minimal risk to you. However, research can carry unforseen risks and we want you to be informed of your rights in the unlikely event that any harm should occur as a result of taking part in this study.

The research is covered by a no-fault compensation scheme which may apply in the event of any significant harm resulting to you from involvement in this study. Under this scheme it would not be necessary for you to prove fault. You also have the right to claim damages in a court of law. This would require you to prove fault on the part of the Hospital/Institute and/or any manufacturer involved.

8) Do I have to take part in this study?

No. Should you decide not to participate in this study now, or at a later stage, that is entirely your right.

9) Who do I speak to if problems arise?

Please contact the researcher, Dave Williams directly with any problems relating to this study.

If you have any complaints about the way in which the study has been, or is being conducted, please, in the first instance, discuss them with the researcher. If the problems are not resolved, or you wish to comment in any other way, please contact the Chairman of the Research Ethics Committee by post via the Research and Development Office, Institute of Child Health, 30 Guilford Street, London, WC IN 3ER or if urgent, by telephone on 0171 - 242 - 9789, ex. 2620 and the Committee administration will put you in contact with him.

10) Researcher:

The researcher who will have contact with you is Dave Williams. You are welcome to contact him to discuss this project or any problems related to it on: 0 171 - 794 - 0500 ex. 4130/4131 during the day, or 0370 - 050 - 1918 at other times.

Please feel free to ask any questions if there is anything you do not understand.

I have read and understood the information presented above

Signed .....

D. C. Williams
c/o RTU 3rd Floor
Royal Free Hospital
Ex.: 4130 - 4131

Chairman of the Ethics Committee
The Royal Free Hampstead NHS Trust
Pond St
Hampstead

Dear Dr Pegg

I am currently studying part-time for a PhD under a scholarship awarded by the University of Westminster. I am also currently employed by the Royal Free as a phlebotomist/support worker on the Renal Transplant Unit.

I wish to perform a study (the third of three validation studies) at the Royal Free, using volunteer members of staff as subjects. I have completed the enclosed document to the best of my ability, but as the form is oriented primarily to clinical trials, and as this particular study is non-clinical and is one of a series of linked studies, there are many sections which are not applicable. In light of this, I have enclosed the following information, briefly outlining the rationale behind my thesis, what has been done thus far and the protocol for the proposed study.

RATIONALE:

The provisional title of my thesis is Pain and Social Context. There is a large body of literature on experimental pain which concentrates on subject variables, such as extroversion and neuroticism (Miró & Raich, 1992), gender (Feine *et al.*, 1991; LeResche, 1995; Rollman, 1995), and ethnicity (Sternbach & Tursky, 1965; Bates, Edwards & Anderson, 1993). However, experimental subjects are individuals and as such will be affected by the context in which they find themselves. The context in experimental and clinical situations is, in effect, largely created by the clinicians and researchers. In light of this, it is surprising that with the exception of a few studies on the effects of experimenter gender (for example, Levine & DeSimone, 1990), no research has been done investigating the effects of experimenter variables.

Experiments investigating the effects of subject variables such as gender, ethnicity and personality, overlook the possibility that these factors, rather than being discrete and fixed, producing fixed effects, in fact represent one half of a variable social dyad (subject - experimenter or patient - clinician), and that what is in fact being measured are (at least partly) the effects of the dyadic interaction. Snyder *et al.* (1977) suggest that `*many social stereotypes concern highly visible and distinctive personal characteristics, for example, sex and race. These pieces of information are usually the first to be noticed in social interaction and can gain high priority for channelling subsequent information processing and even social interaction*`. It is argued that social stereotypes also include such constructs as 'the scientist', 'the nurse' and 'the doctor'. Snyder *et al.* go on to state that `*stereotypes can and do channel dyadic interaction so as to create their own social reality.*` Indeed, the fact that scientists, nurses and doctors are what they are may be sufficient in itself to alter the affective state of the subject or patient. However, further to the 'fixed' factors of social stereotypes, are variable factors, primarily the behaviours of the experimenter/clinician, as perceived by the

In order to assess the effect of social context on the perception of pain, a new methodology has been designed. This involves a new pressure algometer (designed and built by the author, see figure 1) which applies a scalable force (calibrated in grams) through a straight edge to the lunula of the subjects nail. It was proposed that due to the location of the stimulus, and the nature of the resulting pain, this would provide a highly reliable and safe method of delivering pain stimulus. The Pressure Pain Threshold (PPT) measures are taken in combination with subjective pain ratings using visual analogue scales (VAS). It is proposed that observation of the relative changes between PPT and VAS measures provide a level of information that is not available using either measure alone.

