Psychological factors associated with pain 24 hours post-tooth extraction

Kazuyo Enomoto
BSc, MSc (London)

The Division of Research Strategy
The Faculty of Biomedical Sciences
UCL School of Life and Medical Sciences
University College London
Gower Street
London WC1E 6BT

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Declaration

I, Kazuyo Enomoto, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Name: Kazuyo Enomoto Signed:______________________________

Dedication

To the force which had made me uphold hope and maintain strength in adversity to complete this thesis.

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Abstract

Background: There is a considerable variation in dental patients' post-operative pain experience and analgesic requirements following identical surgical procedures. This has been related to a variety of psychological factors. Pain is one of the most commonly cited factors that is strongly associated with dental fear. Surgical removal of a third molar, the most common procedure in oral surgery and generally associated with dread, has received limited research attention. It is, therefore, essential to understand factors likely to influence the pain experience of patients in such a stressful setting. Such an understanding will not only help patients cope with fear and pain, but also will assist clinicians create a less stressful environment. This study investigated psychological factors predicting heightened pain perception in tooth extraction: *dental anxiety*; *dental control*; *pain catastrophizing*; *expectation of pain*; *social desirability* (*defensiveness*); *trait anxiety* and *monitor-blunter style coping*.

Methods: The sample consisted of 306 participants (144 male and 162 female aged between 18 and 62 years with the mean age of 31.82) who were referred by their local dental practitioners for the surgical removal of tooth/teeth under local anaesthetic at the unit of Oral and Maxillofacial surgery at UCL Eastman Dental Institute. The tooth/teeth which needed extraction were not limited to the third molars. The variables were measured at four different time points: on recruitment (baseline: T0), before (T1), after (T2) and the following day (T3) of the dental surgery. The variables assessed were: *dental anxiety*; *dental control*; *pain catastrophizing*; *social desirability*; *trait anxiety*; *monitor-blunter style coping*; *sensory intensity of pain*, *affective quality of pain*, *state anxiety* and *mood states*. After the surgery, the dental surgeons rated the complexity of the surgical procedure and the perception of their patients' distress levels.

Results: It was found that pain 24 hours post-tooth extraction was best predicted by the levels of *expected sensory pain* together with post-surgery *state anxiety*, *trait anxiety* and *expected affective pain*. *Expected sensory pain*, in turn, was predicted by *dental anxiety*, *monitoring* and *felt (perceived) control* (i.e., the dental pain predictors). Moreover, *dental anxiety* was found to be a precursor to all the dental pain predictors. Furthermore, *pain catastrophizing* did not make to the primary dental pain predictors. Nevertheless, it contributed to heightened levels of *trait anxiety* and *expected affective pain* which sequentially helped to intensify perception of dental pain.

In addition, it was revealed that dental surgeons underevaluated their patients' treatment pain.

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CHAPTER 1: Introduction

1-1. Introduction to the study

It is now acknowledged that human pain perception is made up of multiple dimensions, including a sensory aspect and an affective quality (i.e., emotional) aspect. Psychological factors, therefore, may play a significant role in modulating an individual's perception of pain. In addition, fear of pain is one of the most frequently stated single causes for dental fear (Ragnarsson, Arnlaugsson, Karlsson, Magnusson & Arnarson, 2003) which, in turn, may be attributed to avoidance or delay of dental check-ups and treatments. As a result, the eventual treatment is more urgent, more costly and often more difficult for the dental practitioners to deal with due to anxiety-related patient behaviours. Moreover, acute pain can progress into chronic pain. It is, therefore, important to identify and understand the factors which cause heightened pain perception in dentistry.

Chapter 1 will first explore the mechanisms of perceiving pain in general, and later will look at specifically perception of dental pain, followed by psychological factors influencing dental pain. Those factors are: *dental anxiety*, *dental control* (i.e., *desired control and felt control*), *pain catastrophizing*; *expectation of pain*; *social desirability* and *monitor-blunter style coping*. The chapter also includes a section about *coping* in relation to *dental control – desired and felt control* and *monitor-blunter style coping*. It will also examine dental surgeons' perception of their patients' pain. In addition, it will look at mood states – *positive affect* and *negative affect*, and will discuss why they were not utilised as psychological predictors of dental pain in the present study.

1-1-1. Pain and theories of pain

Definition of pain

Chronic pain is one of largest medical health problems worldwide. In the UK, more than half a million people suffer from chronic pain, and around one third of the world's population suffers from recurrent or persistent pain, costing billions of pounds in health care, compensation, lost earning potential, personal suffering and litigation (Michael-Titus, Revest & Shortland, 2010).

Traditionally, concepts of pain had focused on somatic factors as the primary variables, and the role of psychological factors was considered only when physical factors failed to account for the reports of pain. The differentiation of pain from nociception has provided the basis for regarding pain as a psychological phenomenon. While nociception refers to the neurophysiologic processing of events that stimulate nociceptors and are capable of being experienced as pain, pain represents a perceptual process associated with conscious awareness, selective abstraction, ascribed meaning, appraisal and learning (Melzack & Casey, 1968).

The widely accepted definition of pain by The International Association for the Study of Pain (IASP) describes pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (Merskey & Bogduk, 1994). Importantly, pain as a psycho-biological phenomenon is more reflected in its added note: "If they regard their experience as pain and if they report it in the same ways as pain caused by tissue damage, it should be accepted as pain. This definition avoids tying pain to the stimulus. Activity induced in the nociceptor and nociceptive pathways by a noxious stimulus is not pain, which is always a psychological state, even though we may well appreciate that pain most often has a proximate physical cause".

The definition sounds broad and indistinct, hence, can become meaningless by attempting to incorporate all possible perspectives of pain (Horn & Munafò, 1997). Nonetheless, this does not fail to describe the phenomenon since pain is a multidimensional experience made up of a complex interaction of sensory, affective and cognitive factors as described by Melzack and Casey (1968). Indeed, pain is a conscious experience, an interpretation of the nociceptive input influenced by memories, emotional, pathological, genetic and cognitive factors (Tracey & Mantyh, 2007). Accordingly, it is crucial to clearly state in each study what question regarding the nature of the phenomenon is being asked and from what perspective an answer will be sought (Horn & Munafò, 1997).

Although pain is used to define all sensations that hurt or are unpleasant, one common dimension along which pains can be classified is in terms of their duration: *acute* (or *nociceptive*) *pain*; *prolonged pain* and *chronic* (or *neuropathic*) *pain* (Michael-Titus *et al*., 2010). Acute pain is elicited by a brief noxious stimulus, and induces a flexion withdrawal response to the stimulus. Hence, acute pain is an adaptive sensation whose primary function is to protect the body from damage. The duration of pain usually corresponds roughly to the continued existence of the disturbance to the body (Toates, 2007). In prolonged pain, such as sunburn, injury to the body has already occurred. The function of pain, therefore, is to prevent further damage, assist healing and tissue repair. It does this by the development of areas of hypersensitivity in and around the injury site, which are the result of a decreased activation threshold of nociceptors, a phenomenon called *peripheral sensitization* (Michael-Titus *et al*., 2010). Chronic pain is pain that persists for at least two to three months. Chronic or neuropathic pain is defined by the

IASP as pain resulting from disease or damage to the peripheral or central nervous systems (CNS) and from dysfunction of the nervous system. Accordingly, the term covers a wide range of conditions such as visceral pain (e.g., irritable bowel syndrome), muscle and joint pain (e.g., fibromyalgia and back pain) and pain in diseases (e.g., arthritis, diabetes, cancer and AIDS). Chronic pain often results from abnormal sensitivity of nociceptors, non-nociceptors and pathological changes in the nervous system known as *central sensitization*. Hence, the pain, rather than the original injury, becomes of great concern and is often very difficult to treat (Michael-Titus *et al*., 2010).

Acute pain can progress into chronic pain. This pre-chronic period, therefore, is critical because the person either overcomes the pain at this time or develops chronic pain. For example, it is reported that an estimated 10% of patients with acute low back pain develop chronic low back pain as defined by duration of more than 12 weeks (Abbot & Mercer, 2002; Schultz, Crook, Berkowitz, Milner & Meloche, 2005). Accordingly, the transition from acute to chronic pain states might be the most important challenge in research to improve clinical treatment of debilitating pain (Reichling & Levine, 2009).

Early pain theories

Concepts of pain have been significantly developed throughout the last century. Historical trends demonstrate the importance of psychological mechanisms in pain perception. Sensory-specific models proved unable to explain many of the aspects of pain, and consequently, yielded to multidimensional models that acknowledge pain as a complex synthesis of thoughts, feelings and sensory input (Craig & Hadjistavropoulos, 2004).

Early models of pain perception exemplified by René Descartes (1664) focused on the mechanistic nature of pain, describing pain within a biomedical framework as an automatic response to a painful stimulus. Accordingly, pain is the direct product of a noxious stimulus activating a dedicated pain pathway, from a receptor in the skin, along a thread or chain of nerve fibres to the “pain centre” in the brain. The early dominant theories of pain are *specificity theory* and *pattern theory*.

Specificity theory. Specificity theory, developed by von Frey (1895), is similar to that of the Cartesian model. It suggested that there were specific sensory receptors which transmit touch, warmth/cold and pain, and that each receptor was sensitive to specific stimulation. The activation of specific pain receptors as a result of injury leads to the transmission of pain information via a spinal pain pathway to the pain centre in the brain. Causation was linear and psychological factors were ignored to the extent that peripheral injury was directly equated with pain sensation.

Various pain case anomalies could not be accounted for by specificity theories, and this motivated the search for the alternatives. Such anomaly examples included: late-stage syphilis pain (Goldscheider, 1884), phantom limb pain (Livingston, 1943) and congenital universal insensitivity to pain (CUIP) (Nagasako, Oaklander & Dworkin, 2003).

Pattern theory. Formulated by Goldscheider (1920), pattern theory suggested that pain sensation was a result of spatial and temporal patterns of neural transmission as opposed to of neural transmission through independent pathways unique to pain information. Nerve impulse patterns determine the degree of pain, and messages from the damaged area are sent to the brain via these neural activities. Accordingly, one would only experience pain when a certain pattern of neural activity reaches a critical level. Moreover, over time, activity from many sensory fibres might accumulate in the dorsal horns of the spinal cord, and begin to signal pain once a certain threshold of accumulated stimulation has been crossed as in the cases. Thus, central summation of pain fibre activity in the dorsal horns or balance of activity between large-diameter and small-diameter pain fibres were intended to explain these pain anomalies.

According to pattern theory, the stimuli must be intense to trigger pain. The theory, therefore, did not adequately explain the fact that innocuous stimuli can trigger episodes of causalgia and neuralgia (Sarafino, 2008). Similarly, the notion of patterns of firing lacked explanatory value in the mechanisms of CUIP.

The gate control theory of pain

These early models suggested that pain occurred as the result of a linear process that begins with sensory stimulation of pain pathways and ends with the experience of pain with no indication of modulating factors acting between the stimulus and the response. These models had failed to recognise the importance of psychological processes such as emotion, attention and cognition. Psychological factors such as anxiety, fear and depression were implicated in the models as consequences of pain, not causal influences. The failures of the earlier models in effectively account for pain cases with no discernible organic pathology such as chronic pain or variation in the pain reports between soldiers and civilians (Beecher, 1956) led to the development of the gate control theory by Ronald Melzack and Patrick Wall (1965, 1982).

