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Information Processing Bias in Chronic Pain

By

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Contents

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Thesis Abstract

Chronic pain represents an enormous burden to individual sufferers and their families, to clinicians and to society as a whole. To alleviate this burden, better treatments are required, which necessitate a more thorough understanding of the problem. The first paper outlines the impact of psychological theory and research on our understanding of chronic pain. It focuses on information processing theories and methodologies, borrowed from the field of cognitive psychology. The evidence concerning the presence and role of cognitive biases is critically reviewed and suggestions for future research are made. Two main conclusions are discussed. Firstly, that further research is needed to explore the implications of cognitive bias in chronic pain. Secondly, that an interpretation bias in chronic pain may hold the key to understanding the development and maintenance of the problem in the absence of on-going injury.

The second paper describes a study which investigated the presence of an interpretation bias towards health, pain and illness interpretations of ambiguous stimuli in chronic back pain. The hypothesised characteristic presence of such an interpretation bias in this patient group was not supported using either method. The most likely conclusion is that the word association task failed to demonstrate a bias due to small sample size, s a mediu effect size was observed. However, the further failure to demonstrate a bias using the text comprehension task calls in to question the results of previous studies. Previous significant findings may have been due to response bias and experimenter demand effects, rather than a genuine difference between participant groups. A secondary possibility is that the results may reflect a difference in cognitive bias between sub-groups of chronic pain patients. The need for further research to test these alternative hypotheses is discussed along with the potential clinical implications of such research.

Literature Review Paper

Attention, Memory and Interpretation Bias in Chronic Pain: A Review of the Evidence.

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Attention, memory and interpretation bias in chronic pain: a review of the evidence.

Abstract

Chronic pain represents a huge and growing problem. It affects society in terms of the financial cost of disability, work absenteeism, and National Health Service treatment, places great strain on families, and causes the individual immense suffering. Our understanding of it however, remains limited and our treatments for it are only partially successful. Recent progression in the field of cognitive psychology and information processing approaches in particular, has led to huge advances in our understanding of mood disorders since the original models of Beck and Bower. Such advances are now beginning to filter through to facilitate treatment improvements. Researchers in the field of chronic pain have therefore borrowed the methodologies and utilised the findings from that literature in an attempt to bring about increased understanding and improved treatments in the field of chronic pain. This review outlines the research findings and discusses the implications of the studies of cognitive bias in chronic pain. It will argue firstly, that further research is needed in order to understand the implications and potential applications of the findings. Secondly, the review argues that the study of interpretation bias in chronic pain may prove vital in our understanding of the chronic pain experience, and yet, studies to date have been unreliable, and the area remains vitally under-researched.

Attention, memory and interpretation bias in chronic pain: a review of the literature.

The clinical picture of chronic pain; the impact on the individual and society

Chronic pain affects a huge percentage of the population and has an enormous impact on society in terms of the costs of absenteeism, and NHS resources, and to the individual and their family in terms of physical and emotional suffering, (Craig, 1994; Payne & Norfleet, 1986; Sternbach, 1986; Turk, 1996).

Chronic back pain is the most common medical complaint in developed countries (Bigos, Bowyer, & Biaen, 1994), Surveys of back pain in particular indicate that 60-80% of the adult population experience low back pain at some time, with 5-10% continuing to have some back pain symptoms over the course of their life. (Clinical Standards Advisory Group, CSAG, 1994a). Low back pain is now one of the most prevalent reasons for seeking health care and for work loss (Faculty of Occupational Medicine, 2000). In 1993, the annual estimated cost to the NHS for back pain was £480 million. Lost work production costs were estimated at £3.9 billion (CSAG, 1994b) and an estimated 430,000 people received social security benefits primarily for back pain (Faculty of Occupational Medicine, 2000).

The most salient feature of the chronic pain experience is distress (Craig, 1994; Turk, 1996). Depression rates in chronic pain are higher than in other medical populations (Banks & Kerns, 1996). A complete understanding of the complex relationship between mood and chronic pain remains illusive despite many attempts

to explain it (Banks & Kerns, 1996; Pincus & Morley, 2001; Robinson & Riley, 1999).

Despite prolific medical and psychological research, our understanding of pain remains limited. As a result, pain continues to challenge the sufferer who tries to live with it, the clinician who tries to alleviate it, and the researcher who struggles to understand the cause and to devise more effective treatments (Melzack & Wall, 1996).

The focus of this review

This review will focus on the problem of chronic pain. Many attempts have been made to understand what causes and maintains it in the absence of ongoing injury. The most recent attempts have utilised information processing models and in particular, have involved the study of non-conscious cognitive biases. The primary aim of this paper is to review the studies in this area, to highlight their findings, and to discuss their implications for our understanding of chronic pain. The most clear and consistent evidence for the presence of biased processing in chronic pain has come from the study of mnemonic processing. In contrast to this, little evidence has been found to support the presence of biased attention. Finally, the study of interpretation of ambiguity in chronic pain, has revealed some promising evidence in support of the role of biases in this area, both in terms of causing and maintaining the problem. Whilst the study of cognitive bias has revealed a number of interesting findings, to date they have contributed little in terms of implications and applications

to the field of chronic pain (Pincus & Newman, 2001; Pincus & Morley, 2001). A secondary aim of this review will be to highlight future research directions and to make suggestions about methodological improvements. In particular, the review will conclude that further cognitive bias research will lead to greater understanding of chronic pain and potentially to future developments in treatment approaches. Suggestions will be made for future research in this area.

Before considering the cognitive bias research to date and its implications, a brief consideration of the definitions of pain will be provided, followed by a summary of the contributions of earlier models of chronic pain which laid the vital foundations for later information processing frameworks.

Definitions of pain and chronic pain

Pain is defined as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.' (The International Association for the Study of Pain (IASP), 1986, p. S217). The IASP defines *chronic* pain as pain which continues past the stage of normal tissue healing, usually taken to be three months. However, the majority of studies reviewed below have defined chronic pain as pain which has lasted more than six months. This is in keeping with the medical approach which tends to label patients as having chronic pain after this amount of time (Skevington, 1995).

The IASP chronic pain definition is complicated by the fact that it includes pain for which there is no observable physical basis, pain which is disproportionate in magnitude to the apparent injury and phantom pain in body parts which are no longer present (Novy, Nelson, Francis & Turk, 1995.) This lack of consideration of subgroups within the definition of chronic pain represents a serious omission, which is also reflected in the research literature. This point will be discussed throughout this paper.

Understanding chronic pain; previous attempts

Early physiological models of pain and the emerging importance of psychological factors

Early theories of pain emphasised purely physiological mechanisms and suggested a direct link between injury and pain. Pain which could not be accounted for was referred to as 'psychogenic' and 'not real' (Horn & Munafo, 1997).

The above models were eventually abandoned in the light of a series of challenges to the proposed direct relationship between injury, pain and disability, (Magora & Schwartz, 1980; Waddell & Main, 1984; Wall, 1979). Such evidence demonstrated that the association between pain and pathophysiology is only tenuous at best (Saal & Saal, 1989; Weber, 1994).

In place of a direct injury / pain link, studies began to demonstrate that the amount and quality of pain perceived is partly a function of the culture we live in,

our previous experiences, and other factors unique to the individual (Melzack & Wall, 1988).

This increasing evidence demanded a new, comprehensive theory, capable of integrating these findings with the growing physiological and biological evidence. The Gate Control Theory (GCT), (Melzack & Casey, 1968; Melzack & Wall, 1965) was the first comprehensive theory to integrate psychological and biomedical factors, and to propose a mechanism which could explain the influence of psychosocial factors. This theory represented a radical paradigm shift in pain conceptualisation.

The Gate Control Theory (GCT); a theory of pain with tantalising gaps

The GCT remains the theory of pain most prominently used by clinicians even today. It has proved resilient in the face of accumulating scientific data and is still described as " a powerful summary of the phenomena observed in the spinal cord and brain...(with)... the capacity to explain many of the most mysterious and puzzling problems encountered in the clinic." (Melzack & Wall, 1982, p261.)

Briefly, the theory posits that neural mechanisms in the dorsal horn of the spinal cord, act as gates, which modulate the transmission of nerve impulses. When the gate is open, the transmission cells send impulses freely. When the gate is closed, the output is limited, thus limiting the perception of pain. Three interrelated factors have been proposed as contributing to the experience of pain via their

influence on the gates (Melzack & Casey, 1968). The first two include strength of noxious stimulation, and the amount of activation in other fibres, which if stimulated can close the gate. However, most importantly for psychology, the GCT posited that the gates could also be opened and closed by messages which descend from the brain.

In direct contrast to earlier physiological models, the posited role of the brain as active rather than passive in the process of the pain experience provided the basis for the action of psychological elements in affecting the hypothesised gate mechanism. According to this theory, the experience of pain results from the workings of several parallel information processing systems which analyse sensory and motivational / affective information simultaneously.

Despite the importance of the theory and its demonstrated utility, it provides only a sketchy outline of the phenomena of pain. In particular, whilst it emphasizes the importance of psychosocial elements, it fails to describe in any detail, the specifics of the psychological factors involved (Turk & Flor, 1999). This tantalizing gap in the explanation, has led to the recent explosion in psychological research in an attempt to complete the picture.

The cognitive behavioural model, borrowed from the psychological study of emotional disorders, has been the most frequently used theoretical framework for hypothesising about this gap (Pincus & Morley, 2001).

The cognitive behavioural model of chronic pain; an inadequate answer

The cognitive behavioural model was developed originally as a treatment model for depression by Beck, Rush, Shaw & Emery (1979), but has since been adapted to apply to a range of emotional disorders. When applied to chronic pain, the model suggests that patients' thoughts and feelings may contribute to the exacerbation, attenuation or maintenance of chronic pain, pain behaviour, affective distress, and dysfunctional adjustment (Turk, 1996; Turk, 1999; Turk, Meichenbaum & Genest, 1983).

The cognitive behavioural model views pain patients as 'active processors of information. They have negative expectations about their own ability and responsibility to exert any control over their pain. Moreover they often view themselves as helpless. Such negative, maladaptive appraisals about their situation and their personal efficacy may reinforce the experience of demoralisation, inactivity, and over reaction to nocioceptive stimulation. Such cognitive appraisals and expectations are postulated as having an effect on behaviour, leading to reduced effort and activity and increased psychological distress,' (p.103) (Turk & Rudy, 1992).

In addition, the cognitive behavioural model has been expanded in order to account for the common co-occurrence of mood disorders in chronic pain. Banks & Kerns (1996) have suggested a diathesis-stress framework to account for this

relationship. They suggest that the interaction of both underlying psychological and biological vulnerabilities (diatheses) must be present in addition to stressors which are unique to the chronic pain experience, in order to trigger the development of depression in chronic pain.

A large body of research supports the cognitive behavioural model of chronic pain, both by demonstrating the importance of appraisals, beliefs and expectancies in the pain experience (Boothby, Thorn, Stroud & Jensen, 1999; Jensen, Romano, Turner, Good & Wald, 1999; Turk, 1999; Turk & Rudy, 1992), and by illustrating the efficacy of treatment approaches aimed at cognitive factors (Morley, Eccleston & Williams, 1999). However, in terms of providing a comprehensive explanation which completes the gate control picture of pain, this model remains inadequate (Novy, Nelson, Francis & Turk, 1995) for the following reasons;

Firstly, it fails to suggest which factors create a vulnerability to chronic pain and which maintain or exacerbate the problem. In addition, it is unable to shed light on the differences between sub groups of patients with chronic pain. Secondly, research has been based mainly on self-report questionnaires. This methodology is open to experimenter demand effects and response bias, and is also unable to investigate the processing of information at a higher or non-conscious level.

Finally, the inadequacy of the model is highlighted by the limitations of the treatment approach. Despite its demonstrated efficacy compared to other treatments,

a large proportion of people still fail to receive benefit, partly due to high drop out rates and failure to engage (Kerns & Haythornthwaite, 1988; Richmond & Carmody, 1999), and of those who do benefit, many relapse (Morley *et al.* 1999).

Novy *et al.* (1995) argue that a greater specification of the salient facets of the cognitive behavioural model would have direct implications for understanding the differences between subgroups of pain patients, including those with different syndromes, those with acute, chronic and experimentally induced pain as well as remitting pain, and children, adolescents and older adults. They further suggest that greater specification will lead to improvements in the assessment and treatment of chronic pain and in the allocation of resources. The information processing approach and the study of cognitive bias represents exactly such an attempt to specify the salient cognitive facets.

The information processing approach

The information processing approach was influenced primarily by the cognitive models of Beck (described earlier) and Bower. Beck's theory posited cognitive distortions at the level of conscious thinking, and was less concerned with non-conscious processing. However, Bower's network theory (Bower, 1981; Bower, 1987; Bower & Cohen, 1982; Gilligan & Bower 1984) went much further in describing the hypothesised working of schemas which bias the processing of incoming information at a non-conscious level.

The information processing approach has attempted to clarify the relative involvement of different levels of cognition, including both conscious and unconscious levels (Williams, Watts, MacLeod & Mathews, 1997.) The methodologies employed by this approach allow the study of non-conscious processes and are thus an improvement over the self-report measures used in the cognitive behavioural framework.

Before considering the research concerning non-conscious cognitive biases in chronic pain, the review will now examine three information processing models which attempt to explain the phenomena of chronic pain.

Information processing theories of chronic pain

Several specific information processing models have attempted to account for chronic pain. In keeping with the suggestions of the GCT described earlier, such models have addressed the fact that chronic pain demands the processing of both bottom-up influences (sensory information) and top-down (affective information) ones.

Price, (Price,1988; Price & Harkins, 1994; Wade, Dougherty, Archer & Price, 1996) suggested that pain related information is processed in a series of four sequential stages. The initial two stages are suggested to be involved with the immediate unpleasantness of the painful sensation and are subsumed under the title of Stage I – affect-unpleasantness. The final two stages are included within Stage II

– affect suffering, and are concerned with the processing of the individual's beliefs, attitudes, expectations and past experience of pain, which are hypothesised to mediate the individual's affective response. Within this model, cognitive biases are hypothesised to play a central role in the pain experience only once the initial processing of sensory material has taken place. The model suggests that at stage I processing is insensitive to influences from cognitive reflection.