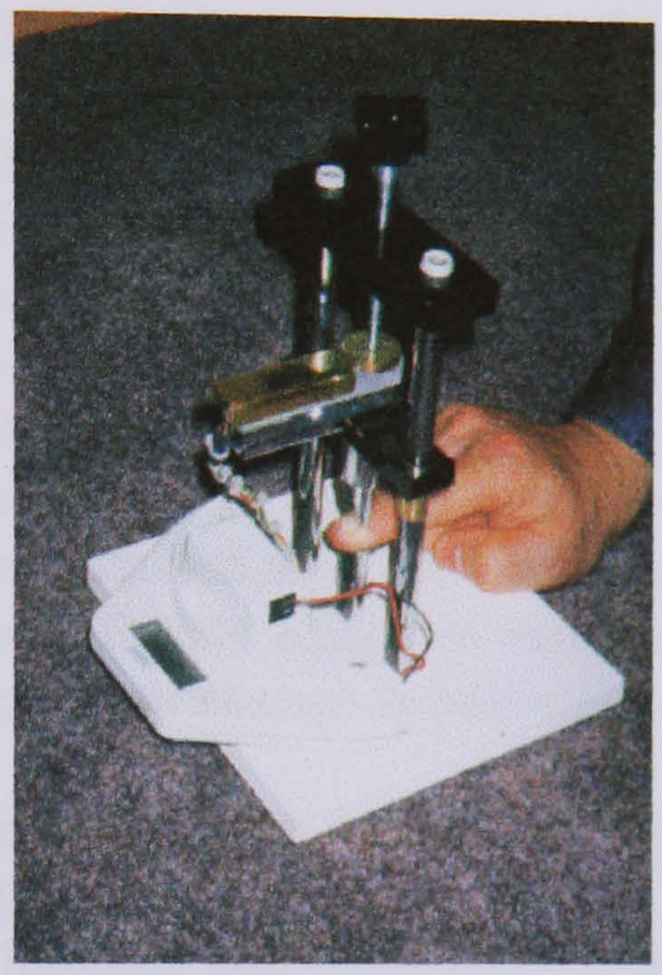


Figure 1 The Nail-bed Pressure Algometer

Validation:

Phase one of the research was to assess the validity of the combined measures methodology. To this end, a series of studies were designed in order to assess the reliability of the method, and its sensitivity to physical and non-physical intervention.

Experiment 1: Test - Retest Reliability.

To assess the reliability of the method, a repeated measures study was used, involving 22 student volunteers (7 male; mean age 30 years, SD 8.26 years, range 19 - 57 years; 3 left handed, 2 male, 1 female). Pressure Pain Threshold (PPT) and Visual Analogue Scale (VAS) measures were taken at weekly intervals, on the same days of the week, for five consecutive weeks. Due to time tabling, undergraduates were tested between 13:30 and 14:30 at each trial, Postgraduates were tested between 17:30 and 20:00 at each trial.

The results showed a wide but stable distribution of PPT and VAS pain ratings between subjects. There were no significant differences between PPT values or pain rating over five trials. Repeated measures ANOVA revealed no significant main effects or interactions for time of day, handedness or gender on either PPT or VAS measures. Mean PPT values were highly correlated between trials ($N = 22$; $r = 0.58$; - 0.95; $p = 0.01$ - < 0.001) and mean VAS scores were highly correlated between trials ($N = 22$; $r = 0.82$ - 0.98; $p < 0.001$). This shows a high degree of within subject reliability.

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Experiment 2: The Effect of Vibration on Pressure Pain Threshold and Pain Report in Normal Subjects

To assess the sensitivity of the combined measures protocol to mechanical intervention in the form of vibration stimulus (VS), a repeated measures study was performed involving 10 healthy volunteers (4 male: mean age 34.20 years, SD 6.78 years, range from 26 to 46 years, 2 left handed, 1 male, 1 female). Baseline PPT and VAS measures were taken, after which VS (1mm amplitude sine wave at 100Hz) was applied intrasegmentally (C7 dermatome) to the proximal phalanx of the index finger, proximal to the site of pressure pain stimulus (but within 6cm) for 30 minutes. At 30 minutes, a second set of measures were taken, after which VS was removed. The subjects remained seated for a further 15 minutes, at which point a third set of measures were taken. It was hypothesised that VS would result in an increase in PPT, congruent with the Gate Control Theory of Pain (Melzack & Wall, 1965), but, as the context in which the measures would be obtained were uniform, that is, no factors were introduced between measures to affect the subjects affective state or qualitative assessment of the situation, there would be no significant change in pain rating (VAS scores).

The results showed a significant increase in PPT at 30 minutes vibration ($F_{2, 18} = 6.57$, $p = 0.007$). Importantly, the direction of change was uniform in all subjects. There was no significant difference between baseline and 15 minutes post-vibration PPTs . There was no significant change in pain rating across three measures. A small control group ($N = 4$) received VS extrasegmentally (C6 dermatome) adjacent to the trapezium (~16cm proximal to the site of pressure pain stimulus). VS had no effect on either pain threshold or pain rating in this case.

So far, the combined measures method has been shown to be reliable and sensitive to mechanical intervention (in the form of vibration stimulus). It has also shown that the change in PPT brought about by the application of vibration did not result in a corresponding change in pain rating, as by definition a pain threshold signals the *advent* of pain. Thus, it has been demonstrated that in the absence of any significant alteration in the affective state of the subject (resulting in changes in the qualitative nature of the experience), the experience of a pain threshold will be the same, regardless of the force required to achieve it.

The following is the protocol for the study I wish to carry out at the Royal Free.

Experiment 3: INFORMATION, CONTROL AND PAIN RATING.

PROTOCOL

The aim of the study is to investigate the effects of information and control on the subjective experience of pain. It has been shown that the nail-bed pressure algometer in combination with subjective pain report provides reliable within subjects pressure pain threshold and pain report measures. It has also been shown that intervention in the form of mechanical (vibration) stimulation resulted in increased PPT, but no change in pain rating. As a counterpoint, this study is designed to investigate the sensitivity of the combined measures methodology to non-

physical intervention under stable pain stimulus intensities. The conceptual hypothesis (to counterpoint experiment 2) is that changes which are designed to alter the affective state of the subject will produce changes in the experience of a pain stimulus, in the absence of any significant changes in pain stimulus intensity.