Melzack and Wall used the analogy of a “gate” for the factors which modify the experience of pain. That is, the neural mechanisms in the spinal cord act like a gate that can either increase or decrease the flow of neural impulses, modulating incoming pain signals. Central to the theory is the notion that two sets of processes are involved, with equal importance, in the opening and closing of this neural gate: ascending physiological inputs of painful/non-painful stimulation and descending psychological inputs such as emotional and cognitive processes. Activation of small nerve (nociceptive) fibres (i.e., *A delta* and *C fibres*) from the site of pain to the spinal column "opens" the gate which lets a neurotransmitter called *substance P* pass through and stimulate transmission cells which in turn transmit impulses to the pain centres in the brain. Similarly, non-painful stimulation leads to activation of large nerve (non-nociceptive) fibres (i.e., *A beta fibres*) which consecutively "closes" the gate for the pain information pass through. The descending pathways activated by psychological factors, such as behavioural state, emotional state and previous experiences, can also influence the opening and closing of the gate.

Various psychological factors such as anxiety, distraction, hypnosis and excitement are known to have the capacity to influence the position of the gate. From a biopsychosocial point of view, messages from the brain, i.e., efferent pathways is the most important component of the gate control theory as it provides a clear route through which cognitive, affective and social factors can influence pain perception (Abraham, Conner, Jones & O'Connor, 2008). Hence, psychological factors which were previously dismissed as "reaction to pain" became seen to be an integral part of pain processing, and new avenues for pain control by psychological therapies were opened (Melzack & Katz, 2004).

Beyond the gate – dimensions of pain

Consequently, Melzack (Melzack & Casey, 1968; Melzack & Torgerson, 1971) conceptualised pain experience in terms of its three dimensions – *sensory-discriminative*, *motivational-affective* and *cognitive-evaluative* which became the basis of The McGill Pain Questionnaire (Melzack, 1975). The sensory-discriminative component describes the type of the stimulus itself in terms of temporal, spatial, punctuate pressure, incisive pressure, constrictive pressure, traction pressure, brightness, dullness and sensory. The motivational-affective component tells what the sensation is doing to the sufferer in terms of tension, autonomic, fear, punishment and affective. In contrast, the cognitive-evaluative element expresses the degree of suffering such as “annoying”, “troublesome” and “unbearable” under the influence of anticipation, attention, suggestion and past experiences. In addition, a behavioural component refers to what the sufferer says and does.

Since the multidimensional model of pain was proposed, most subsequent theories of pain have regarded the noxious experience as a function of both nociceptive stimulation and the psychological reactions which such stimulation triggers. Accordingly, psychological factors such as affective or cognitive element of pain experience are implicated to be possibly modified, while one cannot minimise the neurophysiological part of it. For that reason, this multidimensional view of pain perception has led health professionals to explore psychological factors which may in turn help sufferers to achieve some degree of control over their pain.

The neuromatrix theory of pain

More recently, Melzack (Melzack, 1989; 1990; 1999; 2001; 2005; Melzack & Katz, 2004) extended his gate control theory to a new theory of a conceptual nervous system called the “neuromatrix” to account for the phenomena such as phantom limb pain and pain in the phantom body of paraplegics with verified total sections of the spinal cord

(Melzack & Loeser, 1978). Melzack's analyses of the phenomena led to four assumptions which had led to the creation of the new concept.

First, since the phantom limb (or other body part) is felt so real, the same neural processes that are involved in pain perception in the intact body are involved in pain perception in the phantom limb. Second, all the qualities that one normally feels from the body, including pain, can be felt in the absence of inputs from the body. Third, the body is perceived as a unity and is identified as the "self", distinct from other people and the surrounding world. Fourth, the brain processes that underlie the body-self are genetically determined, and are modified by later learning.

Melzack contends that a network of neurons, known as the neuromatrix, is distributed throughout the brain to process all incoming sensory information including pain signals. This neural network consists of cyclical, feedback loops between three of the brain's main neural circuits: the thalamus, the cortex and limbic system. The neuromatrix can process "experiences" such as pain in the absence of inputs from the body. When the neuromatrix receives sensory inputs such as pain information (i.e., physical elements of the injury and emotional reactions to it), the repeated *cyclical processing and synthesis* of the nerve impulses becomes imprinted on the matrix creating what is known as a "neurosignature" (i.e., network of information about the nature and emotional reaction to pain stimulus). The neurosignature is projected to areas of the brain – the *sentient neural hub* – where the flow of nerve impulses is transformed into a constantly changing stream of awareness. The body is perceived as a unity, and is identified as the "self" called as "body-self neuromatrix". The experience of a unity is produced by central neural processes, and cannot be derived from the peripheral nervous system or spinal cord. Accordingly, the neuromatrix is initially "built-in" by genetic specification, and is later sculpted by sensory inputs. Hence, the new theory has regarded the brain as an active system that filters, selects and modulates inputs.

According to Melzack, the neuromatrix is pre-wired to “assume” that the limbs can move. In people who have had their limbs removed, therefore, the neuromatrix still sends signals to try to move them. When they do not move in response to these signals, stronger and more frequent messages may be sent to the muscles, and these are perceived as pain.

Psychological reasons for the neuromatrix

Melzack (Melzack, 2001; 2005; Melzack & Katz, 2004) contends that the qualities of pain experiences are not equivalent to the physical event of breaking skin or bone. Likewise, there are no external equivalents to stinging, smarting, tickling or itching. The experience must be generated by structures in the brain – by the built-in neuromodules whose neurosignatures innately produce the qualities.

According to Melzack, therefore, inputs from the body modulate the continuous neuromatrix output to produce the wide variety of experiences one feels. The experience of the body-self involves multiple dimensions – sensory, affective and evaluative which include visual images, affect and “knowledge” of the self as well as the meaning of body parts in terms of social norms and values. While the sensory dimensions are subserved by portions of the neuromatrix that lie in the sensory projection areas of the brain and the affective dimensions, by areas in the brainstem and limbic system, psychological dimension of experience are subserved by a particular portion of the neuromatrix that contributes to a distinct portion of the total neurosignature.

The neuromatrix theory maintains that conscious awareness and perception of the body-self including pain are primarily generated within the brain via patterns of activity (i.e., neurosignatures) that can be triggered or modulated by various perceptual inputs. These inputs include (a) somatosensory inputs (cutaneous, visceral and other somatic receptors), (b) visual and other sensory inputs that influence the cognitive interpretation of the situation, (c) phasic and tonic cognitive and emotional inputs from other areas of the brain, (d) intrinsic neural inhibitory modulation inherent in all brain function and (e) the activity of the body's stress regulation systems, including cytokines as well as the endocrine, autonomic, immune and opioid systems (Melzack, 1999). Although the genetic contribution to the structure of the neuromatrix is emphasised in the theory, the neuromatrix seems to be a psychologically meaningful unit whose development is influenced by both heredity and learning, which represents an entire unified entity (Melzack, 2005).

Limitations of the neuromatrix

Much of the criticism of the neuromatrix theory involves Melzack’s (1999) first description of the nociceptive processing network as the pain “neuromatrix”. This gives the false impression that the matrix is designated for pain perception, yet, it is a collection of brain regions, none of which are unique to pain, and many are involved in other aspects of perception and behaviour (Tracey & Johns, 2010). Along the same line, since different brain regions are found to play a more or less active role depending upon the precise interplay of the factors involved in influencing pain perception (e.g., cognition, mood, injury and context), what comprises the pain neuromatrix or which regions are to be included is not unequivocally defined (Tracey & Mantyh, 2007).

Moreover, it fails to explain how the body-self neuromatrix (i.e., internal representations of the self) interacts with specific sensory afferents (e.g., visual, proprioceptive, motor, vestibular) in relation to phantom limb sensations (Giummarra, Gibson, Georgiou-Karistianis & Bradshaw, 2007). Further, it does not address why phantom sensations continue to be perceived by some amputees, while for others phantom sensations diminish, telescope or disappear over time. Further work is required before phantom limb pain experience is fully understood. Nonetheless, the neuromatrix theory has provided valuable insights into the mechanisms underlying this phenomenon (Giummarra *et al*., 2007).

Central sensitization

A painful or unpleasant experience can result without a nociceptive input, providing an alternative explanation for how pain might arise in difficult clinical cases where the organic cause is not obvious (Tracey, 2008) such as phantom limb pain or persistent sensations from deafferentated body parts. As a result, what has become clear is that processing of sensory inputs is not hard wired, but adapts to sensory experience by facilitating higher CNS changes. Thus, it was an understanding of the nature of pathological pain states, that provided evidence which led to the discovery of *central sensitization*.

Central sensitization is a long-lasting increase in pain sensitivity that occurs following an intense noxious event (Hollins, 2010). This sensitivity includes both increased responsiveness to noxious stimulation (*hyperalgesia*) and pain perception in response to normally innocuous stimulation (*allodynia*). *Central sensitization* represents an enhancement in the function of neurons and circuits in nociceptive pathways caused by increases in membrane excitability and synaptic efficacy as well as by reduced inhibition, and is a manifestation of the remarkable plasticity of the somatosensory nervous system in response to activity, inflammation and neural injury (Latremoliere & Woolf, 2009). It is now established that such neuroplastic changes can occur not only in primary afferent terminals (*peripheral sensitization*), but also in the spinal cord and in the brain (*central sensitization*), thereby altering the processing of sensory information. *Peripheral sensitization* is manifest as a reduction in the threshold and an amplification in the responsiveness of nociceptors, and *central sensitization*, an activity dependent increase in the excitability of the CNS neurones (Michael-Titus, Revest & Shortland, 2010). Consequently, the *central sensitization* process includes altered sensory processing in the brain (Staud, Craggs, Robinson, Perlstein & Price, 2007), malfunctioning of descending anti-nociceptive mechanisms (Meeus, Nijs, Van de Wauwer, Toeback & Truijen, 2008), increased activity of pain facilitatory pathways, temporal summation of second pain or wind-up (Meeus & Nijs, 2007; Staud *et a*l., 2007). The outcome of the processes involved is an increased responsiveness to a variety of peripheral stimuli such as mechanical pressure, chemical substances, light, sound, cold, heat and electrical stimuli (Nijs, Van Houdenhove & Oostendorp, 2010).

Peripheral injury induces a decreased pain threshold at the site of injury (*primary hyperalgesia*) as well as in the surrounding tissue (*secondary hyperalgesia*). *Peripheral sensitization* is responsive for primary hyperalgesia which is mediated by a lowering of the activation threshold of sensitized A delta and C fibres, while *central sensitization* is responsible for the secondary hyperalgesia seen after injury, thereby the input from A beta fibres produces pain by changes in the sensory processing by neurones in the spinal cord and not by changes in the threshold for activation (Michael-Titus *et al*., 2010). *Central sensitization* together with *peripheral sensitization* is, therefore, a fundamental mechanism contributing to the post-injury hypersensitivity that is common in chronic pain syndromes (*ibid*.).

Pathophysiologic changes may occur to produce symptomatic, persistent neuropathic pain in both the peripheral and central nervous systems (Michael-Titus *et al*., 2010). Changes in peripheral nervous system include: ectopic discharge (p1); ephaptic conduction (p2) and alterations in ion channel expression (p3). Ectopic impulse generation occurs by an increase in the level of spontaneous firings from newly formed nerve sprouts, or neuromas, which have grown from the injured nerve at the site of injury or the spinal ganglion or the dorsal roots of injured afferents. This ectopic activity is likely due to changes in the sodium channels (p1). After some period of time, atypical connections may develop between the nerve sprouts and neighbouring afferent neurons, leading to “ephaptic conduction” or “cross-talk” between neurons. Therefore, pain that results from peripheral nerve damage may originate in injured or intact sensory neurons (p2). Abnormal chemical sensitivity develops in primary afferents, so that they become sensitive to substances they were not responding to prior to injury such as catecholamines. Sodium channels are critical to the physiology of excitable membranes, such as neurons, and are likely increased in number and density with neuronal damage. Calcium channels may also be affected with peripheral nerve injury (p3).