Leventhal's model proposes parallel processing of both emotion related information and sensory perceptual information from the point of contact with the noxious stimulus, (Leventhal, 1984). Within each of the two parallel processing arms (one concerning perception of sensory information and the other concerning emotion related information) he posits three hierarchically arranged stages of processing: An expressive-motor level, a schematic level and a conceptual level, with opportunities for interactions between each of the levels. The expressive-motor level is the basic processor of emotional behaviour and experience, present even in the neonate. The schematic level involves the encoding of emotional experience in memory and is seen as providing a record of conditioned emotional reactions. The main function of the schema is as an attention selector which serves to bias the selection of material which enters awareness. The conceptual level concerns the individual's conceptualisations of pain-distress experiences and involves the beliefs the individual holds about the cause, consequences, appropriate coping strategies and temporal course of the pain. Within this model, the conscious experience of pain-distress is the "end product of temporal processing and integration of

information about noxious stimuli with emotional reactions". (p274 Leventhal & Everhart, 1979.)

A third information processing model of chronic pain has been put forward by Jerome, (1993). This simplistic model suggests that the experience of pain is the result of a series of mental events which occur between peripheral nociception and behavioural response which serve to transform nociception in to information that is perceived, appraised and acted upon (Jerome, 1993). Chronic pain is conceptualised as resulting from a breakdown in a five stage system of filtering incoming information. As a result of the breakdown the individual is unable to integrate additional incoming noxious data in to adaptive information processing routines and thereby elicit effective coping strategies and instead perceives incoming input as a threat to the self, resulting in suffering. The model suggests a simultaneous bottom-up and top-down processing.

Summary and limitations of the pain specific information processing theories

Whilst the above theories are useful in conceptualising the processing of sensory and affective components, none of the models succeeds in specifying the important cognitive facets involved in the chronic pain experience, as demanded by Novy *et al.* (1995). For example whilst each suggests the presence of schemas and subsequent biases, they fail to hypothesise which biases might be important and what types of bias might be responsible for which aspect of the experience (Pincus & Morley, 2001). In addition, the models fail to address the relationship between mood and

chronic pain in detail, and to suggest differences between precipitating and maintaining factors. None of the models succeed in considering the differences between subgroups of patients and finally, they say little about treatment improvements.

The failure of the specific information processing driven theories of chronic pain to answer the above questions, has led to the adaptation and application of experimental paradigms used in the investigation of cognitive bias in mood disorders in to the field of chronic pain.

Cognitive bias in chronic pain: a review of the research literature

The study of cognitive bias in mood disorders has dramatically increased our understanding of specific clinical problems from the original cognitive models of Beck and Bower. In particular, this research has demonstrated that different disorders are characterized by different cognitive biases and can therefore be considered to have different cause and maintenance features (Williams *et al.* 1997).

Following on from this success, the methodologies and findings from the mood disorder literature have been borrowed in order to investigate the role of cognitive biases in the chronic pain experience. The assumption is that cognitive biases may play a vital role in distorting the processing of internal and external stimuli related to the experience of pain. As a result, they may cause increased preoccupation, over-interpretation and inadequate perception of internal stimuli

(Turk & Flor, 1999) leading to the development and maintenance of chronic pain states.

In the following section, each of the three main areas of investigation including memory, attention, and interpretation will be reviewed. Within each area, a brief summary of the findings from the mood disorder literature will be given before the evidence concerning chronic pain is examined in detail. When examining the evidence in relation to chronic pain, the following questions will be asked of the literature: What is the evidence for the presence of pre-conscious cognitive bias in chronic pain? Where evidence exists, is it a part of the pain experience itself, or can it be accounted for by the presence of mood disorder? What evidence do we have for the role it might play in either causing or maintaining chronic pain? Finally, what are the implications of the evidence with regard to treatment and future research directions?

The review will begin with studies concerning mnemonic processing which have generated the greatest amount of evidence in favour of a specific cognitive bias in chronic pain.

Memory

Memory bias; mood disorders

The findings with regard to the influence of mood on memory are well established. The most consistent and robust findings are in favour of the presence of a state congruity effect in depression. For example, studies have demonstrated that

clinically depressed people tend to over-recall negative material and under-recall positive material (e.g. Clark & Teasdale 1982; Gilligan & Bower 1984). This phenomenon has been postulated as an important factor in the cause and maintenance of depressive disorders.

In addition, robust and consistent evidence exists for the influence of self-referential encoding on memory in depression. The evidence is clear that depressed groups process information differently when relating it to themselves. For example, Mathews & Bradley (1983) showed that depressed patients demonstrated a recall bias for negative words only in a self-referential encoding condition (describes you?) but not in another person encoding condition (describes your best friend?). In addition, there is some evidence that self-referential memory bias is associated with vulnerability to depression (Bradley & Mathews, 1983).

Memory bias; chronic pain

The gate control theory and the pain specific information processing models described above highlight the central importance of memory for past painful events in mediating an individual's response to pain. It is also possible, given the evidence concerning the relationship between depression and memory, that memory may influence the pain experience by inducing a negative affective state, thus increasing pain related distress and contributing to the vicious cycle of decreasing activity and increasing disability.

The investigation of biased mnemonic processing in chronic pain is the area of cognitive bias which has received the most interest and which has generated the most evidence in support of the presence of biased processing. The majority of evidence has been derived from the study of recall whilst limited additional evidence has also been generated by the study of recognition and autobiographical memory. Each of these areas will now be reviewed briefly.

Recall

Early studies examined the accuracy of recall of pain intensity and were successful in demonstrating a state-congruity effect as found previously in depression. Results indicated that increased pain intensity (Eich, Reeves, Jaeger, & Graff-Radford, 1985) and anxiety (Kent, 1985) was associated with over-estimates of past painful episodes.

Subsequent studies have examined the relationship between pain and ability to recall pain and illness related words. In the first study of this type, pain patients and healthy controls were compared on their ability to recall pain sensory words (taken from the McGill Pain Questionnaire (Melzack, 1975), neutral and negative words (Pearce, Isherwood, Hrouda, Richardson, Erskine, & Skinner, 1990). The chronic pain group demonstrated a significant bias towards the pain words. Whilst these results were initially encouraging, higher levels of depression in the pain group could have accounted for the findings.

This possibility was later investigated in a study comparing depressed and non-depressed chronic pain patients, depressed psychiatric patients and healthy controls on their recall of pain affect, pain sensory and neutral words (Edwards, Pearce, Collett & Pugh, 1992) and the above findings were supported. Non-depressed chronic pain patients once again demonstrated a bias towards pain sensory information, suggesting that the bias was not solely due to mood. In addition, both of the chronic pain groups demonstrated better recall of both types of pain words compared to the neutral words, further supporting the presence of a recall bias associated with chronic pain.

Recall of words with self-referent encoding

Later studies began to explore the effects of self-referent encoding in chronic pain, and were led by the hypothesis that selective recall in chronic pain patients should include only that which is encoded with reference to themselves (Pincus, Pearce, McLelland & Turner-Stokes, 1993). Considerable support for this hypothesis has been generated.

In the subsequent studies, participants were asked to imagine themselves in situations involving the stimuli words (the self-referent condition) and also to imagine another person (e.g. a favourite medical character from a television series) in situations involving the same words (the other-referent condition).

Studies using pain related stimuli specifically, have demonstrated that patients with chronic pain selectively recall pain sensory words which have been encoded with reference to themselves, (self-referent condition) but not in the other-referent condition (Koutanji, Pearce, Oakley & Feinman, 1999; Pincus, Pearce, McClelland & Turner-Stokes, 1993). In the Pincus *et al.* (1993) study, pain patients and healthy controls' recall of pain sensory, affective and neutral words were compared. Analysis revealed that pain patients showed an increase in the number of pain sensory words recalled and a decrease in the number of neutral words recalled in the self-referent condition, whereas the healthy control participants showed no difference in recall of different word types regardless of encoding condition. Importantly, the pattern of recall of the same material across the different conditions was different, thus ruling out the possibility that the results were due to the chronic pain group having encountered the pain words more frequently.

A number of other studies have investigated the effect of self reference encoding using health and illness related words and each of these have found evidence for a bias associated with depression.

In a study comparing depressed and non depressed rheumatoid arthritis (RA) sufferers with depressed and non depressed controls, participants were tested on their recall of positive and negative health and illness related words (e.g. 'sick', 'diseased' vs. 'healthy', 'symptom free'.) A mood related bias was demonstrated. The depressed RA sufferers recalled more negative self-referent stimuli where as the

non-depressed rheumatoid arthritis sufferers demonstrated a bias towards recall of positive self-referent stimuli (Clemmey & Nicassio, 1997). In addition, the depressed RA sufferers recalled more negative health and illness stimuli than the non-pain control groups. These results suggest that the presence of pain and depression interact to create a bias in recall towards negative, self-referent stimuli.

However, the depression measure contained somatic elements which have been shown to overlap with the symptoms of chronic pain (Peck, Smith, Ward & Milano 1989; Pincus & Williams, 1999). Calfas, Ingram & Kaplan (1997) subsequently supported the above findings, overcoming the methodological weakness by removing the somatic elements of the Beck Depression Inventory (Beck, 1967).

In a more complex study which aimed to investigate the relationship between mood and memory bias in chronic pain further, Pincus, Pearce, McClelland & Isenberg (1995) compared depressed and non-depressed pain patients (with arthritis), and healthy controls, on their recall of affectively valenced, depression related, pain related and neutral adjectives. In keeping with the previous findings, this study confirmed the presence of a processing bias in depressed pain patients towards self-referent, pain related stimuli. The non-depressed pain patients however did not process negative pain related information selectively suggesting that the presence of depression is necessary for a bias to be demonstrated. However, the authors blame the affective nature of the stimuli for the lack of bias in the non-

depressed group. Also of interest here is that the depressed pain patients did not demonstrate a bias towards self-referent depression stimuli, which the authors suggest is due to the fact that depression in chronic pain is qualitatively different from that of other depressed groups.

Recognition and autobiographical memory

Recognition tasks have frequently been included in studies incorporating recall tasks. For example, Edwards *et al.* (1992) asked participants to recognize the fifty-four words previously presented to them amongst a list of one hundred and eight words (the additional words were matched for frequency and length). They demonstrated a recognition bias towards pain sensory words in depressed pain patients. However, these results, along with other studies which have investigated recognition, can only be viewed as inconclusive, due to a range of methodological weaknesses and the difficulties inherent in separating out effects due to mood (Pincus & Morley, 2001).

Similar problems have abounded in studies examining autobiographical memory in chronic pain. The main difficulty here is that the number of pain related memories recalled is confounded by the fact that chronic pain patients have more pain related experiences to draw upon (e.g. Wright & Morley, 1995).

However, tentative support for a mood related autobiographical memory bias in chronic pain has been provided by Eich, Rachman & Lopatka (1990). They

overcame the above problem by comparing the recall of real-life events in female students when they were experiencing menstrual pain with the same student's recall once pain free. After taking part, participants were asked to rate the pleasantness of each of the memories they had retrieved. Pain impeded access to pleasant memories and promoted the retrieval of unpleasant events only if it was accompanied by low mood.

Role of memory bias; cause or consequence?

The evidence with regard to the role of a memory bias is conflicting and remains insufficient to allow us to draw reliable assumptions about causality.

One ingenious study investigated this question by comparing pain patient's recall of pain and neutral words both prior to pain relieving surgery and two and six months after surgery (Edwards, Pearce & Beard, 1994). A recall bias towards pain related information which existed prior to the surgery, disappeared afterwards. Whilst it is important to interpret these findings with caution due to the high drop out rate in the follow-up data, it provided preliminary evidence that memory bias is a direct consequence of the experience of pain, rather than a pre-existing vulnerability factor. The authors suggest that if the bias was a stable 'trait' like component, then it would be unlikely to disappear following pain reduction. Ideally, studies examining recall bias in pain patients prior to the development of chronic pain are needed to support these findings.

In contrast, Koutanji, Pearce & Oakley (2000) found evidence of recall bias for pain related words amongst a healthy student population with a frequent number of pain episodes. They suggest that their evidence provides tentative support for the role of a recall bias as an indicator of vulnerability to developing chronic pain.

Summary, clinical implications and suggestions for future research

The evidence in favour of biased mnemonic processing associated with chronic pain is robust and consistent. The majority of evidence suggests that chronic pain patients selectively recall self-referent, sensory pain related information (not affective information). There is further evidence to suggest that biased recall of health and illness related stimuli is related to depression, although studies have failed to demonstrate an association between the pain related bias and mood. The failure of non-depressed pain patients to demonstrate a bias towards negative pain related information (Pincus *et al.* 1995) has been interpreted as evidence for the qualitative difference between depression in chronic pain and other depressive conditions. There is also tentative support for the hypothesis that the presence of pain promotes the retrieval of unpleasant events. Despite the weight of evidence, it remains unclear whether this bias is implicated in the cause or maintenance of the chronic pain problem.

The above studies have shed very little light on the implications and applications of a bias in mnemonic processing. One recent retrospective study, the first attempt to test the relationship between cognitive bias and behaviour, has

provided initial evidence for a predictive link between biased recall and behaviour (including level of disability and utilization of health care resources), (Pincus & Newman, 2001). In this study, increased recall bias in back pain patients was associated with greater disability and many more expensive referrals to out patient clinics.

Future research should aim to investigate this possible predictive quality and to replicate these findings using improved prospective methodologies (Pincus & Newman, 2001). In addition, future research should investigate the impact of a specific memory bias on treatment for chronic pain and in particular, whether changes in processing style are associated with improved outcomes, (Calfas *et al.* 1997). Longitudinal research may shed light on the cause versus maintenance question (Koutantji *et al.* 2000; Pincus *et al.* 1995).

Attention

Attentional bias; mood disorders

Attentional bias has been implicated in both the cause and the maintenance of a range of emotional disorders (Williams *et al.* 1997). The evidence in favour of an attentional bias is most compelling in the field of anxiety, where a bias towards threat related words has been consistently demonstrated (e.g Mathews & MacLeod, 1985; MacLeod, Mathews & Tata, 1986; Mogg, Mathews & Eysenck, 1992), with a smaller and less reliable body of evidence existing in favour of attentional bias in depressive states (Williams *et al.* 1997).

The most commonly used paradigm for investigating the presence of attentional bias is the emotional stroop adapted from the original stroop task (Stroop, 1935). This task requires participants to name the colour of ink in which a word is printed, whilst ignoring the content of the word. Typically, colour naming is slowed down when the word is related to the patient's concern, indicating that attention to the word has interfered with the task. This paradigm has also been used to investigate the hypothesis that chronic pain patients will demonstrate an attentional bias towards pain related information.