This study will act as both counterpoint to the previous studies and as a bridge into phase two, providing a basis for further studies into social context, in so far as a part of any social interaction is the locus of control within the dyad (certainly in a clinical context), and the passing of information during the interaction.

Measures:

Pain pressure threshold (PPT) and pain rating using visual analogue scales (VAS) will be taken from each subject under one of three conditions, termed *Information + Control*, *Information - No Control* and *No Information - No Control*, operationalised as follows:

At the beginning of each trial, each volunteer will receive an identical (scripted) primary briefing. This will explain the procedure, provide information on the use of VAS and explain the rights of the volunteer not to participate and/or to withdraw from the study at any time. After the primary briefing, PPT and VAS measures will be taken. After no less than 10 minutes, the volunteer will return for the second set of measures. Prior to the measures being taken, the volunteer will receive one of three secondary briefings designed to induce the experimental conditions:

Information + Control

This time I'll look only at your dominant hand. Again, I'll slowly increase the pressure. As soon as you feel the pressure has become pain, say stop and I will stop. After that, you mark the scale again.

Information - No control

This time I'll look only at your dominant hand. Again, I'll slowly increase the pressure. There is no point in saying stop this time. I know your pain threshold value is (x) *from the first measure, so I'll take you up to that value, after which you mark the scale again.*

No Information - No Control

This time I'll only look at your dominant hand. Again, I'll slowly increase the pressure. There is no point in saying stop this time. I'm going to take the pressure up to a predetermined value, after which you mark the scale again.

The first is essentially the same as the primary briefing (control group), providing both control and information. The second removes control from the volunteer by stating that 'there is no point in saying stop this time' (Control for the purposes of this study is defined as `*the belief that one has at one's disposal a response that can influence the aversiveness of an event*`

(Thompson, 1981)) whilst providing full information as to what is about to happen. The third removes control from the volunteer and also provides no information as to what intensity the subject may expect. In reality, the 'predetermined value' will, as in the second condition, be the volunteers own PPT as recorded in the first set of measures. Thus no volunteer will be subjected to a greater stimulus intensity than they have already reported as their pain threshold.

A final measure will be taken where volunteers will be asked to rate the second stimulus in relation to the first using a five point category scale, the categories of which are *Much Less; Less; The Same; More; Much More.* (this is to allow an even bimodal response range, which may be restricted using VAS alone. The previous studied have shown that pain ratings of pain threshold stimulus intensity results in positively skewed data, which restricts the usable range of subsequent 'lower' responses on the VAS).

Following the final measure, volunteers will receive a full debriefing appropriate to the condition, that is, where the study will be explained to all subjects, it will be explained to subjects under conditions two and three exactly what happened and that the second stimulus they received was, in fact, identical to the first.

Initial analysis of data from a pilot to this study (N = 13) under the no control - no information condition reveal a bimodal response for the second VAS measure, with means moving either higher or lower than the first VAS measure means.

The main reason for my wanting to carry out this study at the Royal Free is that it would enable me to expand my subject population beyond undergraduate students which, if through no other reason than age, tend to be unrepresentative of the general population.

If further information is required, please contact me on RTU, extension 4130/4131.

My Ph.D supervisors are:

Director of studies	Dr. Tony Towell.
Second supervisor	Dr. John Golding.
Third Supervisor	Prof. Keith Phillips.

They may be contacted at:

Department of Psychology.
University of Westminster.
309 Regent St.
London.
Tel: 0171 911 5000

Yours Faithfully

D. C. Williams.
Phlebotomist, Renal Transplant Unit.

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VOLUNTEER INFORMATION SHEET

Project title .

INFORMATION, CONTROL AND PAIN RATING

1) The aim of the study.
The aim of this study is to investigate how different contexts and situations affect how people experience a potentially painful procedure.

2) Why is the study being done?
This study is one of several studies designed to validate a new method of measuring pain threshold and pain rating. Along with other studies that have been done, this study is designed to show that the method can measure the same things that other, previously validated methods do.

3) How is the study to be done?
a) *General.* This type of study is called a repeated measures study. In this study, the factors we are interested in (in this case pain rating) are measured twice, about ten minutes apart.

b) *Measures*. The method we use to measure pressure pain threshold is to apply a slowly increasing pressure to the nail-bed of your index finger. The moment you decide the pressure has become painful, you say stop, and the pressure is released. The amount of pressure applied (measured in grams) at the point you say stop is your pressure pain threshold. Immediately after this, you score the amount of pain you felt using a Visual Analogue Scale (VAS). The VAS is a 10cm line with the words `*no pain*` and one end, and `*worst pain imaginable*` at the other. All you do is place a mark at some point along the scale that you feel best matches the amount of pain you felt.

c) *Procedure.* The measures described above will be taken twice. The first is called a baseline measure. This tells us what your normal PPT and VAS score is. Ten minutes after the first measure, you will be given another briefing, and will be asked to complete a short questionnaire. After this, another set of PPT and VAS measures will be taken.

4) What are the risks and discomfort?
There are no foreseeable risks. The pressure is only applied until it *begins* to hurt. By definition there will be some discomfort. As long as you are honest and do not try to see how much pressure you can take, or try to take more pressure than other subjects, the force involved is much less than required to cause any damage.

5) What are the potential benefits?
There are no immediate benefits to people taking part in this study. However, if the method used in this study is validated, it may provide a useful new tool that can be used in the study of pain and more specifically, factors that affect the perception of pain.