In contrast, changes in the central nervous system include: sensitization of spinal cord (c1); disinhibition of spinal cord cells (c2); CNS plasticity (c3) and changes at rostral levels of the neuraxis (c4). *Central sensitization* amplifies and facilitates the synaptic transfer from primary afferent neurons to secondary neurons in the dorsal horn. This phenomenon is sometimes referred to as wind-up, which is characterised by an increasing response to repeated input from C fibres resulting in enhanced spinal cord excitability (c1). Suppression of an inhibitory system due to afferent cell death, atrophy or decreased supraspinal inhibition or loss of inhibitory neurotransmitters such as the gamma-aminobutyric acid (GABA) is associated with neuropathic pain (GABA) (c2). Degenerative and regenerative events in the CNS result in structural rearrangements of neuronal connections leading to permanent aberrant connections (c3). Changes at one level of the nervous system lead to subsequent pathophysiological changes. For example, thalamus and cortex that can lead to altered sensory perceptions such as phantom limb pain (c4).

The nociceptor-induced sensitization of the somatosensory system is adaptive in that it makes the system hyper-alert in conditions in which a risk of further damage is high (Latremoliere & Woolf, 2009). Nevertheless, it is not solely for vital protective functions: this is especially true in the chronic pain states (Tracey, 2008). Consequently, pain is not simply a reflection of peripheral inputs or pathology, but is also a dynamic reflection of central neuronal plasticity, involving emotional responses, cognitive evaluations and behavioural responses and motivative learning processes (Flor & Turk, 2006).

Evidence of central sensitization

While the idea of central changes resulting in pathological pain states is not new, the use of empirical evidence to support this is recent. *Central sensitization* has been reported to be present in various chronic musculoskeletal pain disorders (Nijs *et al.*, 2010). Examples include chronic pancreatitis (Buscher, Wilder-Smith & van Goor, 2006), fibromyalgia (e.g., Price & Staud, 2005; Staud, 2006; Vierck, 2006), rheumatoid arthritis (Yunus, 2007), experimentally induced chest wall allodynia (Willert, Delaney, Kelly, Sharma, Aziz & Hobson, 2007), temporomandibular joints arthralgia (Ayesh, Jensen &

Svensson, 2007), chronic migraine and chronic tension-type headache (Cooke, Eliasziw & Becker, 2007; Filatova, Latysheva & Kurenkov, 2008), myofascial temporomandibular disorders (Fernández-de-las-Peñas, Galán-del-Río, Fernández-Carnero, Pesquera, Arendt-Nielsen & Svensson, 2009) and carpal tunnel syndrome (Fernández-de-las-Peñas, de la Llave-Rincón, Fernández-Carnero, Cuadrado, Arendt-Nielsen & Pareja, 2009).

Psychological factors in central sensitization

The most significant aspect of *central sensitization* is that pain mechanisms are recognised as active systems which may be modified by past experiences, social learning, cognitive and emotional factors. Melzack and Wall (1982) proposed a "memory-like system" in pain, so that the neural mechanisms subserving long-term memory of sensory experiences most probably play a major role in modulating pain response. The modifications may be the result of either or both descending and ascending signals, both of which modulate initial pain response (Melzack & Wall, 1982).

More recently, a widespread network of cortical areas are found to be activated by intense pain, some of which adjoin or overlap and therefore potentially interact with regions that are involved in cognition and emotion. Consequently, pain has been reported to affect, and to be affected by, these "higher-level processes" (Hollins, 2010). Examples of the influence of the higher-level factors on pain include: the effect of placebo skin cream in response to painful laser pulses (Bingel, Lorenz, Schoell, Weiller & Büchel, 2006); amplification of aversive cutaneous pressure and auditory sensations by hyper-vigilant pain patients (Hollins, Harper, Gallagher, Owings, Lim, Miller, Siddiqi & Maixner, 2009) and intensification of pain perception by negative affects (Rhudy, Williams, McCabe, Nguyen & Rambo, 2005; Rainville, Bau & Chrétien, 2005) and by empathy (Loggia, Mogil & Bushnell, 2008).

Functional neuroimaging – images in the brain

By its subjective nature, it is, therefore, difficult to measure, assess and investigate pain. What is clear is that many factors influencing pain perception are centrally modulated, and one's ability to unravel and neuroanatomically explore their contribution has only been feasible since neuroimaging tools brought about non-invasive access to the human CNS (Tracey & Mantyh, 2007). Indeed, since 1991 (Jones, Brown, Friston, Qi & Frackowiak, 1991; Talbot, Marrett, Evans, Meyer, Bushnell & Duncan, 1991), advances in functional neuroimaging techniques have made it possible to perform a three-dimensional analysis of the location of activity in the brain, above the spinal cord, in conscious humans when they are in pain (Kong, Loggia, Zyloney, Tu, LaViolette & Gollub, 2010). As a result, the supraspinal mechanisms are increasingly recognised as playing a major role in the representation and modulation of pain perception in terms of brain circuitry, the effects of analgesics on neural networks, transition of acute into chronic pain, definition of brain regions that heretofore may not have been considered important (e.g., nucleus accumbens, striatal regions), brain plasticity including functional and morphological changes, networks that are involved in the placebo response and alterations in neurochemistry in chronic pain (Borsook, Sava & Becerra, 2010).

Functional neuroimaging techniques measure an aspect of brain function to understand the relationship between activity in certain brain areas and specific mental functions. Neuroimaging techniques used particularly in pain studies include: positron emission tomography (PET); single-photon emission computed tomography (SPECT);

functional magnetic resonance imaging (fMRI); multichannel electroencephalography (EEG); magnetoencephalography (MEG); near infrared spectroscopic imaging (NIRSI) (Apkarian, Bushnell, Treede & Zubieta, 2005); voxel-based morphometry (VBM); diffusion tensor imaging (DTI) and magnetic resonance spectroscopy (MRS) (Borsook *et al*., 2010). PET, SPECT, fMRI and NIRSI can measure localised changes in cerebral blood flow related to neural activity, while EEG and MEG detect the magnetic or electrical fluctuations that occur when a population of neurons is active. In contrast, VBM and DTI are used to assess changes in subcortical structures of the brain including the thalamus, basal ganglia, insula, amygdala, hippocampus and frontal and anterior cingulate cortex (Borsook *et al*., 2010). Whereas, MRS is used to assess different metabolites and neurotransmitters in the brain (Soares & Law, 2009) to identify relationships between disease states and changes in the brain metabolic or chemical composition (Borsook *et al*., 2010).

Relating neural activity changes to the varied pain experiences has led to an increased awareness of how factors such as cognition, emotion and context can separately influence pain perception (Tracey & Mantyh, 2007). Moreover, obtaining reliable objective information related to the individual’s subjective pain experience provides a powerful means of understanding not only the central mechanisms contributing to the chronicity of pain states but also the potential diagnostic information (Tracey, 2008).

Functional neuroimaging of psychological factors in pain

Over the last two decades, the introduction of neuroimaging technologies to pain research has provided an increased understanding for chronic pain from a disease affecting mainly the somatosensory system, to a condition in which emotional, cognitive and modulatory areas of the brain are affected, in addition to degenerative processes (Borsook *et al*., 2010). A recent meta-analysis of human data from neuroimaging studies provides clarity regarding the commonest regions found active during an acute pain experience (Apkarian *et al*., 2005), by identifying the cortical and sub-cortical substrate. This network of somatosensory, limbic and associative structures receives parallel inputs from multiple nociceptive pathways which, in turn, may give rise to the multidimensional pain experience.

The main components of the network for acute pain include: primary and secondary somatosensory, insular, anterior cingulate and prefrontal cortices (S1, S2, IC, ACC and PFC); thalamus (Th); amygdala (Amy) and periaqueductal gray (PAG). Pain invokes an early activation of S2 and IC which may play a prominent role in sensory-discriminative functions of pain, whereas the strong affective-motivational character of pain is exemplified by the participation of regions of IC and ACC (Apkarian *et al*., 2005; Michael-Titus *et al*., 2010). Correspondingly, parts of PFC are also involved in cognitive-evaluative processes such as attention to, anticipation of memory of or escape from pain (Michael-Titus *et al*., 2010). The intensity and affective quality of perceived pain is the net result of the interaction between ascending nociceptive inputs and antinociceptive controls.

Studies examining the effects of distraction from pain show modulation of pain-evoked activity in S1, ACC, IC, Th and PAG (Bantick, Wise, Ploghaus, Clare, Smith & Tracey, 2002; Brooks, Nurmikko, Bimson, Singh & Roberts, 2002; Tracey, Ploghaus, Gati, Clare, Smith, Menon & Matthews, 2002), suggesting that these regions may be involved in the modulatory circuitry related to attention. Similarly, modulation of pain by attention is found to reflect a change in sensory processing in S2 (Nakamura, Paur, Zimmermann & Bromm, 2002) which may, in turn, facilitate a decrease in ascending afferent input from the spinal cord due to activation of descending noxious inhibitory controls (Hoshiyama & Kakigi, 2000; Reinert, Treede & Bromm, 2000). Moreover, it is shown that negative emotional states enhance pain-evoked activity in limbic regions, such as ACC and IC (Phillips, Gregory, Cullen, Cohen, Ng, Andrew, Giampietro, Bullmore, Zelaya, Amaro, Thompson, Hobson, Williams, Brammer & Aziz, 2003). Specifically, sad emotional context is found to be associated with activation in Amy, and that Amy and ACC are closely connected during the experience of pain under such conditions (Yoshino, Okamoto, Onoda, Yoshimura, Kunisato, Demoto, Okada & Yamawaki, 2010). Furthermore, catastrophizing is reported to activate the contralateral ACC and the contralateral and ipsilateral lentiform (Gracely, Geisser, Giesecke, Grant, Petzke, Williams & Clauw, 2004).

Further, the anticipation or expectation of pain can activate pain-related regions such as S1, ACC, PAG, IC, PFC and cerebellum in the absence of a physical pain stimulus (Sawamoto, Honda, Okada, Hanakawa, Kanda, Fukuyama, Konishi & Shibasaki, 2000; Porro, Baraldi, Pagnoni, Serafini, Facchin, Maieron & Nichelli, 2002; Fairhurst, Wiech, Dunckley & Tracey, 2007). Furthermore, empathy manipulations such as perception of pain in a loved one without a nociceptive input can trigger activity in bilateral anterior IC, rostral ACC, brainstem and cerebellum (Singer, Seymour, O'Doherty, Kaube, Dolan & Frith, 2004). Similarly, significantly greater haemodynamic activity in pain processing areas such as right anterior IC, anterior midcingulate cortex and PAG is reported during perception of pain in others with stigmatised condition in the absence of nociceptive stimulation (Decety, Echols & Correll, 2010). Accordingly, data showing activity of the almost entire neuromatrix without a nociceptive input necessitate reconsidering how one defines central pain processing with respect to the origin of the input and resultant perception and meaning. That is not to say pain experienced without a nociceptive input is any less real than physically defined pain, indeed, neuroimaging studies have highlighted the physiological reality of such experiences due to the extensive neural activation that occurs (Tracey & Mantyh, 2007).

Limitations of functional neuroimaging

A major limitation of functional neuroimaging is that fMRI or event related electrophysiological recordings do not measure activity related to ongoing, background pain, i.e. chronic pain. Rather, they are techniques capable of recording brain activity in response to an applied exogenous nociceptive stimulus or a provoked clinical symptom, often repeated and cycled between ‘‘pain on” and ‘‘pain off” periods (Tracey & Johns, 2010).