Attentional bias; chronic pain

A pre-conscious attentional bias towards pain related information may play an important role in maintaining chronic pain in the absence of further injury, and hampering treatment efforts. Increased attention towards aspects of the pain experience is likely to increase the monitoring of sensations (Pennebaker & Skelton, 1981), increase subjective pain intensity (Janssen & Arntz, 1996) leading to an increase in pain related distress and anxiety. Furthermore, an attentional bias towards pain related information is likely to 'grab' attention away from other more neutral tasks (Eccleston & Crombez, 1999), thereby hampering treatment efforts which require active participation from the patient (Pincus & Morley, 2001).

In addition, a hypothesized attentional bias in chronic pain makes intuitive sense for three reasons. Firstly, pain is known to demand attention, it is extremely

interruptive of other tasks, and difficult to disengage from (Eccleston & Crombez, 1999; Crombez, Eccleston, Baeyens, Van Houdenhove, & Van den Broeck, 1999). Secondly, pain patients are often pre-occupied with their pain and with monitoring bodily sensations which can become the focus of their lives. Thirdly, as pain related stimuli are likely to be perceived as threatening to pain patients, it is conceivable that they may demonstrate an attentional bias similar to that found in anxious patients.

In contrast to studies of mnemonic processing, studies to date have provided only limited evidence for the presence of a pre-conscious attentional bias. The following section will briefly outline the findings to date and will go on to discuss how they have contributed to our understanding of chronic pain. The section will end with a consideration of the most plausible reasons for the lack of support for the presence of an attentional bias, and with suggestions for future research.

Review of studies to date

Initial research findings were optimistic and supported the presence of an attentional bias in chronic pain. Using the emotional stroop paradigm, Pearce & Morley (1989) found that chronic pain patients showed significantly slower responses when colour naming both pain sensory and pain affect words, than when they were colour naming neutral words. In addition, the importance of mood in mediating this bias was ruled out because firstly, the chronic pain group were no different to a pain free, matched control group when naming negative emotional words, and secondly, correlational

analysis revealed no relationship between mood and Stroop interference. These results were encouraging because they held important implications for both understanding and developing cognitively orientated treatments. Unfortunately however, they have been difficult to replicate in subsequent studies (Pincus & Morley, 2001).

Pincus, Fraser & Pearce (1998) carried out two studies in replication of Pearce & Morley's original work. Neither experiment found evidence for attentional bias towards pain related words. In addition, Asmundson, Kuperos & Norton (1997) found that chronic pain patients did not differ from healthy control participants in their responses to either pain or injury related cues using the alternative dot probe paradigm.

However, limited evidence has been found in support of an attentional bias towards pain sensory information (but not towards pain affect information). Crombez, Hermans & Adriaesen (2000) took care to include pain words which were of particular relevance to the participant group who had low back pain, in order to maximize the sensitivity of the task. They found that colour naming of sensory pain words was significantly slower than colour naming of neutral words although the extent of the bias was small. Unfortunately though, the reliability of this result remains in question as the response towards sensory words was not significantly slower than that of words from other relevant categories, including words related to

back disorder. In addition, the failure to include a control group further weakened the evidence.

Possible mediating variables

A central focus of the research on attentional bias has been the identification of variables which might predict attentional bias in chronic pain. Results in this area have been varied.

Whilst Pearce & Morley (1989) found no evidence for the role of mood, Pincus *et al.* (1998) suggest that this lack of finding was due to their failure to assess mood adequately. In response to this, they demonstrated a positive association between anxiety (using the Hospital Anxiety and Depression scale, Zigmond & Snaith, 1983) and response time to pain sensory words in their first study. In their second study, once pain levels had been statistically controlled, they again demonstrated significant partial correlations between trait anxiety and response time to pain sensory words (Pincus *et al.* 1998).

Crombez *et al.* (2000) however, failed to demonstrate a relationship between response time and the anxiety-related constructs of pain related fear, negative affect, or pain catastrophizing. The best predictor was increasing pain intensity, although this was contrary to the findings of Pincus *et al.* (1998) who were unable to demonstrate a relationship between pain intensity and response time.

Summary and implications

On the basis of current evidence, biased attention does not appear to be a characteristic feature in the cause and maintenance of chronic pain (Pincus *et al.* 1998). Certainly, the findings are not as robust as in anxiety studies. There is a strong argument to suggest that the amount of bias found to date is related to measures of anxiety and depression rather than pain per se (Pincus *et al.* 1998).

Alternative explanations for the lack of evidence

There are two main explanations which have been put forward to account for the paucity of evidence in favour of an attentional bias. The first suggests that the lack of evidence may reflect a true picture of cognitive processing in chronic pain patients, indicating that they resemble depressed patients in their processing style more than anxious patients (Crombez *et al.* 2000). However, the limited evidence in favour of a sensory word bias (rather than an affective bias) is in conflict with this hypothesis.

Crombez *et al.* (2000), suggested that an attentional bias may only be found in certain sub-groups of chronic pain patients. In support of this they found that low back pain patients who avoid back straining reported being more alert to sensations in their back (Crombez, Vervaet, Lysens, Baeyens & Eelen, 1998). Finally, it has been suggested that attentional bias may only be present in the early stages of the pain experience (for adaptive reasons) but may diminish with time (Pincus & Morley, 2001).

The second argument cites design and methodological weaknesses as responsible for the failure to demonstrate an attentional bias. Pincus et. al., (1998) suggest that the emotional stroop paradigm may not be sensitive enough to pick up attentional bias in this group (Pincus *et al.* 1998), (as demonstrated by some of the studies concerning attentional bias in depression). In addition, it has been suggested that self-referent material may be necessary in order to demonstrate a bias (as demonstrated in depression.) Alternatively it has been argued that the use of words in studies to date may not be sufficiently relevant to the chronic pain experience to demonstrate the bias. In order to test this, Crombez *et al.* (2000) suggest the use of a primary task paradigm where a somatic distracter is used instead of word stimuli.

Suggestions for future research

Future research should confirm whether the lack of evidence for attentional bias is a true representation of the chronic pain group or whether it is due to methodological and design difficulties as suggested above. Pincus *et al.* (1998) call for longitudinal studies which map cognitive changes over time as acute problems become chronic conditions, and for studies which explore the effect of attentional biases on responses to pain and treatment.

Interpretation

Interpretation bias; mood disorders

A wealth of research evidence has supported the presence of an interpretative bias in a wide range of emotional disorders including, panic disorder (Richards, Austin & Alvarenga, 2001), social phobia (Amin, Foa & Coles, 1998), eating disorders (Cooper, 1997), and depression (McKendree-Smith & Scogin, 2000). However, the majority of research has been aimed at the field of anxiety, where the evidence in favour of an interpretative bias has remained robust across the use of a number of different paradigms.

Early studies relied on the use of ambiguous homophones (words which have both threatening and non-threatening meanings, but distinct spellings for each meaning). In the first, high and low trait anxious non-clinical participants were presented with threat / neutral homophones and were asked to spell each word after hearing it. High trait anxious individuals were more likely to endorse the threatening spelling of the word than the low trait anxious participants (Eysenck, MacLeod & Mathews, 1987). Later studies involving participants with anxiety related disorders supported these findings, (Eysenck, Mogg, May, Richards & Mathews, 1991; Mathews, Richards & Eysenck 1998). A major criticism of this approach to investigating interpretation bias is that it is open to response bias and experimenter demand effects. For example, it is probable that when participants hear the target word, they become aware of the two possible spellings, and therefore,

have to consciously choose which spelling to utilize. It has been argued therefore that the results of this task reflect the participant's conscious choice, willingness and ability to endorse a particular spelling, rather than a pre-conscious bias towards a particular meaning. In addition, because their choice is a conscious one, it can further be influenced by their perception of how the researcher expects them to answer.

More recent studies have become increasingly complex, utilizing the more sophisticated lexical decision and text comprehension paradigms in an attempt to eliminate the inherent response bias and experimenter demand effects of earlier methods. Despite the change in methodology, the results have confirmed earlier findings in favour of the presence of an interpretation bias (MacLeod & Cohen 1993; Richards & French, 1992).

Recent evidence has provided direct experimental support for the role of interpretation bias in causing anxiety disorders. Mathews & Mackintosh (2000), in a series of five experiments, demonstrated that interpretation of personally relevant emotional information could be induced and modified, and that active generation of personally relevant meanings had a direct effect on levels of state anxiety which changed in parallel with the induced bias. Further support has been provided by Richards *et al.* (2001) who compared participants who were at risk of developing panic disorder with participants who had panic disorder, on their interpretation of ambiguous internal bodily sensations. The findings suggest that people at risk of

developing panic disorder exhibit biased interpretation of ambiguous interoceptive stimuli similar to people with established panic disorder.

Interpretation bias; chronic pain

An interpretation bias in chronic pain may act to increase the likelihood that mild or ambiguous sensations will be interpreted as pain, thus increasing the frequency, intensity and duration of painful episodes in the absence of further injury (Cioffi, 1991). The recent exciting evidence for the causal role of an interpretation bias towards interoceptive stimuli in panic patients (Richards *et al.* 2001) makes it reasonable to assume that an interpretive bias may be implicated in the development of chronic pain.

Few studies to date have investigated the presence and role of an interpretation bias in chronic pain. The study of interpretation bias in chronic pain remains very much in its infancy and the methodologies used have still to reach the level of sophistication acquired within the mood literature. The following section reviews the evidence with regard to the presence of such a bias in chronic pain, the mediating factors involved, and considers the available evidence concerning the role such a bias might play in the development and maintenance of the problem. It will go on to explore the value of this research in terms of increasing our understanding of chronic pain and will conclude with an analysis of the methodological weaknesses and with suggestions for future research.

A review of the evidence

The methods used in the investigation of interpretation bias in chronic pain have relied on homonyms (words such as 'terminal' which have one spelling but a possible illness/pain related meaning as well as a neutral meaning i.e., airport / illness) , homophones (words which sound the same but which can have both an illness/pain related meaning and spelling and a neutral meaning and spelling i.e., 'pain' / 'pane') and word stem completion tasks, where part of a written word can be completed in a variety of ways including completions which are illness/pain related or neutral (i.e. amb/ulance/ient..etc.)

The majority of studies have considered the interpretation of health and illness related stimuli rather than pain related stimuli specifically. This has been a significant fault in the research which will be discussed later. However, studies utilizing health and illness stimuli have found strong and consistent evidence for the presence of an interpretation bias in chronic pain patients. This evidence will now be considered.

Studies using health and illness stimuli

In the most recent study, twenty pain patients, were compared with twenty healthy volunteers who were matched in terms of age, sex and verbal intelligence (Pincus, Pearce & Perrott, 1996). The pain patients had at least six months duration of pain resulting from a wide variety of diagnoses. All participants were presented auditorily with a list of ambiguous homophones, hidden within a list of

unambiguous words, matched for length and frequency, and were asked to write down each word after hearing it. Each of the ambiguous homophones could be interpreted as having both a neutral and a health related meaning. The results indicated that the pain group interpreted significantly more homophones as illness related than the healthy controls.

In order to avoid the possibility of response bias contaminating the results, when participants had reported being aware of the two possible meanings of a homophone, those homophones were removed. The analysis was repeated, and the results remained significant even after this adjustment.

The above research has been criticized due to the possibility of a frequency effect, because pain patients are much more likely to have encountered the negative health related meanings than the healthy control group (Pincus, Pearce, McClelland, Farley & Vogel 1994). In response to this, an additional participant group was included in two similarly designed experiments which compared chronic pain patients, healthy controls and a group of healthy professionals who encountered others in pain on a daily basis (Pincus *et al.* 1994).

In the first study, participants were asked to write down the first word which came in to their minds in response to reading an ambiguous cue (e.g., terminal, needle, etc.,). In keeping with the results from the above study, pain patients generated significantly more pain associations to ambiguous cues than either the

healthy control group or the health care professionals. In addition, the possibility of a frequency effect was dismissed because the means and standard deviations for the health care professionals and the pain free control participants were almost identical.

However, the results from their second study mounted a small challenge against the growing evidence for a pain related interpretation bias. Three participant groups were compared, including, chronic pain patients, non-pain controls and osteopaths (some of whom also had pain) using the same task as above. Once again, the chronic pain patients generated significantly more pain associations than the other groups. However, the group of osteopaths was further divided in to those who reported regular pain themselves, and those who did not. Of particular interest here is the fact that the two osteopath groups did not differ in the number of pain associations generated. In addition, the osteopaths with pain did not report as many pain associations as the chronic pain patient group. This finding provides a small challenge to the mounting evidence in favour of a pain related interpretation bias. The authors suggest two reasons for this; firstly, although they were unable to determine this from their study, they suggest that the difference may have been due to the osteopaths suffering less pain than the chronic pain group. However the failure to measure pain intensity in this study precluded verification of this possibility. Secondly, they suggest that the difference may have been due to the osteopaths and the chronic pain group developing different self-schemas (Pincus *et al.* 1994).

As mentioned above, only two studies have looked specifically at the interpretation of pain related stimuli. The results of these studies enable us to take a tentative, closer look at the type of interpretation bias and the role of the bias in chronic pain.

Studies using pain related stimuli

Edwards & Pearce (1994) used a word stem completion task to compare pain patient's responses with healthy controls and again, a group of health care professionals including nurses and physiotherapists. Twelve word stems were offered, four of which could be completed using pain sensory words, four using pain affect words, and four using either pain or illness words. Each stem was deliberately developed so that it could be completed using either at least one pain or illness related stem, or three or more non-pain or illness related stems of equivalent or greater frequency. However, the difficulty in generating these stimuli resulted in a very small number being used (Edwards & Pearce, 1994) and therefore, the results should be viewed with caution.

The results are fairly complex but revealing. In keeping with the central hypothesis, the results indicated that overall, the chronic pain patients produced significantly more pain related word stems than either the non-pain or health care professional group. However, when examining this in more detail, the bias in the pain participants is shown only to be towards the pain sensory words. No difference was found between any of the groups in terms of their responses to pain affect

words. The health care professionals demonstrated a mean number of pain related word stems which fell between the chronic pain group and the non-pain control group, although the difference between the health professionals and the non-pain group did not reach significance. Both the pain patient group and the health care professionals demonstrated significantly more illness related stems than the non-pain control group.