6) Who will have access to the research records?
Only the researcher, his immediate supervisors and a representative of the Royal Free Research Ethics Committee will have access to the data collected during this study. The data itself will be anonymous, that is, there will be no way to tell which measurements came from which volunteer.

7) Do I have to take part in this study?
You do not have to take part in this study if you do not want to. If you decide to take part, you may withdraw at any time without having to give a reason.

8) Who do I speak to if problems arise?
Please contact the researcher directly with any problems relating to this study.
If you have any complaints about the way in which the study has been, or is being conducted, please, in the first instance, discuss them with the researcher.

9) Researcher:
The researcher who will have contact with you is Dave Williams. You are welcome to contact him to discuss this project or any problems related to it on: 0171 - 794 - 0500 ex. 4130/4131 during the day, or 0370 - 050 - 1918 at other times.

Please feel free to ask any questions if there is anything you do not understand.

CONSENT FORM

Thank you for volunteering to take part in this study. If, having read the information sheet, you decide you wish to continue, please read the questions below. If you are satisfied that the answer to each question is yes, please sign the form in the space provided. If the answer to any question is no, please discuss it with the researcher before signing the form.

1) Have you read the information about this study?

2) Have you had an opportunity to ask questions about this study?

3) Have you received satisfactory answers to your questions?

4) Have you received enough information about this study?

5) Do you understand that you are free to withdraw from this study at any time Without giving a reason for withdrawing

6) Do you agree to take part in this study?

Signatures:

Volunteer.....

Researcher.....

APPENDIX IV

Internal/External Locus of Control questionnaire

(Experiment III)

FOR EACH ITEM, PLEASE TICK THE BOX NEXT TO THE STATEMENT YOU AGREE WITH THE MOST

1		Children get into trouble because their parents punish them too much
		The trouble with most children these days is that their parents are too easy on them
2		Many of the unhappy things in people's lives are partly due to bad luck
		People's misfortunes result from the mistakes they make
3		One of the major reasons why we have wars is because people don't take enough interest in politics
		There will always be wars, no matter how hard people try to prevent them
4		In the long run, people get the respect they deserve in this world
		Unfortunately, an individual's worth often passes unrecognised no matter how hard he tries
5		The idea that teachers are unfair to students is nonsense
		Most students don't realise the extent to which their grades are influenced by accidental happenings
6		Without the right breaks one cannot be an effective leader
		Capable people who fail to become leaders have not taken advantage of their opportunities
7		No matter how hard you try some people just don't like you
		People who can't get others to like them don't understand how to get on with others
8		Heredity plays a major role in determining one's personality
		It is one's experience in life which determines what they're like
9		I have often found that what is going to happen, will happen
		Trusting to fate has never turned out as well for me as making a decision to take a course of action

10		In the case of a well prepared student, there is rarely if ever such a thing as an unfair test
		Many exam questions tend to be so unrelated to course work that studying is really useless
11		Becoming a success is a matter of hard work, luck has little or nothing to do with it
		Getting a good job depends mainly on being in the right place at the right time
12		The average citizen can have an influence in government decisions
		The world is run by the people in power, and there is not much the little guy can do about it
13		When I make plans, I am almost certain I can make them work
		It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyway
14		There are certain people who are just no good
		There is some good in everybody
15		In my case getting what I want has little or nothing to do with luck
		Many time we might just as well decide what to do by flipping a coin
16		Who gets to be the boss often depends on who was lucky enough to be in the right place first
		Getting people to do the right thing depends upon ability, luck has little or nothing to do with it
17		As far as world affairs are concerned, most of us are the victims of forces we can neither understand nor control
		By taking an active part in political and social affairs, the people can control world events
18		Most people don't realise the extent to which their lives are controlled by accidental happenings
		There really is no such thing as "luck"
19		One should always be willing to admit mistakes
		It is usually best to cover one's mistakes

20		It is hard to know whether or not a person really likes you
		How many friends you have depends on how nice a person you are
21		In the long run the bad things that happen to us are balance by the good ones
		Most misfortunes are the result of lack of ability, ignorance, laziness or all three
22		With enough effort, we can wipe out political corruption
		It is difficult for people to have much control over what politicians do in office
23		Sometimes I can't understand how teachers arrive at the grades they give
		here is a direct connection between how hard I work and the grades I get
24		A good leader expects people to decide for themselves what they should do
		A good leader makes it clear to everybody what their jobs are
25		Many times I feel I have little influence over the things that happen to me
		It is impossible for me to believe that chance or luck plays an important role in my life
26		People are lonely because they don't try to be friendly
		There's not too much point in trying too hard to please people, if they like you, they like you
27		There is too much emphasis on athletics in high school
		Team sports are an excellent way to build character
28		What happens to me is my own doing
		Sometimes I feel I don't have enough control over the direction my life is taking
29		Most of the time I can't understand why politicians act the way they do
		In the long run the people are responsible for bad government on a national as well as local level

Researcher only:

ROTTER'S INTERNAL/EXTERNAL LOCUS OF CONTROL QUESTIONNAIRE: SCORING

1: -	**11: B**	**21: A**
2: A	**12: B**	**22: B**
3: B	**13: B**	**23: A**
4: B	**14: -**	**24: -**
5: B	**15: B**	**25: A**
6: A	**16: A**	**26: B**
7: A	**17: A**	**27: -**
8: -	**18: A**	**28: B**
9: A	**19: -**	**29: A**
10: B	**20: A**	

Score 1 point for each response matching the key above (Max. 23).
The six items followed by a dash are 'fillers'.