Conclusion

Before *central sensitization* was discovered there were three major models of pain: a stimulus-specific system as in specificity theory, a quantitative system such as pattern theory and the gate control theory. No models described that pain may arise as a result of changes in the properties of neurons in the CNS, i.e., *central sensitization*. However, it is now appreciated that there are indeed specific nociceptive pathways, that these are subject to complex facilitating and inhibitory controls and that changes in the functional properties of the neurons in these pathways are sufficient to reduce pain threshold, increase the magnitude and duration of responses to noxious input and permit normally innocuous inputs to generate pain sensations (Latremoliere & Woolf, 2009).

Pain-modulating circuits exist because the ability to suppress or augment pain responses enhances the survival of the individual. Suppressing nocifensive reflexes might facilitate escape in the face of threat, whereas enhanced pain in the presence of tissue injury and inflammation could promote recuperative behaviour and healing (Fields, Basbaum & Heinricher, 2006).

Pain can be modulated and biased by influences conveyed from higher centres via descending tracts, known as *reflected feedback pathways* or *pain-modulating pathways* to lower levels of the ascending pathways. Through these connections, the sensitivity of receptors and processing centres can be enhanced or suppressed much like the gamma motor neurons modify the responsiveness of muscle spindles (Noback, Strominger, Demarest & Ruggiero, 2005). It is these descending influences from higher centres that will be explored in this study.

1-1-2. Dental pain

Experience of dental pain

Acute dental pain may involve toothache, dental sensitivity, perioperative pain or postoperative pain (Jerjes, Hopper, Kumar, Upile, Madland, Newman & Feinmann, 2007). A recent study reported that the prevalence of having experienced extreme pain after a dental treatment was 46.9% in a population sample of dental patients in the Netherlands (Oosterink, de Jongh & Aartman, 2009). In addition, a study examining the cortical processing of electrically-induced pain from the tooth pulp in healthy volunteers using fMRI found the bilateral activation of S1, S2 and the IC region (Jantsch, Kemppainen, Ringler, Handwerker & Forster, 2005).

It seems that the amount of pain one experiences is not simply determined by the intensity of nociceptive stimulation. Studies have found a considerable variation among patients in their pain report, in particular, during and after identical dental procedures. For example, when patients undergoing third molar extraction are allowed to vary their degree of sedation according to the amount of stress caused by the procedure ("patient-controlled sedation"), some make very few or no sedation requests, whereas others request sedation more than 60 times during the surgery (Fong & Kwan, 2005).

Although a number of factors can contribute to an individual's pain experience such as genetic makeup, age, gender and life experiences, it is increasingly accepted that pain modulatory mechanisms existing within the nervous system can be influenced by psychological variables (Loggia, Schweinhardt, Villemure & Bushnell, 2008). Indeed, recent neuroimaging techniques used particularly in pain studies have shown the neurophysiologic basis of the psychological modulation of pain, confirming the effects of psychological factors, such as attentional state, emotional context, empathy and expectations, to alter both pain processing in the brain and pain perception (see 1-1-1. *Pain and theories of pain – Functional neuroimaging of psychological factors in pain*).

Interventions on dental pain

Due to a high prevalence of dental anxiety and phobia, traditionally dentistry itself has been seen as a source of stress. Much research, therefore, has been done on dental anxiety and its intervention. In contrast, there have been few studies carried out on dental pain. Little is known, therefore, about the factors associated with patients' heightened perceptions of perioperative and postoperative dental pain.

Psychological intervention strategies explored for dental pain include: hypnosis (Gillett & Coe, 1984; Houle, McGrath, Moran & Garrett, 1988; Enqvist & Fischer, 1997); relaxation (Houle *et al*., 1988); distraction in the form of a white noise (Gardner & Licklider, 1959), of a projected picture on the ceiling (Wardle, 1983) and of virtual reality (Frere, Crout, Yorty & McNeil, 2001; Furman, Jasinevicius, Bissada, Victoroff, Skillicorn & Buchner, 2009); music listening (Anderson, Baron & Logan, 1991); information-giving (Wardle, 1983; Vallerand, Vallerand & Heft, 1994; van Wijk, Duyx & Hoogstraten, 2004); sensory focus (Baron, Logan & Hoppe, 1993; Logan, Baron & Kohout, 1995); stress inoculation training (Law, Logan & Baron, 1994) and emotional disclosure (Sullivan & Neish, 1999).

Generally, these intervention methods have been claimed to be efficacious in ameliorating dental pain. Nonetheless, there is no consistent evidence that any one type of intervention is more effective than others. This may be largely due to dispositional factors such as individual patients' personality types or coping styles rather than any situational factors such as state anxiety or fear evoked by dental environments. People may considerably differ in the way they perceive or cope with a stressful event such as invasive and painful dental procedures. These coping styles, in turn, may influence the levels of pain which individuals experience.

Psychological factors on dental pain

Consequently, various studies have examined the role of dispositional or coping factors in perioperative pain in dental settings. Some studies have looked at multiple factors. Examples are: anxiety and expectations about recovery, trait anxiety, coping behaviours and health locus of control orientation (George, Scott, Turner & Gregg, 1980);

psychiatric morbidity, neuroticism and trait anxiety (Feinmann, Ong, Harvey & Harris, 1987); dental anxiety, general well-being, mood and health locus of control orientation (Croog, Baume & Nalbandian, 1995); negative affectivity, expectancies about recovery, coping styles and parents' encouragement of illness behaviour (Gidron, McGrath & Goodday, 1995) and dental anxiety, perception of dentists and control over the situation (Maggirias & Locker, 2002). On the other hand, more recently, single unique factors were explored: *dental control* (see 1-1-5), *pain catastrophizing* (see 1-1-6), *expectation of pain* (see 1-1-7) and *monitor-blunter style coping* (see 1-1-9). These will be explored together with well-researched *dental anxiety* (see 1-1-3) and *defensiveness*, i.e., *social desirability* (see 1-1-8).

Reasons to study dental pain

Despite progress in anaesthetic procedures and instrumental techniques, which enable dentists to treat their patients in an alleviating manner, a high proportion of people still report pain during dental procedures (Maggirias & Locker, 2002). Clinical studies have indicated failure rates of five to 15% (Matthews, Ball, Goodley, Lenton, Riley, Sanderson & Singleton, 1997). More specifically, the use of anaesthesia makes the removal of lower third molars a relatively painless procedure, yet the intervention often leads to manifestation of anxiety with different clinical implications (Garip, Abali, Göker, Göktürk & Garip, 2004).

Fear of pain is one of the most commonly cited factors that is strongly associated with dental fear (Ragnarsson *et al*., 2003). Hence, fear of pain often prevents patients from seeking dental care. Indeed, approximately one in four adults in the UK delays seeking help for a painful dental condition as a result of their dental fear (Boyle, Newton

& Milgrom, 2009). Fear of dental pain is, therefore, a highly relevant concept in dental pain research and, moreover, in dentistry (van Wijk & Hoogstraten, 2003). In addition, surgical removal of third molar, the most common procedure in oral surgery and generally associated with dread, has limited research attention (Yusa, Onizawa, Hori, Takeda, Takeda, Fukushima & Yoshida, 2004).

The dentist is a specialist for the stomatognathic system. Their predominant concern, therefore, may often be dental problems, and they may be less attentive to the remainder of the body being treated. It is crucial for dentists to understand the influence of psychological state on patients' pain experience. Such an understanding will not only help patients learn how to participate in their own pain control, but will also help clinicians create a fostering environment (Loggia *et al*., 2008).

1-1-3. Dental anxiety

Prevalence of dental anxiety

Anxiety in visiting dentists is commonplace. A large proportion of adults in the United Kingdom is afraid of dentists. While as many as one in four adults in the UK delays seeking help for a painful dental condition as a result of their dental fear (Boyle *et al*., 2009), one in five adults in North America is fearful of dentists (Smith & Heaton, 2003). Dentally anxious patients are reported to be frequently afraid of having dental injections (Vika, Raadal, Skaret & Kvale, 2006; Vika, Skaret, Raadal, Öst & Kvale, 2008). In particular, it is shown that five to 31% of *blood-injury-injection*-phobic patients, characterised by a marked and persistent fear of dental injections, are also afraid of the dentist (Vika *et al*., 2008).

The prevalence of dental anxiety has not changed markedly in the last 30 years, in spite of more modern and less painful dental technology (Boyle *et al*., 2009) and increased knowledge about the fear process.

Definition of dental anxiety

Dental anxiety is defined as a situation-specific trait anxiety disposition to experience anxiety in dental situations (Stouthard, Mellenbergh & Hoogstraten, 1993; Stouthard, Hoogstraten & Mellenbergh, 1995). Klingberg and Broberg (2007) described dental anxiety more specifically as a state of apprehension that something dreadful is going to happen in relation to dental treatment or certain aspects of dental treatment. Specific dental stimuli such as the practice atmosphere, dental drills and injections can act as triggers.

Dental anxiety is a multidimensional construct that consists of somatic, cognitive, behavioural and emotional elements (Klingberg & Broberg, 2007). Behaviourally, during anticipation of a potentially painful stimulus, dentally anxious individuals exhibit strong defensive reactions, including potentiated startle reflexes and heightened skin-conductance activity (Bradley, Silakowski & Lang, 2008). An often unrecognised element of anxiety or fear is the social component (Armfield, 2010)[a]. When a fear takes on a meaningful social consequence, the fear can be said to enter the realm of a diagnosable psychiatric condition (*ibid*.). In the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–IV*), a *specific phobia* is explicitly defined as a marked fear that causes significant impairment to a person's normal routine, occupational or academic functioning, or social activities and relationships (American Psychiatric Association, 1994). Accordingly, since dentally anxious patients report avoidance of dental care, and since dental status has been shown to be strongly affected by fear and avoidance, it is reasonable to assume that dental health is compromised in these patients (Agdal, Raadal, Skaret & Kvale, 2010). This may, in turn, lead to impaired social functioning and problems with interpersonal relationships and reduced oral health-related quality of life (McGrath & Bedi, 2004).

Aetiology of dental anxiety

Anxiety is described as an emotion that helps organisms defend against a variety of threats. It is also referred as an aversive psychological construct, unpleasant to experience and almost always associated with a specific event, which takes time to dissipate (Humphris & Ling, 2000). Anxiety and fear responses contain cognitive, emotional, behavioural and physiological components (Stouthard *et al*., 1993; Westermeyer, 2005). Each of these components contributes something substantial to the overall anxiety or fear response, and each has its basis in the biological fight or flight response to threatening stimuli (Armfield, 2010)[a]. The anxiety disorder, such as dental anxiety, arises from dysregulation of normal defensive responses (Marks & Nesse, 1994).

Women in general report higher dental anxiety than men (Thomson, Locker & Poulton, 2000; Yusa *et al*., 2004). In relation to age, the younger population appears to have higher dental anxiety levels (Thomson *et al*., 2000; Humphris, Freeman, Campbell, Tuutti & D'Souza, 2000; Canakçi & Canakçi, 2007). Further, it was reported that individuals of lower socioeconomic status and with less education have higher anxiety (Locker, Thomson & Poulton, 2001). In general, patients with high trait anxiety also had increased dental anxiety (Economou, 2003; Ng, Chau & Leung, 2004; Yusa *et al*., 2004).

Dental anxiety is a complex phenomenon caused by various factors. In line with Rachman's three-pathways of fear acquisition model (Rachman, 1977), traditionally, the cause of dental anxiety and fear has been explained in terms of learning theory. That is, development of dental anxiety is usually associated with a traumatic experience in connection with dental treatment (de Jongh, Fransen, Oosterink-Wubbe & Aartman, 2006). In other words, many people with high dental fear can recount traumatic stories that explain their fear. Nonetheless, it is also true that while some people with high dental fear have no recollection of ever having had a traumatic dental experience, others with no dental fear recount traumatic experiences (Armfield, 2010)[b]. Indeed, a recent study reported that the prevalence of having experienced extreme pain after a dental treatment was 46.9% in a population sample of dental patients, yet only 11% of the individuals who had experienced a painful traumatic event actually had high dental anxiety (Oosterink *et al.*, 2009).