The authors suggest that it is only the direct experience of pain, which leads to the pain sensory bias in chronic pain patients. They further suggest that the failure to find any differences between participants on the pain affect word stems is related to the fact that previous researchers found elevated depression was necessary in order to induce a bias for pain affect words in a memory task (Edwards & Pearce, 1994). They conclude that the personal experience of pain results in the internal representations of pain being in a higher state of activation, which, they suggest, is likely to be directly related to the development and maintenance of long term pain problems, even in the absence of on-going injury.

In the most recent experiment to incorporate pain related stimuli, Grifith, McLean & Pearce (1996), compared patients with rheumatological problems, back pain patients and patients with cancer pain on an extended version of the above word stem completion task. In their version of the task, they also included a fourth category of stems concerning life threat. In keeping with the main hypothesis, the rheumatology and back pain patients produced significantly more illness related

stems than the controls. Interestingly, the rheumatology patients produced more pain related completions than any other group, hinting at a potential difference between subgroups of pain patients. However, the results which were of particular interest here were those of the cancer patients who showed no differences in their responses on any of the word stems when compared to the control participants. This finding, together with that concerning the osteopaths in the Pincus *et al.* (1994) study, would seem to challenge the growing consensus that interpretation bias is purely a function of pain.

Possible mediating variables; what factors could be responsible for the bias?

The above mentioned studies have sought to examine the role of variables such as mood and pain intensity in predicting interpretation bias.

Despite the evidence for an anxiety linked interpretation bias in the mood disorder literature, there is little evidence that mood is related to interpretation bias within this patient group. In the Pincus *et al.* (1996) study, although the pain group were significantly more anxious and depressed than the controls, as measured by the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) the interpretation bias was found to be independent of these mood differences. Other studies also failed to find a relationship between mood and interpretation bias e.g. (Pincus *et al.* 1994; Griffith *et al.* 1996). However, this lack of finding may be attributable to a failure to include patients with clinical levels of mood disorder in any of the studies (Pincus & Morley, 2001).

There is some evidence for the role of pain characteristics such as intensity in predicting interpretation bias. In the Pincus *et al.* (1996) study, measures of pain intensity and pain duration significantly predicted the number of homophones disambiguated in a health related way and accounted for 44.19 per cent of the variance. The primary significant predictor was the measure of pain intensity experienced by pain patients at the time of the experiment, which predicted 25% of the variance. Pain intensity ratings also accounted for 11% of the variance within the chronic pain group in the earlier study, (Pincus *et al.* 1994). However, the evidence from the comparison of the two osteopath groups (pain vs. no pain), (Pincus *et al.* 1994), as well as that from the cancer patients (Griffiths *et al.* 1996), suggests that interpretation bias is not simply a function of chronic pain alone.

Whilst recent studies from the field of anxiety have provided evidence in favour of a causal link between interpretive bias and mood disorders (Richards *et al.* 2001; Mathews & Mackintosh, 2000), no such evidence is yet available in the chronic pain field.

Summary

The limited studies available have been consistent in their support for the presence of an interpretation bias towards health and illness related stimuli as well as pain sensory stimuli, although the precise role of this bias remains unknown. Interpretation bias does not appear to be caused by a frequency effect, or to be

related to mood. However, there is some evidence in favour of a relationship between interpretation bias and increased pain intensity and duration. Of particular interest is the tentative evidence for differences in interpretation bias between different subgroups of patients (Griffith *et al.* 1996) and for the lack of interpretation bias in both cancer patients, and osteopaths with pain experience.

However, the study of interpretation bias in chronic pain has been the most under researched area of cognitive bias in chronic pain to date and the methodologies used can be criticized for their inherent flaws (discussed further below). This particular cognitive bias demands further investigation. The following section considers the methodological problems of existing studies and makes suggestions for future research directions.

Criticisms of previously used methodologies and suggestions for future research

There are several methodological weaknesses in the studies reviewed. Firstly, the homonym, word association and word stem completion tasks are all subject to response bias and experimenter demand effects (Pincus *et al.* 1994; Pincus & Morley, 2001). As discussed earlier in the section reviewing studies of interpretation bias in mood disorders, this means that the task may be testing the participant's conscious willingness to endorse a particular answer, rather than sampling their unconscious bias. The implications of this are potentially highly meaningful when studying patients with chronic pain. For example, if particupants are consciously aware of the possible spellings, word association and word stem

completions available to them, then they are free to make a conscious choice about which responses to utilize. In the majority of pain related studies, the pain patient participants are usually recruited and tested within a hospital or other pain-relevant setting, making it probable that they will be able to gues the focus of the study, allowing them to tailor their responses to what they perceive is expected of them in such a setting, i.e., a pain related response. In contrast to this, control participants are rarely tested within a similar setting and are therefore (it could be argued) less likely to tailor their responses in a pain related way. Thus, the above tasks may be likely to create false but statistically significant differences between pain and healthy control groups. Whilst one study attempted to control for this by removing those responses where participants indicated that they were aware of the various response options open to them (Pincus *et al.* 1996), the use of an alternative paradigm such as the text comprehension paradigm or the lexical priming task would yield more reliable results (Pincus & Morley, 2001). This is perhaps the most important future step to take in this field in order to verify previous results (Pincus *et al.* 1996).

The lexical decision and the text comprehension task paradigms have a number of proposed advantages over the previously used tasks. They attempt to eliminate the flaws discussed above in the following ways. Neither task relies on participants choosing between several available options. Both tasks use response latency as an indirect measure of interpretation bias. The critical data is therefore measured implicitly, without the participant's awareness or knowledge. By using either of these approaches, it has been argued that responses cannot be influenced by

either experimenter demand or response bias effects, (MacLeod & Cohen 1993; Richards & French 1992).

Secondly, most studies have used health and illness related words rather than words specifically related to pain, with two studies including only a very small number of pain specific stimuli (Edwards & Pearce 1994; Griffith *et al.* 1996). This has prevented an adequate exploration of whether interpretation bias in chronic pain is specific to pain related content or associated with a more general illness related bias (Pincus & Morley, 2001). Future research should seek to specify this relationship by comparing pain patient's performance on separate pain and illness related stimuli.

Thirdly, research to date is unable to tell us whether interpretation bias towards pain and illness stimuli is a characteristic of chronic pain patients only, or related to a range of chronic health problems. It is possible that any chronic health problem may be associated with the need to constantly self-monitor and therefore, may be associated with such a bias. Future research should compare chronic pain patients with other patient groups with long standing health problems but without pain in order to verify this (Pincus & Morley, 2001).

Much of the research has assumed that chronic pain patients are a homogenous group and has included pain patients with a wide variety of diagnoses and level of disability etc. Given the suggestion that interpretation bias may be more

relevant to some subgroups than others, future research should aim to explore this more closely. One approach would be to investigate whether factors such as diagnosis, or level of disability are associated with differences in interpretation bias.

As with the study of other cognitive biases in chronic pain, the relationship between interpretation bias and treatment has been largely ignored. In addition to improving the methodologies, future research should aim to examine the relationship between interpretation bias, prognosis including response to pain and disability, and response to treatment, via longitudinal studies. Research of this nature may help to uncover whether interpretation biases are involved in the cause or maintenance of the chronic pain problem. In addition, it would be useful to explore whether existing treatments for chronic pain result in a remediation of the bias (Pincus *et al.* 1994) and whether they can therefore be used to monitor efficacy of treatment.

Summary of cognitive bias in chronic pain

In an attempt to elucidate the specific cognitive factors involved in the chronic pain experience, researchers have adapted and utilized methodologies from the study of cognitive bias in mood disorders. The results of such studies have provided abundant evidence for the presence of biased mnemonic processing in particular, limited evidence for the role of attentional biases and initial but encouraging evidence for the role of interpretation bias in chronic pain.

The need for further research concerning each of the types of bias has been addressed. In particular, the review highlighted the need for further research concerning interpretation bias in chronic pain. This particular bias has received the least attention in relation to chronic pain despite the vitally important hypothesis that interpretation bias is implicated in the development of somatisation in the absence of further injury (Cioffi, 1991; Colligan, Pennebaker, & Murphy, 1982). Whilst existing studies have supported the hypothesis that pain patients will be more likely to interpret ambiguous words as pain related, they have used primitive methodologies which involve inherent response bias and experimenter demand effects, hampering interpretation of the findings. Further research in this area is needed, firstly to confirm the presence of this bias in chronic pain, utilizing more reliable methodologies. Secondly, a determination of the specificity of the bias is needed, in particular, it is vital to determine whether pain patients' interpretation bias is specific to pain related information or whether it operates with regard to a wider range of general health and illness information. A further priority for future research is to determine whether such a bias is characteristic of chronic pain patients alone, or whether other patients with chronic health problems demonstrate a similar bias. Finally, the suggestion that interpretation bias may be present in some subgroups and not in others demands further research.

Conclusions

The results of the studies concerning cognitive bias in chronic pain have been fascinating, but have so far been very limited in terms of implications and applications (Pincus & Newman, 2001; Pincus & Morley 2001).

One attempt has been made to consider the implications of the research in terms of generating an understanding of the chronic pain experience. Pincus & Morley (2001) have put forward a 'Schema enmeshment model' which attempts to explain all of the available data and which provides testable predictions about information processing bias in chronic pain patients.

Broadly speaking, the schema enmeshment model posits that the observed pattern of demonstrated cognitive bias is the product of the intersection of three schemata representing pain, illness and the self. The pain schemata are hypothesized to contain information about the immediate properties of the pain experience, in particular, the sensory-intensity spatial and temporal features. The illness schemata are proposed to contain information about the affective and behavioural consequences of illnesses, and the self schemata are thought to contain information about the individual's general trait like characteristics, as well as specific behavioural episodes (Pincus & Morley, 2001).

Each of these schemata are suggested to overlap and it is the pattern in which they do so which is critical in determining the individual's response to chronic pain.

For example, chronic pain patients who are 'adaptive copers' are thought to be characterised by the enmeshment of the pain and illness schemata, whilst the self schemata is thought to remain relatively separate. However, enmeshment between the three schemata in which pain and illness become incorporated into the self is thought to characterise those individuals for whom chronic pain is associated with disability and distress. Pincus & Morley (2001) suggest that 'the content of the observed biases are determined by the salience of the content of the overlapping merged schema and the degree to which the ...activated pain schema 'traps' negative aspects of the self'.

Whilst the above model is the first to attempt to incorporate the range of results obtained to date, further research concerning the implications and applications of cognitive bias in chronic pain remains imperative. In particular, further research is needed in order to determine the causal nature of cognitive bias as well as its predictive value, including the relationship between cognitive bias and disability (as initially demonstrated by Pincus & Newman, 2001). In keeping with this idea, further research is needed to determine whether information processing tasks can be used as screening tools. Finally, the relationship between cognitive bias and treatment responses demands further research. The issue of whether cognitive biases can be changed should be studied further (although tentative evidence in support of this has been provided by Edwards & Pearce, 1994). In addition, the question of whether remediation of cognitive bias can be used to indicate treatment outcome requires further research.

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Empirical Paper

Interpretation of Ambiguity in Chronic Back Pain – A Text Comprehension Study.

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Abstract.

Objectives. To investigate the presence of an interpretative bias towards pain and illness stimuli in chronic back pain patients compared to healthy controls, and to explore the hypothesised mediating effects of mood, pain duration and intensity.

Design. Interpretation was assessed using text comprehension and word association tasks. Mood was assessed using the Hospital Anxiety and Depression Scale, pain duration was assessed by self-report, and pain intensity was assessed using visual analogue scales. Response latencies on the text comprehension task were analysed using ANOVA. T-tests were used to compare the mean number of pain and illness related words generated on the word association task.

Methods. Twenty patients with chronic back pain and twenty-two healthy controls participated in the study. In the text comprehension task, the speed with which participants responded to ambiguous sentences (which could be interpreted in a pain/illness or neutral manner) was recorded automatically. In the word association task, participants generated spontaneous associations in response to a list of ambiguous words.

Results. Patients with chronic back pain failed to demonstrate an interpretation bias towards pain and illness stimuli in either task.

Conclusions. The initial results of the study suggest that back pain patients may differ from other pain patient groups in terms of interpretative bias. However, the most likely explanation for the lack of bias is due to small sample size. Further research is needed to confirm the presence of a characteristic interpretative bias in pain patient groups, using more reliable methodologies.

Interpretation of ambiguity in chronic back pain – a text comprehension study.

Chronic back pain has reached epidemic proportions in western civilisation and is now the most common medical complaint in developed countries (Bigos, Bowyer & Biaen, 1994). Back pain causes huge suffering to the individual and their family (Craig, 1994; Payne & Norfleet, 1986; Sternbach, 1986; Turk, 1996) and enormous financial burden to society (Faculty of Occupational Medicine, 2000; Clinical Standards Advisory Group, 1994 a & b).

The current treatment of choice is psychological, using cognitive behavioural approaches in particular. Whilst such approaches have been shown to be effective, they have a number of serious limitations. For example, the domains of mood, social role functioning and cognitive appraisal are not significantly improved by existing cognitive behavioural approaches to treatment (Morley, Eccleston & Williams, 1999). In addition, the efficacy of cognitive behavioural approaches in improving pain intensity ratings is not as reliable as other improvements (Skinner, Erskine, Pearce, Rubenstein & Taylor, 1990). Such treatment approaches are further limited by their inability to benefit a large proportion of people who drop out or fail to engage, (Kerns & Haythornthwaite, 1988; Richmond & Carmody, 1999). In addition, many of those who do benefit also tend to relapse (Morley *et al.* 1999). Advances in the treatment of chronic back pain rely on a greater understanding of the problem (Wall, 1999).

Recent attempts to understand chronic pain have turned to the utilisation of information processing models and approaches to investigation. Information

processing theories of pain have suggested the importance of cognitive biases in maintaining the chronic pain experience in the absence of on-going injury, (Price 1988; Price & Harkins 1994; Leventhal & Everhart 1979; Leventhal 1984; Jerome 1993). However, such theories have failed to predict which biases are critical and what role each might play in the chronic pain experience.

This has led researchers to adapt the methodologies used in the investigation of cognitive bias in mood disorders, to the study of chronic pain. Such research has revealed fascinating results. Mnemonic processing has received the most research interest and has generated the greatest amount of evidence in support of the presence of cognitive bias (e.g. Pearce, Isherwood, Hrouda, Richardson, Erskine & Skinner 1990; Edwards, Pearce, Collett & Pugh 1992; Pincus, Pearce, McLelland & Turner-Stokes 1993.) In contrast, the study of attentional bias has failed to demonstrate consistent evidence in support of the presence of this type of cognitive bias in chronic pain, (Pincus, Fraser & Pearce 1998; Asmundson, Kuperos & Norton 1997). The study of interpretation bias has been the most under-researched cognitive bias in the field of chronic pain to date.