All items in the questionnaire are in A - B order.

High score = External Locus of Control
Low score = Internal Locus of Control

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monogram, 80* (1), 1-28.

APPENDIX V

Diagnostic procedure applied to VAS pain rating data to correct for marked heterogeneity of variance

BOX AND COX DIAGNOSTIC PROCEDURE.

Diagnostic and corrective procedure undertaken to correct the marked heterogeneity of variance within the VAS pain rating data of Experiment 3.

Stage 1: Diagnosis.

The means and standard deviations for VAS ratings for the baseline and condition measures were calculated (Table 10).

Table 10. Means and standard deviations of VAS ratings at baseline and condition measures.

GROUP	VAS 1		VAS 2	
	Mean	**SD**	**Mean**	**SD**
I+C	25.42	19.36	22.26	17.25
I-NC	35.19	22.67	37.48	24.57
NI-NC	36.81	24.26	28.10	27.29

Logs of the means and standard deviations were taken (Table 11).

Table 11. Logs of means and standard deviations.

GROUP	VAS 1		VAS 2	
	Log ($\bar{x}$)	**Log (SD)**	**Log ($\bar{x}$)**	**Log (SD)**
I+C	1.405	1.286	1.347	1.236
I-NC	1.546	1.355	1.573	1.390
NI-NC	1.565	1.384	1.448	1.436

Log(SD) values were plotted against log ($\bar{x}$) for each cell in the design (Figure 28). The plot demonstrates a linear relationship between log ($\bar{x}$) and log (SD).

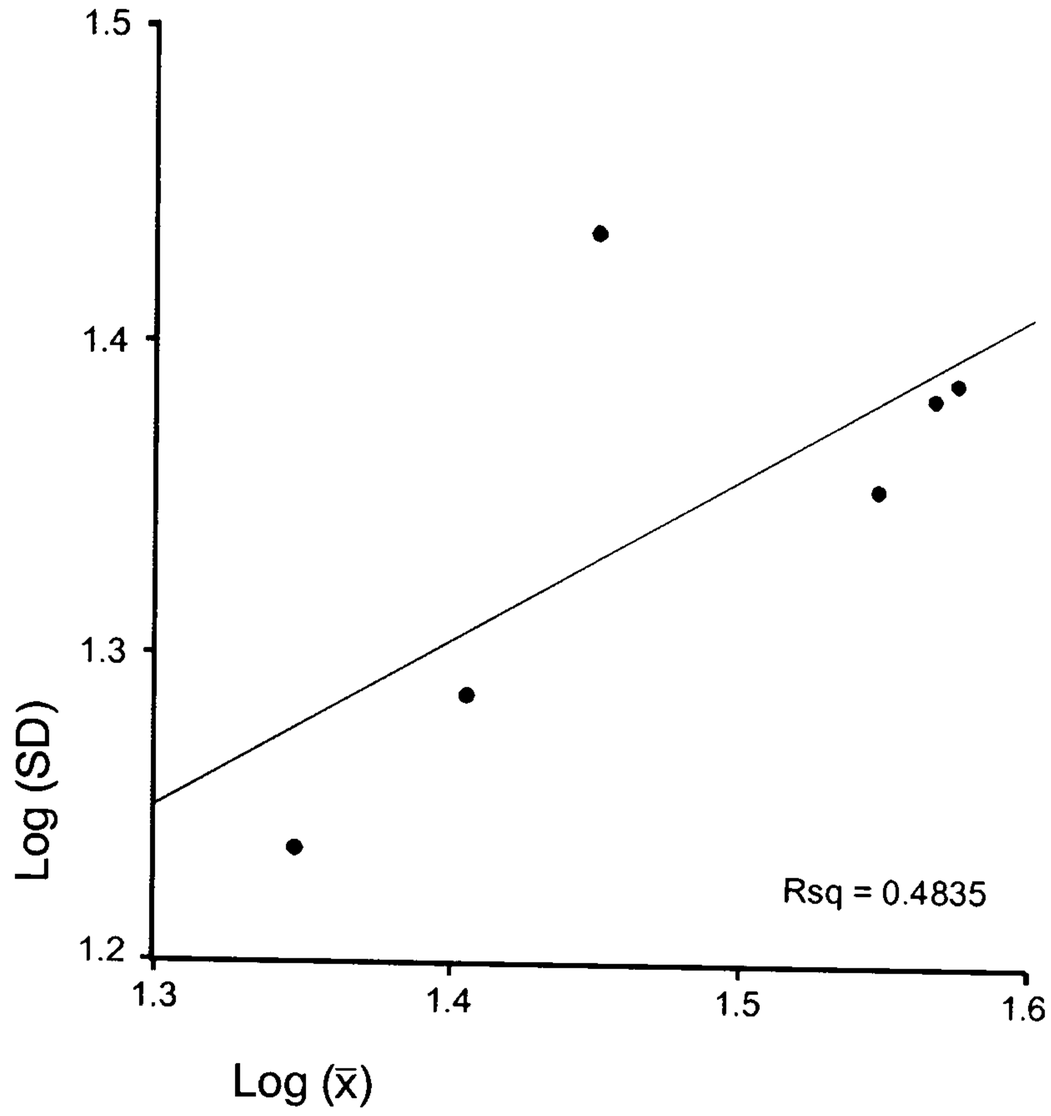

Figure 28 Plot of log (SD) against log ($\bar{x}$)