Most recently, it was found that dental fear was better predicted by cognitive perceptions of going to the dentist as being uncontrollable, unpredictable, dangerous and disgusting compared with past negative dental experiences (Armfield, 2010)[b]. Similarly, perceptions of dentist behaviour and dental beliefs, such as lack of communication, control and trust, have been shown to be associated with dental fear (Abrahamsson, Berggren, Hakeberg & Carlsson, 2003; Abrahamsson, Hakeberg, Stenman & Ohrn, 2006). In summary it seems that rather than learning from our own experiences, learning processes resulting from observing the behaviour of role models such as family members and stories told by people in everyday surroundings (Eli, Uziel, Blumensohn & Baht, 2004) may contribute to forming one's cognitions which can come to influence the emergence and development of different levels of dental anxiety.

In addition, more situational-specific factors causing dental anxiety have been investigated. It was reported that the most fear-producing stimuli were the sight of the dental injection needle and the feeling of being injected (Erten, Akarslan & Bodrumlu, 2006). Similarly, fear of pain was demonstrated to be a reason for dental anxiety in patients having periodontal treatments (Fardal & Hansen, 2007). In another study, the most anxiety-provoking stimuli in decreasing order were having dental surgery, having root canal therapy and insufficient anaesthesia (Oosterink, de Jongh & Aartman, 2008). Moreover, interestingly, it was shown that given situations such as “jaw becoming tired” and “collection of fluid in the mouth” induced higher anxiety than “feeling pain during the operation” in minor surgery patients (Muglali & Komerik, 2008).

Dental anxiety has long been identified as a deterrent from seeking dental care which appears to be associated strongly with significant deterioration of oral and dental health (Mehrstedt, Tonnies & Eisentraut, 2004), leading to a vicious cycle of cumulative anxiety and increasing avoidance (Armfield, Stewart & Spencer, 2007). Anxiety in dental settings is also an impediment to effective dental treatments due to patients’ anxiety-related behaviour during the treatments. Not surprisingly, a recent study showed that oral health among patients with dental anxiety and dental phobia is worse compared to that of the regular population (Agdal, Raadal, Skaret & Kvale, 2008). Indeed, a dental examination revealed the presence of eight to nine decaying teeth in dental phobics compared with one or two teeth in the general population (Thom, Sartory & Jöhren, 2000). For that reason, the assessment of dental anxiety is important to provide evidence-based research into dental anxiety which has been shown to predict dental avoidance and to assist the dental practitioners in the management of anxious patients (Humphris, Clarke & Freeman, 2006).

Interventions on dental anxiety

Due to a high prevalence of fear of dentistry, many intervention strategies have been explored.

Examples include pharmacological strategies which involved the use of benzodiazepines and antidepressants (Moore, Ramsay, Finder & Laverick, 1988) and the administration of lorazepam and triazolam (Litt, Kalinowski & Shafer, 1999).

Psychological intervention examples are: modelling (Melamed, Weinstein, Hawes & Katin-Borland, 1975; Getka & Glass, 1992); information-giving (Siegel & Peterson, 1980; Jackson & Lindsay, 1995; de Jongh, Muris, ter Horst, van Zuuren, Schoenmakers & Makkes, 1995; Ng *et al*., 2004); relaxation (Corah, Gale, Pace & Seyrek, 1981; Litt, Nye & Shafer, 1993; Litt *et al*., 1999; Lahmann, Schoen, Henningsen, Ronel, Muehlbacher, Loew, Tritt, Nickel & Doering, 2008); music listening (Corah *et al.*, 1981; Litt *et al*., 1999; Lahmann *et al*., 2008); distraction in the form of a video ping-pong game (Seyrek, Corah & Pace, 1984); biofeedback (Elmore, 1988), hypnosis (Forgione, 1988; Kleinhauz & Eli, 1991); stress inoculation training (Getka & Glass, 1992); pre-treatment dentist interview (Getka & Glass, 1992); self-efficacy enhancement with a galvanic skin response apparatus (Litt *et al*., 1993); videotaped behavioural intervention (Carpenter, Gatchel & Hasegawa, 1994); cognitive restructuring (de Jongh *et al*., 1995); monitoring/blunting (Muris, de Jongh, van Zuuren, ter Horst, Deforchaux & Somers, 1995); needle desensitization (Litt *et al*., 1999); attention focusing/distraction (Schmid-Leuz, Elsesser, Lohrmann, Jöhren & Sartory, 2007); audiovisual virtual reality (Frere, Crout, Yorty & McNeil, 2001) and the effects of lavender scent (Lehrner, Marwinski, Lehr, Johren & Deecke, 2005; Kritsidima, Newton & Asimakopoulou, 2010) and of orange odour (Lehrner, Eckersberger, Walla, Pötsch & Deecke, 2000; Lehrner *et al*., 2005).

Psychological management seems to be superior to anxiolytic drug therapy (Aartman, de Jongh, Makkes & Hoogstraten, 2000), and dentally anxious patients reported that they prefer non-pharmacological interventions (Halvorsen & Willumsen, 2004). Most of the behaviourally oriented treatments include components based on systematic desensitization (Kvale, Berggren & Milgrom, 2004) and use of relaxation to counteract and weaken the fear response during gradual exposure to treatment (Lahmann *et al*., 2008).

Measures for dental anxiety

Given the pervasiveness of fear of the dentistry and the considerable implications of dental anxiety at the individual, practitioner and public health levels, it is important to be able to determine who has dental anxiety and fear, how many people are affected and the nature and extent of their concerns. Consequently, the evaluation of dental anxiety has been extensively explored, and various dental anxiety measures have been developed. They include: the Fear Survey Schedule (Geer, 1965); the Dental Fear Survey (Kleinknecht, Klepac & Alexander, 1973); the Dental Beliefs Survey (Milgrom, Weinstein, Kleinknecht & Getz, 1985); Gatchel Fear Scale (Gatchel, 1989); the Dental Anxiety Question (Neverlien, 1990); the Weiner Fear Questionnaire (Weiner & Sheehan, 1990); Adolescents' Fear of Dental Treatment Cognitive Inventory (Gauthier, Ricard, Morin, Dufour & Brodeur, 1991); the Dental Anxiety Inventory (Stouthard *et al*., 1993); the Fear of Dental Pain questionnaire (van Wijk & Hoogstraten, 2003) and the Index of Dental Anxiety and Fear (Armfield, 2010)[a].

Amongst them, Corah's four-item Dental Anxiety Scale (CDAS: Corah, 1969) is most often used to measure trait dental anxiety (Newton & Buck, 2000). The four items assess the patient's reactions about going to the dentist, waiting for the treatment, having drilling and scaling. More recently, a new version of the CDAS was developed by Humphris, Morrison & Lindsay (1995): the Modified Dental Anxiety Scale (MDAS). The MDAS includes a reference to a respondent's feelings towards a local anaesthetic injection which is claimed to be a most fear-producing stimulus (Erten *et al*., 2006; Vika *et al*., 2006; Vika *et al*., 2008), a major cause of dental anxiety, and forms a source of distress or compelling reason to avoid dental treatment altogether (Vika *et al*. 2006; Vika *et al*., 2008). In the present study the MDAS was used to measure dental anxiety.

The effects of dental anxiety on dental pain

While anxiety and fear can be seen as a state of distress in anticipation or in the presence of a perceived danger, respectively, fear of pain can be seen as a state of distress related to a very specific type of stimulus, namely, pain (Gower, 2004). Within the dental context, anxiety and pain exist in a reciprocal relationship (Litt, 1996). Fear of dental pain (van Wijk & Hoogstraten 2003) is a concept that attempts to capture this complex interaction, and may be a highly relevant covariate in dental pain research (van Wijk & Hoogstraten, 2006). Indeed, dental anxiety and fear of pain have been shown to exert influence on the perceived pain threshold, resulting in patients experiencing more than the inevitable discomfort. Studies reporting the influence of dental anxiety over perception of dental pain published between 1990 and 2010 were reviewed as follows.

Vassend (1993) studied the levels of anxiety and pain/discomfort associated with dental treatment to evaluate their effects on utilisation of dental care. In the survey respondents representative of an adult population rated their dental anxiety levels and pain/discomfort they experienced during dental treatment in the past. Those with higher anxiety showed significantly higher dental pain/discomfort.

Croog, Baume and Nalbandian (1995) assessed relationships between dental anxiety among other psychological factors and post-operative pain in patients scheduled for their periodontal surgery. Patients were assessed for their dental anxiety, fatigue, depression and positive well-being as well as post-operative pain. It was shown that dental anxiety and fatigue were positively associated with the levels of pain, the amount of pain and the areas of pain.

Eli, Bar-Tal, Fuss and Silberg (1997) compared the anxiety levels caused to patients by different dental treatments, such as calculus removal, filling, root canal treatment and extraction, and their effects on their reports on pain during tooth pulp stimulation by electric pulp test. Patients were assessed in terms of their dental anxiety levels and expected pain for the intended treatments, and were subjected to electric pulp stimulation to rate their sensation/pain thresholds. Patients differed significantly in their dental anxiety levels and in their expectation to experience pain according to the following hierarchy in descending order: extraction, root canal treatment, filling and calculus removal. It was shown that patients having “easier” treatments (i.e., hygienist treatment, filling) tended toward low sensation thresholds as their dental anxiety increases. In contrast, contrary to the researchers’ expectation, patients undergoing “difficult treatments” (i.e., root canal treatment, extraction) showed an increase in their sensation thresholds as their dental anxiety increases. The researchers concluded that, possibly, the focusing of attention on the future expected painful experience distracted the patients from the present low stimuli.

Maggirias and Locker (2002) examined psychological characteristics which predisposed dental patients to experience pain in a five-year longitudinal study. Dental anxiety was measured at baseline and the patients' dental visits were observed over the five-year period. Their dental treatments varied from routine treatments to stressful procedures. It was found that those with high levels of dental anxiety assessed at baseline were more likely than those with low levels to report having experienced pain and moderate to severe pain at follow-up.

Karadottir, Lenoir, Barbierato, Bogle, Riggs, Sigurdsson, Crigger and Egelberg (2002) investigated the degree of pain experienced by patients undergoing probing and debridement to determine whether the pain responses could be predicted by responses to a questionnaire on dental anxiety amongst age, gender and percentage of sites ≥4mm deep. Patients' dental anxiety levels were measured, and the pain levels were recorded. It was revealed that significant portions of the pain levels could be predicted by gender and the patients' answers to two of the dental anxiety questions: "How fearful are you of having your teeth cleaned?" and "In general, how fearful are you of having dental work done?".

Similarly, Chung, Bogle, Bernardini, Stephens, Riggs and Egelberg (2003) studied whether patients' pain responses could be predicted by answers to a questionnaire on dental anxiety amongst others such as age, gender and number of residual periodontal lesions. Patients having periodontal maintenance procedures, such as probing and debridement, were assessed for their dental anxiety and experienced pain levels. One of the questions on dental anxiety, "Having your teeth cleaned" was found to be a significant predictor of the patients' pain responses to the procedures.

Eli, Schwartz-Arad, Baht and Ben-Tuvim (2003) examined the inter-relationship between anxiety and acute pain perception under an oral surgery procedure of implant insertion. Patients were evaluated immediately preoperatively, immediately post-operatively and at four weeks post-operative follow-up. Patients completed questionnaires concerning their anxiety and pain on each occasion. The best predictor of the patients' pain evaluations at each time point was their state of anxiety at that time. Moreover, pain experienced by patients in oral surgery was best predicted by their anxiety at each time point.