An interpretation bias in chronic pain may play a vital role in causing or maintaining the pain experience. One theory of pain in particular has emphasised biased processing of ambiguous sensations as a key factor in the maintenance of pain, (Pennebaker, 1982). This has led to the hypothesis that an interpretation bias may increase the likelihood that mild or ambiguous stimuli will be

misinterpreted as pain related, thus increasing the frequency, intensity and duration of painful episodes in the absence of further injury (Cioffi, 1991).

Studies of interpretation in chronic pain have relied on the use of homonyms, homophones and word stem completion tasks. Homonyms include words which have two distinct meanings, although both meanings are spelled in the same way. For example, the word 'terminal' has a health/illness related meaning, as well as a neutral meaning (i.e., airport terminal). Homophones include words which are presented auditorily, and which have two distinct spellings and meanings, one either health/illness or pain related, and one neutral meaning, both of which sound the same. For example, the words 'pain / pane' sound the same but the listener may choose to interpret the word in either way. Finally, word stem completion tasks include lists of word beginnings, such as 'amb...' which can be completed in several ways i.e., 'ambulance', 'ambient' etc. Each of these methodologies have been criticised due to inherent response bias and experimenter demand problems, (Pincus, Pearce, McClelland, Farley & Vogel 1994; Pincus & Morley 2001). This means that rather than demonstrating an unconscious cognitive bias, the homophone, homonym and word completion tasks may instead be revealing the participant's conscious willingness to endorse a particular answer.

The evidence arising from studies of interpretation bias in chronic pain has been consistent. Each of the studies has supported the hypothesis that when presented with ambiguous words, patients with chronic pain conditions are much more likely to choose the health/illness, (Pincus, Pearce & Perrott 1996; Pincus,

Pearce, McClelland, Farley & Vogel 1994) or pain related interpretation (Edwards & Pearce 1994), than healthy control participants, or health care professionals. This bias does not appear to be caused by frequency effects due to the increased familiarity of pain patients with pain and illness related words (Pincus, Pearce, McClelland, Farley & Vogel, 1994).

Contrary to the findings in relation to memory and attentional biases in chronic pain, studies of interpretation have failed to demonstrate an association between mood and cognitive bias. This is surprising given the wealth of evidence in support of a characteristic interpretation bias towards threat related information in anxiety, (e.g. Eysenck, MacLeod & Mathews 1987; Mathews, Richards & Eysenck 1998; Eysenck, Mogg, May, Richards & Mathews 1991), since it would be reasonable to argue that chronic pain represents a significant threat to pain patients. In addition, initial evidence in support of a central role for an interpretation bias towards internal sensations in panic disorder (Richards, Austin & Alvarenga, 2001), also makes the failure to demonstrate a link between anxiety and interpretation bias in chronic pain puzzling.

There is conflicting evidence with regard to whether pain intensity and duration can account for interpretation bias in chronic pain patients. Whilst there is some suggestion that pain intensity and pain duration are associated with the degree of interpretation bias (Pincus, Pearce & Perrott 1996; Pincus, Pearce, McClelland, Farley & Vogel 1994), two studies in particular have thrown suspicion over this association. The failure of one study to demonstrate that osteopaths in pain have a greater tendency towards generating pain related words

in response to ambiguous cues, compared to osteopaths who were not in pain, challenged this association, (Pincus, Pearce, McClelland, Farley & Vogel 1994). In the second study, the failure to demonstrate an interpretation bias in cancer patients with pain (Griffith, McLean & Pearce, 1996) further challenges this association.

In terms of providing specific information with regard to low back pain, only one study has examined this particular sub-group of patients. With the exception of Griffith, McLean & Pearce (1996), each of the studies to date have included patients with a wide range of chronic pain complaints. It has been suggested that the presence of cognitive biases may vary from one diagnostic sub-group of patients to another (Crombez, Hermans, & Adriaensen, 2000). Griffith, McLean & Pearce (1996), found that rheumatology patients demonstrated a greater number of pain related associations to ambiguous cues than either the chronic back pain group, or the group with cancer related pain. Due to the 'mixing' of pain participants in the studies to date, little is known about interpretation bias in chronic low back pain in particular.

Therefore, the current study had two primary aims. The first was to confirm the presence of an interpretation bias in patients with chronic back pain specifically (towards ambiguous words) by using the word association task utilised by Pincus, Pearce, McClelland, Farley & Vogel, 1994. Confirmation of such a bias within this specific sub-group of patients was considered vital. The presence of an interpretation bias towards pain and illness related meanings in back pain patients would support the hypothesis that the misinterpretation of

ambiguous information may play a vital role in the development and maintenance of chronic back pain in addition to other pain problems. Such evidence would promote the development of specific cognitive behavioural therapy treatment approaches, aimed at ameliorating such a bias, which may prove more effective with this sub-group of patients than existing treatment packages.

The second main aim was to investigate whether such an interpretation bias could still be demonstrated when using a methodology which rules out the possibility of response bias and experimenter demand effects. The text comprehension paradigm, first used to examine interpretation bias in anxiety by MacLeod & Cohen (1983) was chosen for the purpose of comparing chronic low back pain patients' and healthy control participants' interpretation of ambiguous sentences. This paradigm excludes the possibility of experimenter demand effects because the data of interest is recorded implicitly, without the participant's awareness, whilst they are led to believe that their responses on an irrelevant part of the task is the data of interest. The problem of response bias is eliminated in this task because the participant's interpretations of ambiguity are not inferred from their relative tendency to produce or endorse alternative response options (MacLeod & Cohen, 1993).

A secondary aim of the current study was to investigate the relative contributions of mood, pain intensity and pain duration on interpretation bias. Evidence concerning the role of the above in an interpretation bias would also

enable clinicians to tailor cognitive behavioural packages to suit this sub-group of patients more effectively.

The main hypotheses guiding the current study were; i) chronic back pain patients, in keeping with other pain patient groups, will demonstrate an interpretation bias towards the health/illness and pain related meanings of ambiguous words, in comparison to a healthy control group. This was investigated by using the word association task utilised by Pincus, Pearce, McLelland, Farley & Vogel, (1994). ii) Chronic back pain patients will also demonstrate an interpretation bias towards health/illness and pain related meanings of ambiguous sentences compared to healthy control participants when utilising the more reliable text comprehension paradigm. iii) Finally, it was hypothesised that the degree of interpretation bias would be partly a function of mood, pain intensity and pain duration.

Method

Participants

The patient participants in the study were 20 patients (8 male, 12 female), with chronic low back pain who were consecutively referred to the regional, multidisciplinary pain clinic of a district general hospital. This clinic accepts referrals only for those patients for whom past primary care treatment or surgery has been unsuccessful. Patients with chronic low back pain who were due to attend the clinic were sent an additional letter inviting them to participate in the study and an information sheet, along with their usual clinic appointment letter. Willing participants were asked to attend their clinic appointment one hour early

and to approach the researcher on arrival. Data concerning the numbers of patients who were approached but who declined to participate was not available to the researcher. The mean age of pain participants was 43.3 years (SD 12.123, range 26-65 years). The mean duration of low back pain was 70.3 months (SD 58.620, range 6 – 240 months). Length of time spent in formal education (defined as school, sixth-form college, and higher education) was assessed as a general means of measuring intelligence. The mean length of time spent in formal education for the patient participant group was 12.350 years (SD 3.200, range 5– 17years).

The control participants consisted of 22 administrative staff (8 male, 14 female), recruited from a university department, a primary school, and a local supermarket. Potential control participants were excluded if they were currently suffering any chronic illness or pain problem, or if they cared for, or lived with another person who was suffering from a chronic illness or pain problem. The mean age of the control participants was 41.09 years (SD 11.426, range 24-57 years). The mean length of time spent in formal education for the control group was 14.364 years (SD 3.499), range 11-24 years).

Materials (Self-Report Measures).

Hospital anxiety and depression scale (HAD); (Zigmond & Snaith, 1983). This is a fourteen item, self report measure, designed to assess anxiety and depression in the physically ill. It was developed in response to the finding that other self-report measures of mood, such as the Beck Depression Inventory (BDI) provided misleading scores when used with a chronic pain population due to overlap in

somatic complaints (criterion contamination), (Williams & Richardson, 1993). The HAD therefore excludes all somatic items. The items are divided into two subscales, for anxiety and depression, and the patient rates each item on a four-point scale. Higher scores indicate the presence of problems, with scores of 10/11 and over taken to imply 'probable' caseness, (Zigmond & Snaith, 1983). The authors demonstrated good validity and reliability in an outpatient medical setting, which has since been supported by subsequent studies, (e.g., Vassilas, Nicol, Short 1995). Strong internal consistency between the two subscales has also been demonstrated (Moorey, Greer, Watson, Gorman, Rowden, Tunmore, Robertson & Bliss, 1991).

Visual Analogue Scales (see Appendix II)

Three visual analogue scales were used to assess pain intensity at three different times, a) at time of participation, b) on average over the past week, and c) worst pain ever. This involved using a 10cm horizontal line, with two end points labelled 'no pain' and 'worst pain ever.' This simple method has been found to be both valid and reliable for the measurement of pain intensity, (Scott & Huskisson, 1979). The participant is required to place a mark on the line at a position which correlates to their level of pain intensity. Distance in centimetres from the low end is taken as a numerical index of the severity of the pain. This method of assessing pain intensity was chosen because it is easy and quick to administer and score (Jensen, 1986), it involves minimal intrusiveness, (Wall & Melzack, 1999), and is relatively easy for patients to understand, (Huskisson, 1983 and Chapman, 1985). Such individual 0-10 rating scales have also been

found to have sufficient validity and reliability to be used in chronic pain research, (Jensen, Turner, Romano & Fisher, 1999).

Pain duration

Pain patients were asked to report how long they had suffered back pain. This score was recorded in months.

Materials (Interpretation of ambiguity).

Word association task. (See Appendix III).

The word association task used in this study was constructed according to the instructions laid out by Pincus, Pearce, McClelland, Farley & Vogel, (1994) for their 'trimmed' version of the task. Participants were presented with a questionnaire, detailing eleven ambiguous cue words which could either be interpreted as having a pain related meaning or a neutral meaning. These cue words were interspersed with an equal number of neutral fillers which were matched according to frequency and length by using Johaansson & Hofland, (1989). Participants were instructed to write beside each word, the first word which came in to their mind. In keeping with Pincus, Pearce, McClelland, Farley & Vogel's scoring method, responses were scored according to whether they were related to pain/illness or not. A conservative list of acceptable pain/illness related answers was drawn up prior to scoring, and answers which appeared on this list were accepted whilst all other answers were rejected.

Text-comprehension task

The text comprehension task requires participants to read short passages, presented on a computer screen, sentence by sentence, at a rate determined by themselves. The pace is controlled by the participant who presses a button to receive the next sentence. At the end of each passage, the participant is asked to respond by pressing a 'yes' or 'no' button following a simple question. They are led to believe that the answers to the question are the data of interest. However, the real data of interest is the time taken between button presses. This latency has been shown to be inversely related to the degree to which the continuation sentence represents a plausible follow-on from the previous sentence. Therefore, the response latency is related to the meaning or interpretation which the participant imposes on the first sentence. The examination of patterns of latencies shown over a range of continuation sentences therefore allows researchers to infer the participant's interpretation tendency, (e.g., Garnham, 1981, Garrod & Sanford, 1981).

In the version of the text comprehension paradigm used in the current study, participants were required to read two sentences, the first sentence being ambiguous. The ambiguous sentence could be interpreted in either a pain/illness related or a non-threatening way. Two versions of the second sentence were possible. The two versions differed in their meaning, so that one version was related to the pain/illness interpretation of the first ambiguous sentence, and the other was related to the neutral meaning of the ambiguous sentence. However, crucially, the two versions of the second sentence differed by only one word. The speed with which either of the two versions of the second sentence were read

and comprehended was assumed to be related to the meaning which the participant imposed on the initial ambiguous sentence. To be specific, if the version of the second sentence presented was in keeping with the meaning imposed on the preceding ambiguous sentence, then the speed of comprehension would be faster. If the version of the second sentence was not in keeping with the meaning which the participant had imposed on the initial sentence, then the speed of comprehension would be slower. The meaning imposed on each ambiguous sentence (the interpretation) was thus revealed by comparing the latencies shown for each continuation sentence version.

However, as MacLeod & Cohen (1993) discuss, the response latency for each continuation condition could be affected by factors other than the interpretation of the initial sentence. For example, speed could be affected by the emotional valence of the continuation sentence. Given this possibility, the examination of the relative latencies for each version of continuation sentence following an ambiguous sentence only, would give an unclear picture concerning the interpretation tendency of the groups. In order to avoid this problem, the task used involved the comparison of relative comprehension latencies for both versions of the continuation sentences, across three different cue conditions. The three cue conditions included; a) when the initial sentence was unconstrained or left ambiguous, (no cue given). b) when the initial sentence was constrained to a definite pain/illness related meaning (pain/illness cue given) and c) when the initial sentence was constrained to a definite neutral meaning (neutral cue given). By doing it in this way, the experiment allows the comparison of responses when the initial sentence is constrained to either a threatening or a non-threatening

meaning, with those responses when the initial sentence remains ambiguous. MacLeod and Cohen (1983) suggest this method more clearly implicates interpretative processing. However, this approach clearly does not erradicate the potential problem that participants' responses may still be affected by factors other than the ambiguous sentence. The limitations of this paradigm are explored further in the 'discussion' section.

Using this task, participants who demonstrate an interpretation bias towards the pain/illness related meanings of the ambiguous sentences, should show the same relative comprehension latencies for the two types of continuation sentences when receiving no cue (cue condition a), and when receiving a definite pain/illness cue (cue condition b). These participants should show a disproportionately long latency for threat related versions of the continuation sentences when the initial sentence was constrained to a definite neutral meaning (cue condition c). In order to support hypothesis (ii), pain patients should demonstrate the above pattern of results. This pattern is illustrated in Figure 1.