Stage 2. Appropriate re-expression of data

According to Box and Cox (1964), selection of the appropriate transformation depends upon the value given by the formula: $X' = X^{(1-b)}$ (see Table 12), where *b* is the slope (regression coefficient) of the regression line

Table 12. Conventional transformations indicated by $X' = X^{(1-b)}$ (Box & Cox, 1964).

b	**1 - *b***		**TRANSFORMATION**
0	1	$X^1 = X$	(Untransformed)
0.5	0.5	$X^{0.5} = \sqrt{X}$	(Square root)
1	0	$X^0 = \text{Log}$	(By convention Log_{10} transformation)
1.5	-0.5	$X^{-0.5} = \sqrt{1/X}$	(Square root of the reciprocal)
2	-1	$X^{-1} = 1/X$	(Reciprocal)

The regression coefficient for the VAS data was calculated: $b = 0.54$ and $1 - b = 0.46$. Thus, according to the conventions presented in Table 3, a square root transformation was appropriate.

APPENDIX VI

Experimenter instructions and briefing script

Experiment IV

PROCEDURE

I will have the lab set out for you. I will also attend the 'female experimenter' sessions, but will be outside the lab.

Materials:

I have provided a PPT score sheet, 10 sets of score sheets and a watch with a sweep hand, or a stopwatch. The score sheets consist of a cover page (1st session only) and two pairs of VAS scales (one for anxiety, one for pain). The cover page contains instructions to the participant on the use of VAS scales. The cover page and each pair of VAS scales are uniquely labelled.

- ✯ When the participant enters the room, greet them and ask them to sit down. Read them the first section of the briefing (asking them to read the instructions). If they are still unsure how to use VAS scales, paraphrase the instructions for them.

- ✯ When they are confident that they can use the VAS scales, ask them to complete the first scale (anxiety).

- ✯ After they have done so, continue with the briefing. Try to stick closely to the script, but be natural. Your demeanour should be normal/neutral, as you would be dealing with any student you don't know under any other circumstance. The script is simply to control Experimenter/Pt interaction (i.e. to ensure that each participant receives the same information in more or less the same manner, over the same period of time).

- ✯ If they have any questions at the end of the briefing, paraphrase the relevant section (as concisely as possible).

- ✯ When you are satisfied that they know what they are doing, take the first PPT using the index finger of the **non-dominant** hand (the first reading is usually the lower of the two, and serves to reduce bias due to initial anxiety). Record the force on the PPT score sheet, using the highest value you saw before the participant said 'stop' (the participant should not see the value, it gives them a 'target').

- ✯ If the participant is happy to continue, take the trial PPT in the same manner from the dominant hand and record the reading on the PPT score sheet.

- ✯ Having recorded both PPT measures, ask the participant to complete the pain VAS.

- ✯ When they have done so, thank them and explain that a full debriefing cannot be given until the end of the experiment. At that time I will issue full debriefing sheets. If any participant has any concerns or wishes to be debriefed before the end of the experiment, give them my contact details and I will provide them with a full debrief.

xxx

- ✯ **NB: Before they leave, give them the cover page from their score sheets, and remind them that they have to keep it safe and present it at their second session.**

- ✯ Between their leaving the room and the next participant entering, copy the PPT values from the rough sheet to the boxes provided under their pain VAS (dummy trial in box 1, real trial in box 2). This way, *all* the data pertaining to any participant is kept on their individual sheets, and we won't mix them up, or lose them.

- ✯ The score sheets should be given to the next experimenter ready for the second session (if crossover), or kept for the second session by the same experimenter (if control).

BRIEFING SCRIPT

Before we do the experiment, I'll give you a moment to read the instructions on the score sheets and fill in the blanks.

(***After participants have read the instructions***)

Do you understand how to use the VAS scales?

Using the first scale, please indicate how nervous you are about doing this test.

(Once they have done so, continue...)

This test is designed to measure pain threshold. This doesn't mean how much pain you can take, or for how long, it means the point at which the pressure becomes painful. This isn't a competition. Your scores aren't going to be compared with anyone else's, they'll all be added to find an overall average.

When you're ready, I'll ask you to place the index finger of your dominant hand on the plate, then I'll slowly tighten the screw and you'll feel the pressure increase. The moment the pressure becomes painful, say "stop" and I'll stop.

This procedure is perfectly safe and won't even leave a mark as long as you don't try to see how much you can take. As I said, this isn't a competition

Please don't think too long and be as honest as possible when you fill out the score sheets, your fist response is always the best.

Do you have any questions?

This first test will be a 'dummy run', so you'll know what to expect. For this we'll use your non-dominant hand.

(Record 'dummy' PPT, then continue...)

Now we'll take the same measure using your dominant hand. This will be the one you score on the VAS scale, ok?

(Record 'real' PPT, then continue...)

Finally, using the second VAS scale, please rate the amount of pain you felt during the ***second*** trial.

APPENDIX VII

Standardised briefing and debriefing script

Experiment V

POSTER STUDY BRIEFING AND DEBRIEFING

This experiment is part of an on-going investigation into factors influencing the perception of pain.

All we need in this experiment is a simple measure of your pain threshold. This does not mean how much pain you can take, or for how long, it means the point at which you decide the pressure becomes painful.

Here is a set of score sheets. Please read the instructions on the first page and fill in the details where required.

Are you happy about how to use VAS scales?

Please turn to the first scale and complete it as appropriate. Don't think too long about it, your most immediate response is always the best.