Klages, Ulusoy, Kianifard and Wehrbein (2004) looked at associations between dental anxiety and expected and experienced pain in patients undergoing extraction and root canal treatment. The patients' dental anxiety and expected pain were assessed before their treatment, and experience of pain was measured after treatment. The results demonstrated that patients with high dental anxiety expected and experienced more affective, sensory and intense pain than those with low dental anxiety.

Further, the researchers (Klages, Kianifard, Ulusoy & Wehrbein, 2006) explored whether anxiety sensitivity interacts with dental fear to increase expected and experienced pain during routine dental treatment. Patients were those undergoing dental procedures of excavation and filling. Anxiety dispositions were rated in terms of anxiety sensitivity and dental anxiety. Expected and experienced pain were assessed by sensory, affective and intensity measures. Dentally anxious patients with a disposition to high anxiety sensitivity were found to expect and experience more pain than those with low anxiety sensitivity.

Okawa, Ichinohe and Kaneko (2005) studied the effects of state anxiety specific to dentistry over pain perception in tooth-extraction patients. Patients were given a scenario either describing a patient who feels safe and comfortable having a tooth-extraction or a patient who feels strong anxiety about the procedure. They were measured on trait anxiety, dental-specific state anxiety and pain intensity during the anaesthetic injection and the extraction of the tooth. It was found that the latter anxiety-provoked scenario elicited higher dental anxiety and higher pain intensity during the injection and extraction than did the comforting scenario.

How past experience with dental pain influences dental anxiety and in turn affects dental pain was studied by van Wijk and Hoogstraten (2005). Samples were highly anxious dental patients, patients waiting for periodontal treatment and psychology freshmen. The levels of their dental anxiety and fear of experienced dental pain were measured. It was found that subjects tended to overestimate their fear of dental pain when they have not actually experienced the particular pain itself. Moreover, the subjects in general were shown to expect more pain than they experience, and that this effect is stronger in a group with higher dental anxiety scores. However, interestingly, it was reported that the sample of highly anxious dental patients underestimated their experienced pain.

Different groups of patients' dental anxiety and pain related to various routine dental hygienist treatments were evaluated (Hakeberg & Cunha, 2008). Patients were from periodontology, oral medicine and general dental practice clinics. The treatments included: polishing; gingival probing pocket depth; manual and ultrasonic scaling and local anaesthesia. It was found that dental anxiety was significantly associated with perceived pain related to different dental hygienist treatment procedures.

Wijk and Lindeboom (2008) studied the effect of a separate consultation on anxiety levels before third molar removal. Patients were randomly assigned to either the experimental or the control group. Experimental subjects received standard information about third molar extraction in a separate consultation visit before the surgical procedure, whereas control subjects received the same information just before and at the same visit as the surgical third molar removal. Patients were asked about their anxiety levels, expected pain during the extraction procedure, expected pain after the extraction procedure, pain felt in the week after the extraction and the highest level of pain felt in the week after the extraction. There was no significant main effect of a separate consultation found. However, it was shown that dental anxiety levels were positively correlated with the level of pain experienced in the week after surgery.

A study by Kuscu and Akyuz (2008) looked at the influence of anxiety and type of dental injection devices (i.e., a plastic syringe or an electronic computerised device) on the pain perceived by children aged between nine and 13 years. Participants were assigned to three separate sessions: the first one was an introductive familiarisation session; injections were administered in the second and third sessions with one or the other injector. The levels of anxiety prior to injection were measured. While no significant differences in injection pain scores were observed between the devices, higher levels of pre-injection anxiety were found to be related to more severe injection pain reports by the children.

The effects of trait and dental anxiety on postoperative pain after lower third molar surgery was evaluated by Lago-Méndez, Diniz-Freitas, Senra-Rivera, Seoane-Pesqueira, Gándara-Rey and García- García (2009). Patients who underwent lower third molar extractions were assessed on trait anxiety, dental anxiety, postoperative pain, swelling and trismus. It was reported that those with high trait anxiety showed more pain, whereas those with high dental anxiety had greater trismus.

The relationship between anxiety and pain felt during a dental injection in patients about to undergo invasive dental treatment was explored (van Wijk & Hoogstraten, 2009). The levels of anxiety prior to treatment, anxiety related to treatment and anxiety related to receiving an injection were assessed. Duration and intensity of pain during a dental injection were measured. In addition, fear of dental pain was measured. The results showed that anxious dental patients experienced pain of higher intensity and of longer duration than less anxious patients. For the intensity of pain, 22% of variance was accounted for by anxiety for the injection and dental anxiety. For duration of pain, about 28% of variance could be accounted for by fear of dental pain, the use of surface anaesthesia and gender.

As a whole, apart from the study by Eli *et al.* (1997), the research has suggested that dental anxiety increases perception of dental pain. Pain is as much a cognitive and emotional construct as it is a physiological experience (Maggirias & Locker, 2002). Accordingly, anxiety and fear seem to modulate pain experience by influencing perception of pain through a valence by arousal interaction (Guzeldemir, Toygar & Cilasun, 2008). The review provides conclusive evidence that dental anxiety heightens perception of dental pain.

1-1-4. Coping

What is coping?

Coping is defined as "ongoing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus, 1993).

This section will explore the topic of coping in relation to *dental control – desired and felt control* and *monitor-blunter style coping*.

The following is the chapter, “Coping”, of a book “Health Psychology” by Myers, Newman and Enomoto, the present author (2004).

Myers, L. B., Newman, S. P. & Enomoto, K. (2004). Coping. In A. Kaptein and J. Weinman (eds.), *Health psychology* (pp141-157). Oxford, UK: BPS Blackwell.

Introduction. No matter what kind of life one lives, stress is inevitable. Whether you are a cardiac surgeon, a road sweeper or a recluse, you will have some stress in your life. People respond to stress by developing ways to cope with the stress.

In everyday language an individual’s ability to cope refers to their successfully accomplishing a task or dealing with a situation. In health psychology it is used to describe the different ways in which people try to deal with stress. Some of these ways may be more successful than others. Coping is central to stress research and since the 1970s there has been a vast amount of research on coping with chronic illnesses, life events and hassles. The concept of coping has come to play a central role in health psychologists’ attempts to understand a different range of responses to illness and procedural stress as well as outcomes in the health and disease process.

Early research. The study of an individual’s response to stressful situations and hence what can be seen as the origins of coping came about in the 19th Century with the Freudian notion of the defences, mainly repression. A large proportion of Freud’s work on defences was concerned with the ways that people coped with stressful situations. For example, repression was defined as: “...turning something away and keeping it at a distance from the conscious” (Freud, 1915/57, p.147) and that the purpose of repression was to avoid anxiety. Apart from repression, Freud described a further nine defence mechanisms, such as “reaction formation” which transposes a statement into its opposite (e.g. “I love you” into “I hate you”) or “projection” which has an idea transposed from the subject to the object (e.g. “I love you” into “you love me”).

There were some attempts to demonstrate defence mechanisms such as repression experimentally, but these studies were not very successful. One such study attempted to measure repression by the use of stories based on Freud's Oedipus complex (Wilkinson & Cargill, 1955). The well-known Oedipus complex was named after a king in Sophocles's play “Oedipus Rex” who killed his father, and married his mother, without knowing their identity in either case, and thereby brought a plague to Thebes. The Oedipus complex is a conflict which takes place when a boy is 4 or 5 years old with his omnipotent father. The authors rationalised that a story with overt oedipal content will cause anxiety in men, but not in women. Consequently, memory for oedipal material would be worse for men than women, as the material might be repressed due to its anxiety eliciting nature in men. Male and female undergraduate students read either an experimental story contained material with incestual connotations or a control story. Participants were told that the experiment was to do with personality. In a surprise recall test 15 minutes later, they were instructed to recall the story. Males compared to females recalled significantly less of the oedipal content but there was no difference in recall of the control story. The authors concluded that this selective forgetting was evidence for repression arising in memory. However, other researchers suggested that the results were due to the nature of the task (McCullough, Smith & Walker, 1976). Participants had been told that the experiment was about personality, consequently, male participants might have withheld responses, not because of embarrassment about the sexual references, but due to the fact that reporting them might throw unfavourable light on their personality. McCullough *et al*. replicated the experiment, but without alluding to personality and found no difference in recall, supporting their explanation of the results, without having to invoke the concept of repression. Due to these types of difficulties in studying defence mechanisms in the laboratory, their study had declined by the 1970s.

The study of coping *per se* entered the psychological literature in the 1960s with the use of the word coping and related terminology such as coping styles and coping resources (see Parker & Endler, 1996). This work initially came directly from research on defence. However, whereas research on defence mechanisms tended to refer to rather rigid ways of dealing with stress, coping behaviour came to be seen to be much more flexible (Haan, 1965). What distinguishes later work on coping from the earlier work on defence mechanisms is that researchers in the 1960s and 1970s studied what they believed to be much more adaptive defences and ended up studying conscious strategies that people used when encountering stressful situations. However, even today there is still confusion as to exactly what is defence and what is coping.

Early research on coping tended to focus on coping in acute events such as life-threatening or traumatic life events, whereas later this focus broadened to include such events as chronic illness and daily hassles. By focusing on these highly stressful events, early coping researchers found that person characteristics were poor predictors of specific coping responses, because although individuals may have preferred coping responses their choices are limited in extreme situations, hence the study of situational variables became the prominent theme in coping research and this legacy can be seen today (see Parker & Endler, 1996).

Coping models and theories. There are predominantly two main approaches to coping. In both approaches the fundamental question was whether certain forms of coping were more adaptive, i.e., led to better outcomes such as psychological well-being. The dispositional approach looks at whether specific coping styles or dispositions enable people to cope better across situations. The situational approach looks at the process of coping and whether there are specific strategies that are useful in different situations.

Coping as style: the dispositional approach. The dispositional view of coping focuses on relatively stable individual differences in coping, often referred to as coping styles. One of these styles, *monitoring* and *blunting* will be discussed in the section 1-1-9. *Monitoring-blunter style coping*.

Coping as process: the situational approach. One of the main proponents of coping as a process is Lazarus (Lazarus, 1993; Lazarus & Folkman, 1984). Although Lazarus claimed that both dispositional and situational perspectives are essential for understanding coping he defined coping and its functions from a situational viewpoint: “constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person” (Lazarus & Folkman, 1984). This is a very broad definition, and includes the decisions and actions taken by an individual faced with a stressful life event but also the accompanying negative emotions to constitute coping and the cognitive and behavioural efforts that must manage the stressful situation. Lazarus and Folkman see coping as a psychological mechanism for managing external stress and coping is our attempt to change a stressor or make a response to the stress response. They see the response to a potentially stressful situation as encompassing an evaluation process which they termed appraisal. They described three forms of appraisal.

Primary appraisal. The individual appraises the situation in terms of their own well being. The situation may be regarded as stressful in which case the individual has perceived it as either potentially or actually harmful to them. They may however, define the situation as benign positive, in which case the individual views the situation as either potentially or actually beneficial to them. It may, of course be that the individual sees no relevance to them in terms of threat to their well-being, either actual or potential or in terms of benefit to their well-being and therefore the situation is viewed as irrelevant.

Secondary appraisal. Where the situation is evaluated as a threat or a potential threat to their well being, the individual will then need to decide on a course of action. The coping strategy that the person uses takes account of the level of threat in relation to the resources they have available. According to the theory, the coping response should aim at reducing the demands placed upon the individual, and hence, the level of stress. In any situation, stress is related to the relationship between demands and resources available and this is determined by the relationship between primary and secondary appraisal.