Insert Figure 1 about here

The pattern for participants who demonstrate a bias towards interpreting ambiguous sentences in a neutral or non pain/illness related manner should be

different. These individuals should show the same relative comprehension latencies for both versions of the continuation sentences when receiving no cue (cue condition a) and when receiving a neutral cue (cue condition c). They should also show disproportionately long comprehension latencies for neutral continuation sentences when the ambiguous sentence was constrained to a definite pain/illness meaning (cue condition b). The healthy control participants should therefore demonstrate this pattern of results. The following materials are needed for the task.

a) *Stimulus sentence sets.* (See Appendix IV for further examples of stimulus sentence sets used.) In line with MacLeod and Cohen's study, (1993), eighty sentence sets were constructed for use in this experiment. Each set included an ambiguous sentence that had one negative, pain or illness related meaning, and one non-threatening, neutral meaning (e.g., "Her breast was extremely tender"). Each sentence set also contained two different versions of a second sentence. These versions represented plausible continuations from the first, ambiguous sentence. One version was a pain or illness related continuation, and the other was a non-threatening, neutral continuation for the original sentence. Each continuation version differed by only one word. For example, the two versions of the continuation sentence provided for the ambiguous sentence "Her breast was extremely tender" were; 1) "She decided to talk to the chef" (this represented the non-threatening continuation) and 2) "She decided to talk to the doctor" (this represented the pain/illness continuation).

Two different cue words were also included for each sentence set, one which was related to the pain/illness interpretation of the following sentence (pain/illness cue), and one which was related to the neutral interpretation (non-threatening cue). For example, the pain/illness cue for the above sentence was "bosom", whilst the neutral cue was "chicken". Following the presentation of a cue, followed by the ambiguous sentence, and then the continuation sentence, participants were presented with a simple question, to which the answer was 'yes' or 'no'. The question was phrased in such a way that it could be sensibly answered irrespective of the participant's interpretation of the meaning. For example, the continuation sentence for the above example was, "Was it tender?"

b) *Experimental hardware.* A Toshiba 4000 CDT/4.0 lap-top computer was used to present the stimuli sentences to participants. A response box which contained a 'yes', 'no', and 'next' button was attached to the computer which participants used to register their responses to the questions and to move from one condition i.e., cue condition, to the next, i.e., ambiguous sentence. Participant's responses were timed automatically and stored by the computer in milliseconds.

c) *Experimental software.* In exact replication of MacLeod and Cohen's study, the text comprehension software first presented participants with a series of written instructions which appeared in the middle of the screen. Once they had read this and indicated to the researcher that they understood them, the participants responded by pressing the 'next' button to proceed with the task. The task began with twelve practice trials (responses to these were not analysed

as part of the results) followed by eighty experimental trials. Each experimental trial used one of the sentence sets described above. At the beginning of each trial, the participant was presented with the words, "Next Trial" at the centre of the lap-top computer screen, and once they had pressed the 'next' button, this was immediately followed by the cue word (either the pain/illness or neutral cue word) or a series of five question marks (representing the 'no cue' condition). Once the participant pressed the 'next' button again, an ambiguous sentence was displayed, which was then followed by a continuation sentence (either pain/illness related or neutral) once the 'next' button had been pressed again. By pressing the 'next' button again, the continuation sentence was replaced by the question. The participant responded to this by pressing either the 'yes' button or the 'no' button on the response box. Once the participant had responded to the question, the screen then went blank and two seconds later the words "Next trial" signalled the presentation of another sentence set. The order of task presentation is illustrated in Figure 2.

The critical dependent measure, recorded without the participant's knowledge, was the time elapsing between the button press which caused the immediate presentation of the continuation sentence and the subsequent button press which terminated the display of this sentence. The computer recorded this time which provided an index of the comprehension latency for each individual participant, on each of the eighty trials.

Insert Figure 2 about here

As illustrated in Figure 3, the text comprehension software programme presented forty (half) of the sentence sets in the no cue condition (i.e., pre-empted by five question marks instead of a cue word). The remaining forty sentence sets were provided with a word cue, evenly divided between the threat cue (20), and the neutral cue conditions, (20). For each cue condition, half of the sentence sets included a threat continuation, (10), and half included the neutral continuation sentence condition (10). The program permitted the assignment of experimental conditions to sentence sets to be rotated in a fully balanced manner.

Insert Figure 3 about here

Procedure

Pain patients were seen at an NHS pain clinic, in a district hospital, prior to their appointment. A small office adjacent to the main waiting area was provided for the purposes of this research. The lap-top computer and response box were set up on the desk in this office and the pain patient participants all completed the

following tasks in this setting. Patients willing to participate, were asked to sign a consent form. Demographic details were then recorded, including age, gender, time spent in formal education and pain duration. Participants then completed the text comprehension task, followed by the word association task, and finally, they completed the HAD and the visual analogue scales. After completion of the above, participants were debriefed.

Control participants were seen either at their place of work, or in their homes, in a quiet room without interruption. The order of tasks completed was the same as above. Neither participant group was informed that the study concerned back pain prior to participating in the research. However, the patient group may have assumed this from the setting. Both participant groups were told that the study concerned the way in which the brain processed and understood language.

Results

Participant characteristics.

The mean age, number of years in education, anxiety and depression scores of the two participant groups were compared using independent samples t-tests. The results are represented in Table 1. As can be seen, the pain patient and control groups were closely matched in terms of their age, and the number of years in education. However, the pain group demonstrated significantly higher anxiety and depression scores than the control group. The mean anxiety score of the pain patient group fell within the 'probable' case range. Chi-square analysis

revealed that the two groups did not differ significantly in terms of gender (x^2 = .059, p=.530).

Insert Table 1 about here

Word association task.

Hypothesis (i) stated that chronic back pain patients, in keeping with other chronic pain groups studied, would demonstrate a bias towards the health/illness and pain related meanings of the ambiguous words, in comparison to a healthy control group. An independent samples, t-test was used to compare the mean number of pain/illness related words generated in association to the ambiguous words in the word association task (see Table 1). The results showed that although the pain group generated more pain/illness words than the control participants, (a trend towards biased interpretation), this difference was not significant, t (40) =-1.620, p =0.112). Therefore, contrary to hypothesis (i), the pain patient group did not demonstrate a significant bias towards health, pain and illness words compared to the control group.

Comprehension Latencies.

In order to maximise the validity of the results, those response times were eliminated where the participant had answered the subsequent question

incorrectly. In addition, response times of three standard deviations or more above the mean, were excluded prior to the analysis.

Using un-related samples t-tests, comparison of the pain and control groups in terms of mean number of outliers t (40) =-.803, p=.427, mean response time t (40) =1.391. p=.172, and number of questions answered correctly t (40) =-1.379, p=.176, revealed no significant differences.

The latency data, obtained by recording the time (in milliseconds) between button presses before and after the continuation sentence, was analysed using a mixed design, analysis of variance (ANOVA). The mean comprehension latency data across group, cue and continuation conditions is presented in Table 2. The ANOVA considered one between subjects factor, (group) and two repeated measures factors (continuation and cue). The between subjects factor of group included two levels (pain group vs. control group). The repeated measures factors included two levels of continuation (pain and neutral continuations) and three levels of cue (pain, neutral and ambiguous). The main effects are reported first.

Insert Table 2 about here

Two main effects were demonstrated. Firstly, cue (irrespective of group and continuation condition) was shown to affect response times F (1, 40) = 11.46, p=.0001. Comparison of the mean response times according to cue condition revealed that ambiguous cues resulted in the fastest response times, pain cues were intermediate, and neutral cues resulted in the slowest response times. Secondly, continuation (irrespective of group and cue condition) was also found to affect response times F (1,40) =14.30, p=.0001. Comparison of mean response times according to continuation condition revealed that pain/illness continuation sentences resulted in faster response times than neutral continuations. No main effect was found for group F (1, 40) =1.84, p=.183.

A highly significant two-way interaction was demonstrated between cue condition and continuation condition, F (1, 40) =16.71, p=.0001. As with MacLeod and Cohen's study (1993), this confirmed that the task itself was working appropriately and that the relative comprehension latencies across the continuation conditions were influenced by the initial interpretation of the ambiguous sentence.

In keeping with this finding, the pain/illness and neutral cues led to faster processing of congruent continuation sentences (see Table 3). More specifically, the mean response time for pain/illness continuation sentences following a pain/illness cue was 525 milliseconds faster than the mean response time for the neutral continuations following pain/illness related cues. In addition, the mean response time for neutral continuation sentences following neutral cues was 230

milliseconds faster than the mean response time for pain/illness related continuation sentences following neutral cues.

Insert Table 3 about here

Finally, support for hypothesis (ii) was not demonstrated. The absence of a three way interaction between group, cue and continuation showed that the two groups did not differ in terms of their preferred interpretations of ambiguity F (1, 40) =.07, p=.932. As participant group was demonstrated to have no effect on the interpretation of ambiguity, in order to ascertain whether the participants as a whole demonstrated a bias in their interpretation of ambiguity, the mean comprehension latencies (irrespective of group) were considered (as shown in Table 3). The mean latencies in the pain/illness continuation condition were subtracted from those in the neutral continuation condition, thus providing a score indicating relative speeding on threat continuation sentences, according to each cue condition. These scores are illustrated in graph form in Figure 4. The difference between each of the scores according to cue condition was calculated using related samples t-tests. The results of the t-tests indicated firstly, that the speed of response on threat continuations following pain/illness related cues was significantly different to that following neutral cues $t(41) = 4.74$, $p < .001$. This result was expected since the cues had previously been found to successfully

constrain interpretation of the ambiguous sentence, as demonstrated by the two-way interaction. In addition, the speed of response in the pain/illness cued condition was significantly different to that of the ambiguous/no cue condition t (41) = 3.04, p =.004. This difference indicates the absence of a pain/illness related bias. Finally, the speed of response in the neutral cue condition was significantly different to the ambiguous/no cue condition t (41) = 3.93 p<.001. This pattern indicates the absence of a tendency to interpret ambiguous sentences in a neutral manner. The fact that the scores for each cue condition differed significantly from each other indicates that as a whole, the participants demonstrated no bias towards either neutral or pain related interpretations.

Discussion

The results from the word association task originally used by Pincus *et al.*, (1994) were surprising. Contrary to hypothesis i) the back pain patients did not demonstrate a significant bias towards pain related interpretations, when compared to the healthy control participants. This is not in keeping with the previous research which used this task with a 'mixed' pain group, (Pincus *et al.*, 1994) or with the findings of the other studies which used similar methodologies including homophones and word stem completion tasks. This lack of finding is even more puzzling given that the mean anxiety scores of the pain patient group fell within the 'probable' caseness range. In the light of this elevated anxiety score, it would be reasonable to assume that an anxiety related interpretation bias towards threat related information would contribute to the picture. Potential

reasons for the difference between the current study and previous studies should be considered.

Firstly, it is possible that the number of participants involved in the current study was too small to demonstrate an existing bias in this group, using this task. In the first of their two studies, Pincus *et al.*, (1994), used 107 pain patients with different types of pain problems, and in their second, they used 47 pain patients. In both studies, the number of pain related word associations reported by pain patients was statistically significantly different to that reported by healthy control participants. In the current study, the non-significant trend towards a bias in the back pain group (as illustrated in Table 1) may have reached significance if the number of participants had been greater.

Following the suggestion of a senior colleague, the effect sizes from the initial study by Pincus *et al.*, (1994) were compared with the effect size from the current study. This allowed comparison of the results independently of sample size (Clark-Carter, 1997). Using measures suggested by Cohen (1988), in the current study, d=0.45 which has been defined as constituting a small to medium effect size. In the first experiment conducted by Pincus *et al.*, (1994) which used a fourteen word version of the same word association task, the effect size was found to be small (d=0.09). In the second, which used the eleven word version which was also used in the current study, the effect size was found to be large (d=1). Since the effect size in the current study falls between that found in previous experiments which showed significant differences between pain and

control groups, this lends weight to the suggestion that the lack of finding in the current study may have been due to inadequate sample size.

Alternatively, the lack of findings may be attributed to the pain patient group. It is possible that unlike the 'mixed' patient groups included in other studies, back pain patients do not demonstrate a similar interpretation bias. In keeping with this idea, Griffith et al. (1996) demonstrated a weaker interpretation bias amongst back pain patients than rheumatology patients. Furthermore, there has been some suggestion that cognitive bias may be stronger at the outset of the pain problem (for adaptive reasons) and that it may diminish with time (Pincus & Morley, 2001). The mean pain duration in the patients involved in the current study was 70.3 months. It is possible that the pain patients involved in the current study may have 'lost' their interpretative bias as the length of pain duration increased. However, this is unlikely to account for the difference between the current study results and those of Pincus *et al.*, (1994) as the mean duration of pain was longer (11 years) in the latter study.

Finally, the examination of bias in the word association task relied on the comparison of the pain and control groups. The results of either group were meaningless on their own. Therefore, a potential fault with this design, which may have contributed to the failure to demonstrate a bias in the pain group, lies with the control group. Specifically, it is possible that the control group may have become influenced by response bias and experimenter demand effects as a result of knowing the researcher personally (in most cases) and of deducing the pain focus of the study, despite not having been told formally. The impact of

such an effect could have resulted in the control group demonstrating a similar response to the pain group, thus making it appear as though the pain group did not show a bias. Examination of the text comprehension task, which allows separate analysis of pain and control participant responses, provides further information on this point.

The finding of primary importance in consideration of the text comprehension task results was the presence of a two-way interaction between cue and continuation condition. MacLeod and Cohen (1993) suggest this interaction indicates that the task itself has been successful, therefore, ruling out the possibility that any lack of pain/illness related bias in the pain patient group is a result of the task design itself. However, further discussion concerning the problems inherent in this task which MacLeod and Cohen (1993) failed to consider, is offered towards the end of the following section.

Results indicated that contrary to hypothesis ii), there was no significant three-way interaction between group, cue and continuation condition. Therefore, in keeping with the word association task results, the back pain patient group did not demonstrate a pain/illness related interpretation bias. As a result of this finding, hypothesis iii) could not be explored.

Given the likelihood that the word association task would have demonstrated a significant bias in the pain group if a larger sample size had been used, the most plausible reason for the lack of bias shown using the text comprehension task is that the bias is removed when the experimenter demand

and response bias characteristics are erradicated. This suggests that previous findings reported in the earlier studies mentioned, of an interpretative bias in pain patient groups may have been due solely to faulty methodologies. The use of the text comprehension paradigm in this study may have exposed this possibility.