The first measure I'll take will be from the index finger of your non-dominant hand. This is a practice run, just to give you an idea of how it feels and what to expect. You do not score this measure.

Do you have any questions?

OK, place your finger on the rest, and when you're ready, I'll begin to increase the pressure slowly. As soon as you decide the pressure has become painful, say stop, and I'll stop.

(Take measure)

That was the practice run. Now I'll take the test measure. The procedure is exactly the same, but this time we use the index finger of your dominant hand, OK? Remember, as soon as you decide the pressure has become painful, say stop, and I will stop.

(Take measure)

Please score the final scale now.
Probe:

OK, that's all done. I'll sign your participation time sheet now. While I'm doing that, can you tell me what you think this experiment was testing for?

I noticed you were looking at that poster on the wall.

Did you think that was anything to do with the experiment?

Have you ever seen a poster like that before?

It comes from a hospital. Posters like that are quite common in hospitals. Have you worked in, or visited a clinic or hospital recently?

Debriefing

Experimental group:

This experiment was testing the effects of features of the environment on the perception of a painful stimulus. That poster is the experimental stimulus and there were in fact two groups. You were a member of the experimental group. The only difference between groups was that for the other group, the poster was absent and the wall was bare. This experiment is testing the hypothesis that the mere presence of that poster will influence the way in which you perceive this situation, and that this influence will be reflected in a difference in pain threshold measures between this group and the neutral group.

Do you have any issues or concerns relating to this study or the poster?

Do you have any questions or comments at all?

Please DO NOT discuss this study with any other students.

Neutral group:

This experiment was testing the effects of features of the environment on the perception of a painful stimulus. There were in fact two groups. You were a member of the neutral group. The only difference between groups was that for the other group, a poster was pinned to the wall behind me. This experiment is testing the hypothesis that the mere presence of the poster will influence the way in which participants perceive this situation, and that this influence will be reflected in a difference in pain threshold measures between the experimental group and this group.

Do you have any issues or concerns relating to this study?

Do you have any questions or comments at all?

Please DO NOT discuss this study with any other students.

APPENDIX VIII

Ethical principles for conducting research with human participants

From the British Psychological Society Code of Conduct, Ethical Principles and Guidelines; January 2000

Ethical principles for conducting research with human participants

1. Introduction

1.1 The principles given below are intended to apply to research with human participants. Principles of conduct in professional practice are to be found in the Society's Code of Conduct and in the advisory documents prepared by the Divisions Sections and Special Groups of the Society.

1.2 Participants in psychological research should have confidence in the investigators. Good psychological research is possible only if there is mutual respect and confidence between investigators and participants. Psychological investigators are potentially interested in all aspects of human behaviour and conscious experience. However, for ethical reasons, some areas of human experience and behaviour may be beyond the reach of experiment, observation or other form of psychological investigation. Ethical guidelines are necessary to clarify the conditions under which psychological research is acceptable.

1.3 The principles given below supplement for researchers with human participants the general ethical principles of members of the Society as stated in The British Psychological Society's Code of Conduct (q.v,). Members of The British Psychological Society are expected to abide by both the Code of Conduct and the fuller principles expressed here. Members should also draw the principles to the attention of research colleagues who are not members of the Society. Members should encourage colleagues to adopt them and ensure that they are followed by all researchers whom they supervise (e.g. research assistants, postgraduate, undergraduate, A-Level and GCSE students).

1.4 In recent years, there has been an increase in legal actions by members of the general public against professionals for alleged misconduct.

Researchers must recognise the possibility of such legal action if they infringe the rights and dignity of participants in their research.

2. General

2.1 In all circumstances, investigators must consider the ethical implications and psychological consequences for the participants in their research. The essential principle is that the investigation should be considered from the standpoint of all participants; foreseeable threats to their psychological well-being, health, values or dignity should be eliminated. Investigators should recognise that, in our multi-cultural and multiethnic society and where investigations involve individuals of different ages, gender and social background, the investigators may not have sufficient knowledge of the implications of any investigation for the participants. It should be borne in mind that the best judge of whether an investigation will cause offence may be members of the population from which the participants in the research are to be drawn.

3. Consent

3.1 Whenever possible, the investigator should inform all participants of the objectives of the investigation. The investigator should inform the participants of all aspects of the research or intervention that might reasonably be expected to influence willingness to participate. The investigator should, normally, explain all other aspects of the research or intervention about which the participants enquire. Failure to make full disclosure prior to obtaining informed consent requires additional safeguards to protect the welfare and dignity of the participants (see Section 4).

3.2 Research with children or with participants who have impairments that will limit understanding and/or communication such that they are unable to give their real consent requires special safeguarding procedures.

3.3 Where possible, the real consent of children and of adults with impairments in understanding or communication should be obtained. in addition, where research involves any persons under 16 years of age, consent should be obtained from parents or from those in loco parentis. If the nature of the research precludes consent being obtained from parents or permission being obtained from teachers, before proceeding with the research, the investigator must obtain approval from an Ethics Committee.

3.4 Where real consent cannot be obtained from adults with impairments in understanding or communication, wherever possible the investigator should consult a person well-placed to appreciate the participant's reaction, such as a member of the person's family, and must obtain the disinterested approval of the research from independent advisors.

3.5 When research is being conducted with

detained persons, particular care should be taken over informed consent, paying attention to the special circumstances which may affect the person's ability to give free informed consent.

3.6 Investigators should realise that they are often in a position of authority or influence over participants who may be their students, employees or clients. This relationship must not be allowed to pressurise the participants to take part in, or remain in, an investigation.