Re-appraisal. It is rare to find any situation which will remain static even from a demand or resources point of view and for this reason situations are continually re-appraised in the light of further information and perceptions. As a result behaviour may change according to the re-appraisal.

Desired control and felt (perceived) control, which was conceptualised based on this situational approach to coping, will be discussed in the next section 1-1-5. *Dental control*.

In addition, Lazarus and Folkman (1984) also identified two general types of coping.

Problem-focused coping. This is directed towards altering the relationship between the demands of the situation and the resources available. Problem-focused coping will only come into existence if the individual perceives that either the problem they are facing or the resources they have available are changeable, and that they can bring about such change. Life is full of examples of problem-focused coping such as leaving a job which we may have perceived as stressful or going to college to learn more about a subject in order that we may feel more comfortable in everyday life.

Emotion-focused coping. We may be faced with a problem that has no solution and is totally out of our control where the use of problem-focused coping would be inappropriate. For instance, a relative who is dying in hospital will die regardless of what we do, and we can do nothing to change the stressful situation. What we can do, however, is to alter our emotional response to such a situation; this can be done either behaviourally or cognitively. Behaviourally we may change, for instance, by increasing our social contacts with friends and loved ones, in order to gain some support; work very hard so we think of the situation less; or turn to alcohol, drugs etc., in order to change our state of consciousness and awareness. Cognitively we may reappraise the situation in order to reduce the amount of stress that it is inflicting upon us. For instance, with a dying relative we may say that the person is suffering and dying will stop the suffering. If we are taking an examination we may decide just beforehand that passing the examination is not really that important, although we have worked consistently hard because of our underlying belief that the examination was extremely important.

It is likely however, rather than having such clear-cut distinctions as problem-focused coping and an emotion-coping strategy, both are used in conjunction with each other for at least part of the time.

Measurement. Common generic measures include the revised Ways of Coping Questionnaire (WOC; Lazarus & Folkman, 1984), where a particular stressful event is identified and individuals specify how they coped with it on eight subscales. These subscales can be combined to reflect either problem-focused or emotion-focused.

Another popular generic measure is the COPE (Carver, Scheir & Weintraub, 1989). In this measure the authors further subdivided problem-focused and emotion-focused coping as they believe that there are a variety of distinct ways to solve problems or to regulate emotions. Problem-focused coping is subdivided into scales measuring active coping, planning, suppression of competing activities, restraint coping and seeking social support for instrumental reasons. Emotion-focused coping is measured by subscales of seeking social support for emotional reasons, positive re-interpretation and growth, acceptance, turning to religion and focus on and venting of emotions. There are two forms of the COPE. One assesses situational or state coping where participants respond on the basis of their most stressful experience in the past two months. The second assesses dispositional or trait coping where participants complete the questionnaire on how they usually respond to a stressful experience. It is a widely used instrument, and an electronic database search using Web of Science indicates that the original paper has been cited well over 1000 times.

However, use of these checklists is not without difficulty, as a study which looked at how students coped with exam-related stress reveals. The researchers devised alternate forms of the revised WOC. One of these took the form of a daily checklist which students had to complete each evening for seven days prior to an examination. The second form used the traditional retrospective recall checklist, which students filled in seven days after the examination. On average only 25% of shared variance was found between daily and retrospective accounts. For students who reported the highest levels of examination stress less than 10% of the retrospective coping score was predicted by the daily measures. The authors concluded that retrospective coping reports cannot be considered to measure coping obtained in closer proximity to the event (Smith, Leffingwell & Ptacek, 1999). Similarly, in another study of people from the general population, participants were required to give momentary reports of coping via a palm-top computer and short-term retrospective reports of coping. There was relatively poor correspondence between momentary and retrospective coping, with some reports of momentary coping not reported retrospectively and vice versa. Cognitive coping was more likely to be under-reported retrospectively and behavioural coping was over-reported (Stone, Schwartz, Neale et al, 1998).

Do patterns of coping change over time? Frazier (2002) followed patients with Parkinson's disease (PD) over two years to see whether coping was stable, supporting a dispositional model of coping, or changing, supporting a contextual model of coping. PD can be seen as good example of coping with a chronic illness as it is progressive and creates impairment in physical (e.g., tremor), cognitive (e.g., attentional difficulties) and psychosocial (e.g., loss of control) functioning. It was found that as the disease progressed, distress increased and quality of life decreased. Overall, there was no change in coping strategies used to manage disease-related stress, supporting a dispositional model of coping. However, dispositional coping was correlated with poorer physical and mental outcomes, whereas change in coping strategies (contextual) was correlated with more optimal outcomes. Younger patients who reported their illness was less severe and who experienced less distress were more likely to change their use of coping strategies. Accordingly, evidence supporting both types of coping was found.

Individual differences and situational coping. A number of individual difference traits have been linked with different types of situational coping. Some of these are briefly discussed below.

Neuroticism. Most research has shown that neuroticism is linked to maladaptive coping. For example, in a sample of adolescents who were rated as exhibiting some degree of maladjustment, neuroticism predicted avoidant coping (Gomez, Bounds, Holmberg, Fullarton & Gomez, 1999).

Locus of control. This involves individual differences in beliefs about control over reinforcement. Individuals who exhibit an *internal locus of control* perceive personal mastery over outcomes, whereas those who exhibit an *external locus of control* perceive that reinforcement is due to external factors. There is an extensive literature indicating that when those with and *external locus of control* are confronted with stressors they exhibit a wide range of maladaptive coping responses (see Folkman, 1984). For instance, patients who suffer from non-epileptic seizures were found to exhibit a higher *external locus of control* and more escape-avoidance coping strategies than a non-clinical control group (Goldstein, Drew, Mellers, Mithcell-O'Malley & Oakley, 2000).

Dispositional optimism. Most studies have found that dispositional optimism is associated with adaptive coping in response to physical challenges (Scheier, Weintraub & Carver, 1986). In a study of pregnant women, optimism was associated with less use of avoidance coping and lower emotional distress (Yali & Lobe, 2002).

Social support and coping. Social support has been thought only to be beneficial when individuals are coping with stress, with no positive effect at times without stress (Cohen & Wills, 1985). However, social support may lead to not having a life event to deal with.

For instance, consider two women each with a young child and a demanding job when the child becomes ill. Friends and relatives of one woman may help look after the child and allow the person to carry on working. Members of the other woman's social network may not help her or be unreliable. Consequently, one woman may be secure in her job whereas the other woman may lose her job. Social support affects how individuals cope with stressful events, and how individuals cope may influence their use of social support in the future. The relationship between social support and coping is complex (see Pierce, Sarason & Sarason, 1996).

Issues in coping research. Besides the use of retrospective recall in coping research, there are problems with both its conceptualisation and measurement (Coyne & Gottlieb, 1996). Although there have been hundreds of studies using these sorts of measures outlined above, Coyne & Gottlieb concluded that little progress has been made in understanding the role of coping in adaptation to stress. "The study of coping has become too narrowly method-bound, defined by uncritical application of standardised checklists to diverse populations and situations. These checklists are used with little regard for their appropriateness and often without a clearly defined specific aim or clearly defined hypothesis" (*ibid*.).

A major conceptual issue in coping research is whether a person is coping with a discrete one-off trauma or a chronic condition or illness such as multiple sclerosis or diabetes. In the case of a chronic condition, coping can become automatic and anticipatory. Coyne and Gottlieb take up the issues of coping with chronic illnesses within their paper. They argue that coping checklists do not measure a number of concepts which are central to coping in these situations and that the concept of coping should encompass a wider range of adaptive thought and behaviour. For example, anticipatory coping, which happens before a stressful situation, may avert the stressor and as a result there will be nothing for a coping inventory to measure, as there will be no stressful situation. So, someone with diabetes which is controlled with insulin injections may avoid high or low blood sugars by carefully monitoring blood sugars and balancing the amount of insulin they take with diet and exercise. Thereby there is no stress and nothing overtly to cope with that could be measured by a checklist.

Habitual or automatic behaviour should be included within coping as in chronic conditions. For example, in multiple sclerosis, patients and their families may refine coping strategies that have been effective in the past for dealing with exacerbations of the illness, and these strategies may become a routine. So if the multiple sclerosis patient no longer thinks of a flare up of their illness as a catastrophe they may not be thinking about it, and it will not be recognised as a coping strategy.

The use of generic scales also have other problems, such as the scale imposes a specific structure: that people encounter a stressor, make appraisals to what is at stake select coping strategies and experience particular emotions as a result. Coyne and co-workers (Coyne & Calarco, 1995;. Gottlieb & Gignac, 1996) have found when comparing checklists to the individual’s own narrative that the checklist way of eliciting data only fits some of the people some of the time. There is great variation among respondents and across situations, with some people never making an appraisal of what is at stake, never knowing what their resources are and what they are trying to achieve. Importantly, many people do not make primary or secondary appraisal until they have to give one in response to the questionnaire.

Another problem is selecting the stressor, as checklists force the individual to choose a stressor. Consequently, different people will complete the same questionnaire for totally different types of stressful events, making the comparison between coping profiles really not sensible. It has been suggested that when using standardised questionnaires, the researcher should clearly state aims and objectives and theory-driven hypotheses and consider whether checklists are suitable and should really develop more situation-specific checklists geared to hypotheses. Use of semi-structured interviews, although labour intensive, should also be considered (Coyne & Gottlieb, 1996).

Interventions to improve coping. Despite the difficulties in conceptualising and assessing coping, there have been an increasing number of studies evaluating interventions aimed at improving adaptation to chronic illness by enhancing coping responses. These interventions, usually provide patients with support and specific information and alternative coping skills to improve their adaptation to particular stressors.

Lutgendorf, Antomi, Ironson, Starr, Costrllo, Zuckerman, Klimas, Fletcher and Schneiderman (1998) undertook an intervention study that measured changes in coping skills in a group of HIV-positive gay men. Participants were randomised into a 10-week cognitive behavioural skills management programme which was designed to increase cognitive and behavioural coping skills related to managing the distress of symptomatic HIV, or a waiting-list control condition. Members of the treatment group showed an increase in cognitive coping strategies involving positive reframing (to see their situation in a new light) and acceptance (being HIV positive and having symptoms), whereas controls showed decrements in coping abilities. Increase in acceptance showed the greatest magnitude of post-intervention change and it mediated the effects of the interventions on distress outcomes.

However, in reviews of the literature both Coyne and Racioppo (2000) and de Ridder and Schreurs (2001) concluded that most intervention studies do not measure coping, and the stress of the intervention is usually inferred by improved health outcomes, reduced psychological distress and increased quality of life. Since the publication of these two reviews, a number of intervention studies have measured coping pre- and post-intervention. Three of these are discussed below with a description of the coping intervention they employed.

Kennedy, Duff, Evans and Beedie (2003) undertook a controlled trial comparing spinal cord injury (SCI) patients who received a Coping Effectiveness Training (CET) intervention (n=45) with matched controls (n=40). The COPE was used as a measure of coping as well as measures of well-being.

CET is based on Lazarus and Folkman's (1984) theory of stress and coping, but also uses strategies from cognitive behaviour therapy. It was originally developed for use in HIV (Chesney & Folkman, 1994) and was modified for individuals who have recently suffered SCI (King & Kennedy, 1999). The intervention consists of seven 60- to 75-minute sessions run twice a week for six to nine people. The content of each session is as follows:

Session 1: The concept of stress is introduced. The need to develop the ability to think critically about appraising and coping with situations are discussed.

Session 2: In this session the focus is on appraisal skills.

Session 3: This session introduces problem-solving, including working through several scenarios that are commonly experienced by people with SCI.