Alternatively, these results could be interpreted as providing tentative support for the hypothesis that unlike other 'mixed' patient groups, an interpretation bias towards pain/illness related interpretations of ambiguous stimuli is not characteristic of back pain patients. Furthermore, by plotting the relative speeding on pain/illness continuations by cue condition, of the whole participant group, it can be clearly demonstrated that there is no general bias towards the pain/illness interpretations. This finding rules out the possibility considered earlier, that the control participants' responses may have obscured the pain patients' bias.

Also of interest was the failure to demonstrate an interpretation bias towards neutral meanings of ambiguous sentences in the control group. There are two potential reasons for this. Firstly, it is possible, as stated earlier, that the control group's unconscious interpretation of the ambiguous sentences was contaminated due to 'guessing' the focus of the study. The second and more plausible possibility is that a neutral interpretation bias in healthy people would have no adaptive value. The failure to demonstrate either a pain/illness or a neutral interpretation bias in the control group may represent a 'balanced' and healthy approach to processing ambiguous information.

Before summarising the results and conclusions reached, it is important to consider alternative explanations for the lack of biased response shown on the text comprehension task. Whilst as discussed, the lack of bias may be due to the absence of a real existing characteristic bias, or to differences between the groups of pain patients used in this and previous studies, it is also possible that the results may be due to shortcomings in the comprehnsion task itself. For example, it is vital to consider whether the task is a valid and reliable measure of interpretation bias.

Firstly, there is little evidence in support of the validity of the task in measuring interpretation bias. Whilst MacLeod and Cohen (1993) argue that the significant two way interaction between cue and continuation successfully demonstrates the validity of the task, it has been argued that the same effect may still be found if the ambiguous sentence were to be removed completely (Cooper, 2001). Such a finding would suggest that reponse latency was independent of interpretation of ambiguity and was a result of the individual's emotional response to the cue or continuation sentences alone. This possibility demands further investigation.

Secondly, the validity of the question marks used in the 'no cue' condition has also been challenged. It has been suggested that the use of a length and frequency matched word, chosen because it is unrelated to either the neutral or the threatening interpretation of the ambiguous sentence, would increase the task validity. Thirdly, no data is available concerning the construct validity of the task. It remains unclear whether the task is actually measuring the same

construct as the simpler homophone/homonym and word association tasks used previously. In order to determine this, the results of the text comprhension task, as well as a range of other measures of interpretation bias, should be compared using the same participant group.

Finally, there is no evidence regarding reliability issues and internal consistency. It is possible, for example, that individuals' response latencies may differ from one occasion to another, or that some sentence sets act as better measures than others. In the future, a thorough investigation of the validity and reliability of the text comprehension task will be necessary before any firm conclusions can be drawn about participants themselves.

In summary, the current study failed to demonstrate an interpretation bias towards pain and illness interpretations of ambiguous sentences within a back pain patient group, utilising two different experimental methods. As discussed, it is probable that if a larger sample size had been used, a significant result may have been demonstrated using the word association task. The potential implications of this are extremely important because it suggests that pain patients may only demonstrate an interpretation bias when using those tasks which are flawed due to experimenter demand and response bias effects. If the bias is present in flawed tasks, but absent in more reliable methodologies such as the text comprehension paradigm, then it is possible that earlier studies using the flawed tasks may have been misleading. Further research using larger sample sizes, and comparing participants on both the word association task as well as the text comprehension task is needed in order to confirm this possibility.

An alternative but less plausible reason for the lack of bias demonstrated in the current study is that the patient group involved in the current study differed in their level of this particular interpretation bias to previous groups studied. The only difference between the patient group recruited for this study compared to those recruited for other studies is the restriction to back pain patients in the current study. Therefore, the difference in interpretation bias may reflect an absence of a pain/illness related bias or a weaker bias in the back pain group compared to other pain patient groups. One possible reason for this difference might be a difference in core schemas between back pain patients and other pain patients. For example, the high level of disability involved in back pain in relation to other painful conditions may mean that issues concerning disability are more closely related to the individual's schema than stimuli concerning pain and illness. This difference could potentially result in an interpretation bias towards disability related stimuli rather than towards pain and illness stimuli. Previous researchers have made the related suggestion that a failure to demonstrate cognitive bias towards pain and illness related stimuli may be because the stimuli themselves do not represent the core concern of the patient (Crombez, Hermans & Adriaensen, 2000).

However, whilst it is possible that the results of the study are due to either a genuine lack of bias in pain patients, or to differences between participant groups, it is also possible that they are due to faults within the paradigms used which have been discussed.

The clinical implications of the results of this study are limited. The possible absence of an interpretative bias towards health, pain and illness related meanings of ambiguous stimuli, prevents the refinement of existing cognitive behavioural treatment methods to suit this sub-group of patients. However, the absence of a bias in this sub-group of patients may be important in terms of increasing our understanding of the differences between sub-groups of pain patients, which is vital in order for effective treatments to be developed for each group. It is hoped that the above findings may prompt researchers to search for the presence of an alternative interpretation bias in chronic back pain, which may in turn lead to treatment improvements for chronic back pain sufferers.

Future research into back pain should employ larger samples. However, researchers should consider whether a weak bias, represented by a small statistical significance, really provides much useful information in terms of clinical considerations. Future research should also compare groups of back pain patients with different lengths of pain history in order to assess whether bias is more prevalent earlier in the pain experience. In addition, further understanding of back pain in particular, may be enhanced by exploring potential differences in interpretative bias between back pain groups and other sub-groups of pain patients.

A limitation of the current research is that it failed to confirm the presence of an interpretation bias previously found using heavily criticised methodologies. This point was discussed with reference to sample size. It remains important to replicate this study using a larger sample size to confirm the

suggestion that a larger sample would have demonstrated a bias using the word association task, and no bias on a more sophisticated and reliable task such as the text comprehension or lexical decision tasks (Richards & French, 1992). It remains vitally important also to explore the presence of interpretation bias in a 'mixed' pain group similar to that used in previous studies, using a more reliable paradigm such as the text comprehension or lexical decision making task (Richards & French, 1992).

Further understanding of any differences in interpretation bias between sub-groups of pain patients will rely on verification of these earlier findings. If an interpretation bias remains consistent despite the use of a more stringent task, further research should also aim to explore the relationship between an interpretative bias and prognosis and treatment, and whether a test of interpretative bias can usefully be used as a screening tool and means of assessing treatment efficacy.

In addition, future research should aim to develop an understanding and to improve the reliability and validity of the text comprehension paradigm for use with this population.

Table 1.

Comparisons (t-tests) of participant characteristics across groups

	Pain Group		**Control Group**				
	M	*SD*	*M*	*SD*	*DF*	*t*	*Signif*
Age (yrs)	43.300	12.123	41.091	11.426	40	-0.61	**0.547 (NS)**
Education (yrs)	12.350	3.200	14.364	3.499	40	1.940	**0.060 (NS)**
Anxiety	10.350	3.774	5.591	3.157	40	-4.450	**0.0001**
Depression	7.7000	3.729	2.273	1.723	40	-6.150	**0.0001**
Pain/illness associations	3.400	1.353	2.590	1.817	40	-1.620	**0.112 (NS)**

Table 2.

Mean comprehension latency data

		Pain / Illness continuation		*Neutral continuation*	
		M	*SD*	*M*	*SD*
Pain Group	*Pain cue*	3078	1060	3560	1143
	Neutral cue	3272	1065	3036	1124
	Ambiguous cue	2950	729	3056	930
Control Group	*Pain cue*	2483	925	3047	774
	Neutral cue	3088	930	2864	817
	Ambiguous cue	2560	675	2770	723

Table 3.

Mean comprehension latencies indicating interaction of cue and continuation condition

Cue	*Pain / Illness continuation*		*Neutral continuation*		*Relative speeding on threat continuations*
	M	*SD*	*M*	*SD*	
Pain / ill	2776	1025	3291	990	525
Neutral	3176	988	2946	967	-230
Ambiguous	2746	720	2906	830	160

Figure 1.

Diagram to illustrate the pattern of relative comprehension latencies predicted by Hypothesis (ii)

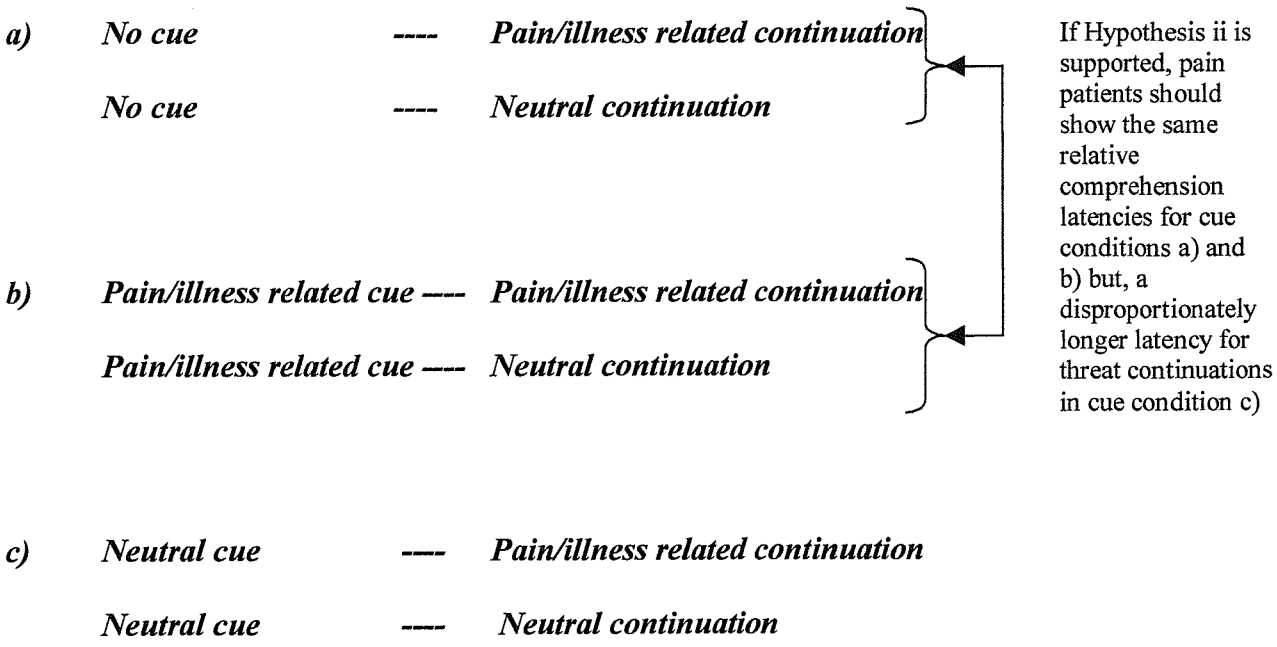


Figure 2.