3.7 The payment of participants must not be used to induce them to risk harm beyond that which they risk without payment in their normal lifestyle.

3.8 If harm, unusual discomfort, or other negative consequences for the individual's future life might occur, the investigator must obtain the disinterested approval of independent advisors, inform the participants, and obtain informed, real consent from each of them.

3.9 In longitudinal research, consent may need to be obtained on more than one occasion.

4. Deception

4.1 The withholding of information or the misleading of participants is unacceptable if the participants are typically likely to object or show unease once debriefed. Where this is in any doubt, appropriate consultation must precede the investigation. Consultation is best carried out with individuals who share the social and cultural background of the participants in the research, but the advice of ethics committees or experienced and disinterested colleagues may be sufficient.

4.2 Intentional deception of the participants over the purpose and general nature of the investigation should be avoided whenever possible. Participants should never be deliberately misled without extremely strong scientific or medical justification. Even then there should be strict controls and the disinterested approval of independent advisors.

4.3 It may be impossible to study some psychological processes without withholding information about the true object of the study or deliberately misleading the participants. Before conducting such a study, the investigator has a special responsibility to (a) determine that alternative procedures avoiding concealment or deception are not available;
sufficient information at the earliest stage; and
(c) consult appropriately upon the way that the withholding of information or deliberate deception will be received.

5. Debriefing

5.1 In studies where the participants are aware that they have taken part in an investigation, when the data have been collected, the investigator should provide the participants with any necessary information to complete their understanding of the nature of the research. The investigator should discuss with the participants their experience of the research in order to monitor any unforeseen negative effects or misconceptions.

5.2 Debriefing does not provide a justification for unethical aspects of any investigation.

5.3 Some effects which may be produced by an experiment will not be negated by a verbal description following the research. Investigators have a responsibility to ensure that participants receive any necessary debriefing in the form of active intervention before they leave the research setting.

6. Withdrawal from the investigation

6.1 At the onset of the investigation investigators should make plain to participants their right to withdraw from the research at any time, irrespective of whether or not payment or other inducement has been offered. It is recognised that this may be difficult in certain observational or organisational settings, but nevertheless the investigator must attempt to ensure that participants (including children) know of their right to withdraw. When testing children, avoidance of the testing situation may be taken as evidence of failure to consent to the procedure and should be acknowledged.

6.2 In the light of experience of the investigation, or as a result of debriefing, the participant has the right to withdraw retrospectively any consent given, and to require that their own data, including recordings, be destroyed.

7. Confidentiality

7.1 Subject to the requirements of legislation, including the Data Protection Act, information obtained about a participant during an investigation is confidential unless otherwise agreed in advance. Investigators who are put under pressure to disclose confidential information should draw this point to the attention of those exerting such pressure. Participants in psychological research have a right to expect that information they provide will be treated

confidentially and, If published, will not be identifiable as theirs. In the event that confidentiality and/or anonymity cannot be guaranteed, the participant must be warned of this in advance of agreeing to participate.

8. Protection of participants

8.1 Investigators have a primary responsibility to protect participants from physical and mental harm during the investigation. Normally, the risk of harm must be no greater than in ordinary life, i.e. participants should not be exposed to risks greater than or additional to those encountered in their normal lifestyles. Where the risk of harm is greater than in ordinary life the provisions of 3.8 should apply. Participants must be asked about any factors in the procedure that might create a risk, such as pre-existing medical conditions, and must be advised of any special action they should take to avoid risk.

8.2 Participants should be informed of procedures for contacting the investigator within a reasonable time period following participation should stress, potential harm, or related questions or concern arise despite the precautions required by the Principles. Where research procedures might result in undesirable consequences for participants, the investigator has the responsibility to detect and remove or correct these consequences.

8.3 Where research may involve behaviour or experiences that participants may regard as personal and private the participants must be protected from stress by all appropriate measures, including the assurance that answers to personal questions need not be given. There should be no concealment or deception when seeking information that might encroach on privacy.

8.4 In research involving children, great caution should be exercised when discussing the results with parents, teachers or others acting in loco parentis, since evaluative statements may carry unintended weight.

9. Observational research

9.1 Studies based upon observation must respect the privacy and psychological well-being of the individuals studied. Unless those observed give their consent to being observed, observational research is only acceptable in situations where those observed would expect to be observed by strangers. Additionally, particular account should be taken of local cultural values and of the possibility of intruding upon the privacy of individuals who, even while in a normally public space, may believe they are unobserved.

10. Giving advice

10.1 During research, an investigator may obtain evidence of psychological or physical problems of which a participant is, apparently, unaware. In such a case, the investigator has a responsibility to inform the participant if the investigator believes that by not doing so the participant's future well being may be endangered.

10.2 If, in the normal course of psychological research, or as a result of problems detected as in 10.1, a participant solicits advice concerning educational, personality, behavioural or health issues, caution should be exercised. If the issue is serious and the investigator is not qualified to offer assistance, the appropriate source of professional advice should be recommended. Further details on the giving of advice will be found in the Society's Code of Conduct.

10.3 In some kinds of investigation the giving of advice is appropriate if this forms an intrinsic part of the research and has been agreed in advance.

11. Colleagues

11.1 Investigators share responsibility for the ethical treatment of research participants with their collaborators, assistants, students and employees. A psychologist who believes that another psychologist or investigator may be conducting research that is not in accordance with the principles above should encourage that investigator to re-evaluate the research.