Flow diagram to show order of text comprehension task presentation

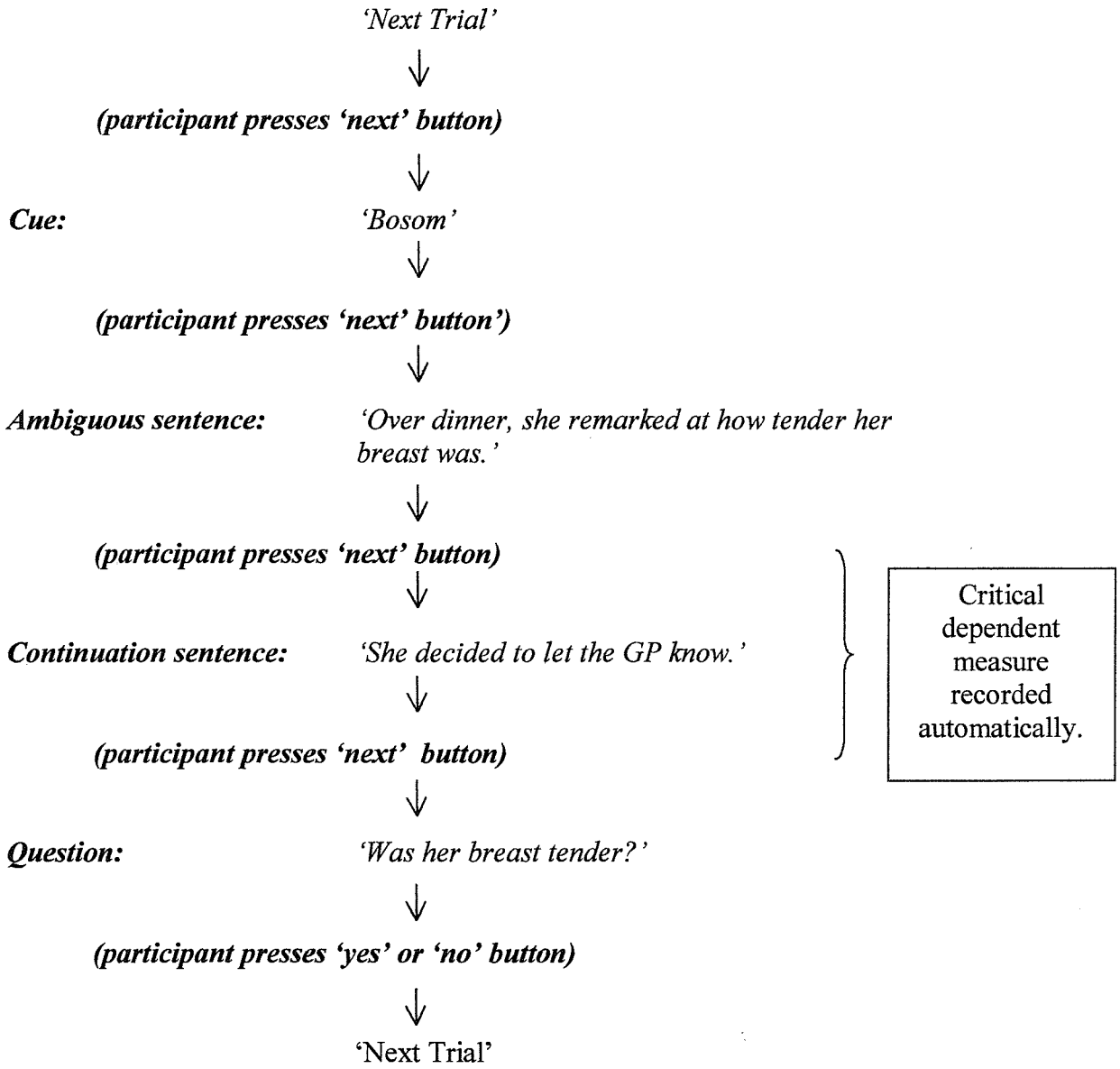


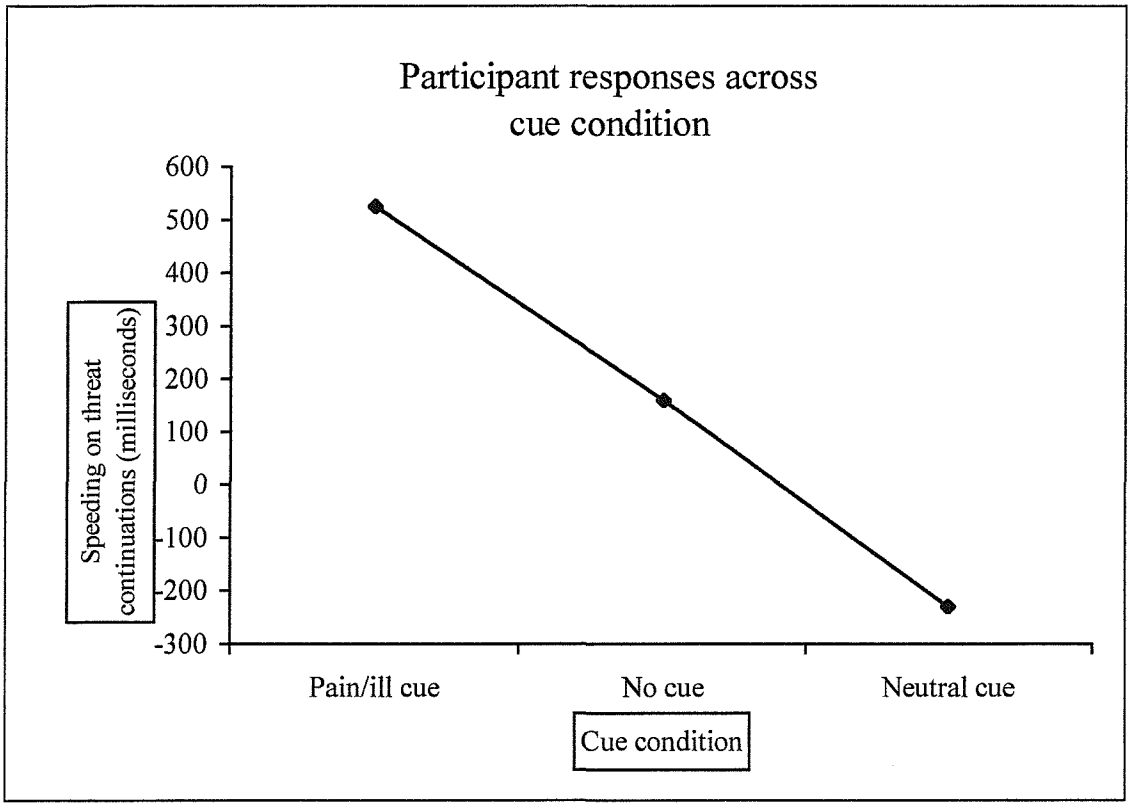
Figure 3.

Software presentation of cue and continuation conditions

Cue condition	*Continuation condition*
40 No cue	*20 Pain/illness continuation*
	20 Neutral continuation
20 Pain/illness cue	*10 Pain/illness continuation*
	10 Neutral continuation
20 Neutral cue	*10 Pain/illness continuation*
	10 Neutral continuation

Figure 4.

Graph to show relative speeding on threat continuations across cue conditions, irrespective of participant group



Appendices

Appendix 1
Instructions for authors

NOTES FOR CONTRIBUTORS

1. The aim of the *British Journal of Health Psychology* is to provide a forum for high quality research relating to health and illness. The scope of the Journal includes all areas of health psychology across the life span, ranging from experimental and clinical research on aetiology and the management of acute and chronic illness, responses to ill-health, screening and medical procedures, to research on health behaviour and psychological aspects of prevention. Research carried out at the individual, group and community levels is welcome, and submissions concerning clinical applications and interventions are particularly encouraged.

The following types of paper are invited:

(a) Papers reporting original empirical investigations
(b) Theoretical papers which may be analyses or commentaries on established theories in health psychology, or presentations of theoretical innovations
(c) Review papers, which should aim to provide systematic overviews, evaluations and interpretations of research in a given field of health psychology
(d) Methodological papers dealing with methodological issues of particular relevance to health psychology.

2. The Journal is international in its authors and readers. Contributors should bear the international readership in mind, particularly when referring to specific health services.

3. Pressure on Journal space is considerable and brevity is requested. Papers should normally be no more than 5000 words.

4. Supplementary data too extensive for publication may also be deposited with the British Library Document Supply Centre. Such material should be submitted to the Editors together with the article for simultaneous refereeing. Further details of the scheme are given in the *Bulletin of the British Psychological Society*, 1977, **30**, February, p. 58.

5. This Journal operates a policy of blind peer review. Papers will normally be scrutinized and commented on by at least two independent expert referees as well as by an editor or associate editor. The referees will not be made aware of the identity of the author. All information about authorship including personal acknowledgements and institutional affiliations should be confined to a removable front page (and the text should be free of such clues as identifiable self-citations ('In our earlier work...').) The paper's title should be repeated on the first page of text.

6. The editors will reject papers which evidence discriminatory, unethical or unprofessional practices.

7. Submission of a paper implies that it has neither been published elsewhere nor is under consideration by another journal.

8. In preparing material for submission authors should follow these guidelines:

(*a*) Contributions must be typed in double spacing with wide margins and on only one side of each sheet. Sheets must be numbered. Four good copies of the manuscript should be submitted and a copy should be retained by the author.

(*b*) Tables should be typed in double spacing, each on a separate sheet of paper. Each should have a self-explanatory title and be comprehensible without reference to the text.

(*c*) Figures are usually produced direct from authors' originals and should be presented as good black and white images preferably on high contrast glossy paper, carefully labelled in initial capital/lower case lettering with symbols in a form consistent with text use. Unnecessary background patterns or lines and shading should be avoided. Captions should be listed on a separate sheet.

(*d*) The Editors propose to adopt structured abstracts and all articles should be preceded by a structured abstract of between 100 and 250 words (less in the case of a short paper), giving a concise statement of the intention and results or conclusions of the article. Authors requiring further details on structured abstracts should contact the Journals Department (details on inside front cover).

(*e*) Bibliographic references in the text should quote the author's name and the date of publication thus: Hunt (1995). Multiple citations should be given alphabetically rather than chronologically: (Blackburn, 1996; Fortheringhame, 1994; Norman, 1995). If a work has two authors, cite both names in the text throughout: Choi and Salmon (1995). In the case of reference to five authors, use all the names on the first mention and *et al.* thereafter except in the reference list. For six or more, use *et al.* throughout.

(*f*) References cited in the text must appear in the list at the end of the article. The list should be typed double spaced in the following format:

Hunter, M. (1994). *Counselling in obstetrics and gynaecology.* Leicester: The British Psychological Society.

Pruitt, S.D., & Elliott, C.H. (1989). Paediatric procedures. In M. Johnstone & L. Wallace (Eds.), *Stress and medical procedures* (pp. 157–174). Oxford: Oxford University Press.

Ray, C., Phillips, L., & Weir, W.R.C. (1993). Quality of attention in chronic fatigue syndrome: Subjective reports of everyday attention and cognitive difficulty, and performance on tasks of focused attention. *British Journal of Clinical Psychology, 32*, 357–364.

Note that journal titles are cited without abbrevation.

(*h*) Measurements should be in units of the International System.

(*i*) If the title of the article is longer than 80 characters, a short title should be provided for use as a running head.

(*j*) Footnotes are expensive to set and should be avoided.

(9) Proofs are sent to the corresponding author for correction of print but not for rewriting or the introduction of new material. Fifty complimentary copies of each paper are supplied to the corresponding author, but further copies may be ordered on a form supplied with the proofs.

(10) Authors should consult the Journal editor concerning prior publication in any form or in any language of all or part of their article.

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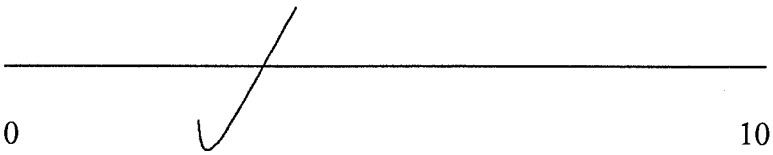
Appendix II
Visual Analogue Scales

Name:..... Date:..... Participant No:.....

A QUESTIONNAIRE ABOUT YOUR PAIN

I would like to know about your pain. It would help me to understand it you could give it a score out of 10 (0=No pain at all, 10= Extreme pain), for each of the three questions below. In order to indicate the score, please place a tick somewhere along each of the lines like this;

Example.



0 (no pain at all.) 10 (extreme pain.)

1) Please place a tick along the line to **indicate how severe your pain is at the moment.**

0 (no pain at all.) 10 (extreme pain.)

2) Please place a tick along the line to **indicate how severe your pain has been over the past week (on average).**

0 (no pain at all.) 10 (extreme pain.)

3) Please place a tick along the line to **indicate how severe your pain has ever been.**

0 (no pain at all.) 10 (extreme pain.)

Appendix III
Word association task – ambiguous words and acceptable pain/illness related answers

Word association task – ambiguous words used and acceptable responses.

Ambiguous word (taken from Pincus, Pearce, McClelland, Farley & Vogel, 1994)	**Range of responses accepted**
Terminal	death, ill*, dying, cancer
Needle	jab, injection, blood*, pain*, sore*, ouch, hypodermic
Wheel	mark*, sore*, bruise*, wound*, skin, injury
Plaster	of paris, limb*, cut, graze, hurt, cast, sticky, wound*, bandage
Growth	illness, cancer, tumour, lump
Wrenching	back, pain*, sick*
Block	nerve, injection
Back	pain*, ache*, tender, sore*
Relief	tablets, injection, pain*, pain killers
Nerve	pain*, pinch*, trap*, tender, tension, hurt
Bed	ill*, sick*

* indicates any completion of the word is acceptable

Appendix IV
Examples of stimulus sentence sets

Examples of stimuli sentences used in the text comprehension task

1. Cue: Vertebra \ Music
   Ambiguous sentence: She wondered of the damaged disc would make playing difficult.
   Pain/illness continuation : The pain might be intolerable.
   Neutral continuation: The sound might be intolerable.

2. Cue: Bones \ Pipes
   Ambiguous sentence: More fractures occur in the freezing weather.
   Pain/illness continuation: The paramedics are constantly asked to deal with fractures.
   Neutral continuation: The waterboard are constantly asked to dealt with fractures.

3. Cue: Wound \ Tree
   Ambiguous sentence: He looked carefully at where it had been grazed.
   Pain/illness continuation: The skin needed careful attention.
   Neutral continuation: The pasture needed careful attention.

4. Cue: Squeeze \ Salt
   Ambiguous sentence: He gave him a small pinch
   Pain/illness continuation: Just enough to make it bruise.
   Neutral continuation: Just enough to make it tasty.

5. Cue: Fighting \ Cooking
   Ambiguous sentence: He carefully examined the effects of the beating.
   Pain/illness continuation: The man had gone stiff and white.
   Neutral continuation: The eggs had gone stiff and white.

6. Cue: Punish \ Whisk
   Ambiguous sentence: Whipping was the method most commonly used in the past.
   Pain/illness continuation: Now people let the courts do the work.
   Neutral continuation: Now people let the blenders do the work.

7. Cue: Bosom \ Chicken
   Ambiguous sentence: Over dinner, she remarked at how tender her breast was.
   Pain/illness continuation: She decided to let the GP know.
   Neutral continuation: She decided to let the chef know.

Appendix V
Letters indicating ethical approval

Wiltshire NHS
Health Authority

Ref: SL kap SA 57/2000

Southgate House
Pans Lane
Devizes
Wiltshire
SN10 5EQ

Tel: 01380 728899
Fax: 01380 722443
DX 121831
www.healthywiltshire.org.uk

13 November 2000

Miss Steve Holmes
Department of Psychology
University of Southampton
Highfield
Soton

Dear Miss Holmes

SA 57/2000 ***(This number must be quoted in all correspondence)***
Interpretation of Ambiguity in Chronic Pain; A Text Comprehension Study

The above application, which included the documents listed below, was considered at the meeting of the Salisbury Research Ethics Committee on 1 November 2000:

a) Protocol
b) Application Form and accompanying documentation

This Study was approved subject to confirmation that the following points have been addressed:

(a) All reference to the South West Local Research Ethics Committee must be removed.

(b) The Committee felt that there was no necessity for you to have access to the patients medical records and item 3 on the consent form should be removed.

(c) Study title must be consistent throughout.

(d) The Committee felt that a three page information sheet was too long and suggest that it be reduced.

Yours sincerely

Stephen Loxton (Mr)
Chairman - Salisbury Research Ethics Committee

Wiltshire NHS
Health Authority

DJ kp SA 57/2000

6 February 2001

Southgate House
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Ms Steve Holmes
26 Avon Terrace
Salisbury
Wiltshire
SP2 7BT

Dear Ms Holmes

SA 57/2000 (This number must be quoted in all correspondence)
Interpretation of Ambiguity in Chronic Pain; A Text Comprehension Study

At its meeting on 24 January 2001 the Salisbury Research Ethics Committee received your letter dated 19 January 2001 addressing the issues raised by the Committee. This study may now proceed. The two amendments outlined in your letter were approved.

Any changes or extensions to the protocol, or additional investigators, should be notified to the Committee for approval. Adverse events should also be reported to the Committee. May we remind you of the Data Protection Act 1984, and the need to conduct the trial in accordance with the Good Clinical Practice guidelines.

The Committee is required to audit progress of research, and to produce a yearly report to the Wiltshire Health Authority and Department of Health. You are therefore required to provide a brief yearly report and a short final report.

The Salisbury Research Ethics Committee is fully compliant with the International Conference on Harmonisation/Good Clinical Practice (ICH) Guidelines for the Conduct of Trials Involving the Participation of Human Subjects and undertakes to adhere to the relevant clauses of the guidelines for clinical practice adopted by the European Union in January 1997.

Yours sincerely

Kirsten Peck

John Dalton (Dr)
Acting Chairman - Salisbury Research Ethics Committee

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