Session 4: Connections and distinctions between thoughts, feelings and behaviour are examined.

Session 5: How to be aware of and challenge negative assumptions, thoughts and expectations are shown.

Session 6/7: Description of a "meta-strategy" is introduced to help patients to choose appropriate ways of coping and to increase social support.

Kennedy *et al*. found a decrease in depression and anxiety in the intervention group at post-intervention and six weeks follow-up, but not in the control group. There were no differences in coping, although the patients' comments on the most effective part of the intervention involved making more positive appraisals of their situation. It may have been that the COPE was not sensitive enough to detect changes in appraisal and coping over six weeks.

Heckman, Kochman, Sikkema, Kalichman, Masten, Bergholte and Catz (2001) devised a coping improvement group intervention for HIV-infected older adults. The intervention focuses on teaching patients to accurately appraise sources of stress, develop active coping responses, and access social support resources to facilitate adaptive coping. In a pilot study of this intervention using a small sample (n=16) and no control group, pre-test versus post-test, individuals produced higher perceptions of well-being, engaged in more problem-solving coping, and displayed more optimism about the future.

A coping intervention was devised to teach people with rheumatoid disease to cope actively with their problems (Savelkoul, de Witte, Candel, van der Tempel & van den Borne, 2001). One hundred sixty eight patients were randomly assigned to a coping intervention group, a mutual support control group, or a wait list control group. The intervention was aimed at improving a form of problem-solving coping and increasing social support. The problem-solving aspect of the intervention involved getting patients to describe the problem, think about all sorts of possible solutions, choose one or more solution, implement the solution or solutions and evaluate the results. Participants were allowed to use the different steps of problem-solving at their own pace, and they had homework assignments to help them to apply the content of the sessions to their own lives. Post-intervention the coping intervention group increased problem-solving coping compared to the mutual support group, but this difference did not last at six months follow-up. This suggests that maintenance sessions would be advisable.

Summary and conclusion. In the last four decades there has been a burgeoning of research on coping since the transactional model of Lazarus in the 1970s. Although the original focus on defence and dispositional measures largely was superseded by situational variables, now that coping research also includes chronic stressors, the importance of more stable characteristic should be explored along with situational variables. Coping research is undergoing somewhat of a crisis with a number of conceptual and methodological problems, which have been highlighted in this chapter. However, intervention studies in chronic illness to improve coping with good measures of coping may be the way forward in clarifying the role of coping and also its measurement. Care needs to be taken in the uncritical use of generic checklists, and researchers should look for other measures, possibly specific self-measures and consider semi-structured interviews, qualitative analyses and daily reports. In addition, it remains useful to assess both dispositional and situational determinant of coping, and the incorporation of repressive coping in the wider field of coping may help to illuminate our understanding of coping. The area would also benefit from more theoretical development.

Coping research topics

This section will give an over view of coping research topics. It will focus on four articles which examine solutions to the issues raised in theory and research into coping. Much research in the field of coping has generated a vast body of literature over 40 years. However, as pointed out by Lazarus (1999), the quantity of research on stress and coping is not matched by its quality, because of a range of conceptual and methodological issues.

A daily process approach to coping research. Tennen, Affleck, Armeli and Carney (2000) claim that “for decades, coping researchers have used between-person designs to address inherently within-person questions derived from theory and clinical practice”. They note that although there are many studies exploring the relations between daily events and mood; physical symptoms; or chronic illnesses, comparatively few studies examine coping as a daily process. Instead, they propose idiographic designs, i.e., an approach which is within-person, process-oriented. By this method, researchers intensively examine individuals over time by tracking proximal stressors, rapidly fluctuating processes of mood and coping close to their real-time moments of change. Tennen *et al*. contend that these designs minimise recall errors, including systematic errors in which individuals who differ on measured or unmeasured variables provide differentially accurate data or use different cognitive heuristics to assist their recall.

The authors provide empirical evidence to support their idiographic approach based on their findings from research on regular drinkers, depressed and formerly depressed individuals and people with chronic pain. The findings from each item of research are discussed below.

They studied whether alcohol consumption is associated with daily reports of avoidant or emotion-focused coping. The participants, moderate- to heavy-drinkers completed structured nightly diaries for 60 consecutive days. On days of stressful events, the participants recorded how they coped with their most negative event using a variety of dimensions – e.g., problem-focused, emotion-focused or avoidant coping. The between-person analyses showed that average level of daily problem-focused coping was unrelated to average daily drinking, average level of daily emotion-focused coping was negatively related to average daily drinking and for men only average daily avoidant coping was positively related to average daily drinking. However, the within-person analyses unearthed different findings. The participants drank less on stressful days during which they used more active coping strategies compared with stressful days during which they used less active coping strategies. They also drank more on stressful days during which they used more emotion-focused strategies. Yet, avoidant coping was not related to consumption.

The authors also applied the daily process designs to collaborate and test the self-medication hypothesis (Swendsen, Tennen, Carney, Affleck, Willard & Hromi, 2000) – the use of alcohol to soothe negative affect potentially leads to alcohol abuse and dependence. Using electronic interviews on hand-held computers, they found that greater nervousness in the evening anticipated more drinking later that evening, and alcohol consumption was associated with a reduction in nervousness.

Hence, the daily process studies enabled them to explore, for women with primary fibromyalgia syndrome (PFS), the sequential relation between last night's sleep and today's *pain catastrophizing* and the inclination to cut back on planned activities on more painful days. The PFS sufferers were categorised as to (a) a recently-depressed group, (b) a remotely-depressed group and (c) a never-depressed group. They completed nightly diaries of that day's perceived control over symptoms, the perceived efficacy of that day's coping strategies, assessment of *pain catastrophizing* and descriptions of activity limitations for 30 consecutive days. Hand-held computers also recorded their previous night's sleep, that day's pain, pain attention, fatigue and mood. The recently-depressed individuals paid greater attention to their pain than did their never-depressed counterparts. They also engaged in more *pain catastrophizing*. The authors also report the residual effects of depression on patient's coping related judgement and their perception of control. Remotely-depressed patients believed that their coping strategies were inefficacious in reducing their pain and in enhancing their mood and that they had less personal control over their pain.

Similarly, the daily process approach made it possible for Tennen *et al*. to demonstrate the scar symptom reactivity hypothesis - an episode of major depression may leave a psychological scar or residual dysfunction (Hedlund & Rude, 1995). They report that patients with a history of depression, either recent or remote, were less able to inhibit *pain catastrophizing* the day after a good night's sleep than were never-depressed patients. Further, recently-depressed patients were more apt to refrain from social, vocational and personal activities when they were in greater pain. They were also more likely, when their pain increased, to experience negative and positive mood changes, threats to their perception of personal control and doubts that their pain coping strategies were effective in reducing their pain. When their fatigue increased, they were less confident that they had exerted personal control over their pain that day.

Further, in their studies of rheumatoid arthritis patients, Tennen *et al*. test their fallback hypothesis (Tennen *et al*., 2000) – whereas problem-focused strategies are used regularly in the absence of emotion-focused strategies, emotion-focused strategies are less likely used unless problem-focused strategies are present. They maintain that these associations – i.e., joint use of problem- and emotion-focused coping with the use of either one in the absence of the other – cannot be directly compared by cross-sectional or several longitudinal designs. As hypothesised, it was found that whereas problem-focused strategies were used regularly without emotion-focused strategies, emotion-focused strategies were used quite infrequently without problem-focused strategies. Further, it was shown that an increase in today's pain over yesterday's pain increased the likelihood that problem-focused coping yesterday would be followed by emotion-focused coping today.

Defence mechanisms in adaptational processes. Tennen *et al*. (2000) favour the approach proposed by Lazarus (1993) and Haan (1992) over coping strategies and adaptational processes: coping represents a "subset of adaptational activities that involves effort, therefore, a hallmark of coping is *conscious* choice". Contrary to their position, Cramer (2000) advocates unconscious psychological processes in adaptation. She emphasises the importance of defence mechanisms in adaptational processes, claiming that with defences seen as an alternative type of adaptational strategy, it would seem critical to study them when investigating how people deal with stress. According to Cramer, defence mechanisms are unconscious, unintentional psychological processes in contrast with coping processes which are conscious and intentional. She exemplifies the evidence of these unconscious psychological processes found in cognitive, social, developmental, personality and clinical psychology. These are now looked at respectively.

Cramer gives examples of her own (1965) and Marcel's (1983) priming experiments of implicit memories in that activation of memories, unavailable to consciousness, subsequently influences conscious recall and judgement. She also illustrates the existence of unconscious decision making in terms of erroneous nonconscious inferential processes (Lewicki, Hill & Czyzewska, 1992), automatised psychological process (Jacoby, Lindsay & Toth, 1992), subliminal psychodynamic activation (Paulhus, Fridhandler & Hayes, 1997) in which stimuli not attended to subsequently influence behaviour.

Cramer claims the existence of defensive processes in the field of social psychology. She regards the processes by which humans deceive themselves, enhance self-esteem and foster unrealistic self-illusions as defence mechanisms. She illustrates Baumeiste, Dale and Sommer's (1998) study for evidence of the use of defence mechanisms in situations where there is a threat to self-esteem. Similarly, the author itemises cognitive processes involved in the defence in the field of social psychology, such as *attribution* or *false consensus effect* for projection, *scapegoating* for displacement, *dissonance reduction* for defensive isolation, *self-presentation ploys* for reaction formation, *positive illusions* for denial and *counter factual thinking* for undoing.

The author gives an example of defence mechanisms within developmental psychology as in the infants' attachment. She claims the infant's avoidant response to the caretaker is a psychological defence mechanism to defend against the presence of a caretaker who evokes unpleasant emotions (Cassidy & Kobak, 1988). Similarly, she exemplifies the existence of defensive processes also in children's impression management, i.e., their self-reports of high self-esteem, inhibition of negative emotion and adolescent moral development.

Cramer argues, in the field of personality studies, that late adolescents in the non-committed identity statuses show strong use of defences to control anxiety in the process of identity development, in contrast to those in the committed statuses (Cramer, 1998). She reports other work in which threat to the gender identity resulted in greater defence use in the person with gender role conflict - i.e., men with a feminine personality organisation and women with a masculine personality organisation - than those with a gender-consistent personality organisation (Cramer, 1999).

Within clinical psychology Cramer shows studies of patients with serious medical conditions, such as cancer, diabetes, kidney failure or obesity, reporting that those who do not comply with medical advice also show strong use of defence mechanisms (Oettingen, 1996) to protect them from anxiety about being ill. The author argues that such individuals are likely to show considerable resistance to insight-oriented psychotherapy.

According to Cramer, since defensiveness is implicated in the overestimate of current adaptive functioning or in the over-reporting of symptoms, it is critical in assessing patients' functioning to recognise that the patients' descriptions of how they cope and their description of their out come status are going to be influenced by defences.

Finally, regarding the adaptiveness of defences, she also argues that mature defences such as *humour*, *altruism* and *sublimation* are associated with adaptive functioning, whereas whether *denial* is adaptive can only be answered by considering the context, both external and internal in which they occur.

A role of positive affect in adaptational processes. Folkman and Moskowitz (2000) claim that one of the reasons more progress in coping research has not been made is the almost exclusive focus on negative outcomes in the adaptational processes. Here, they are not concerned with the relationship between positive and negative affect at any given moment as traditionally debated, but are concerned why positive affect is there. Accordingly, they explore theories and empirical evidence on the "stress-buffering" and "resource-replenishing" functions of positive affect.

The investigators, nonetheless, note that positive affect has not entirely been ignored in coping literature. It has been discussed in relation to the primary appraisal of stressful situations, in relation to the appraisal of the resolution of a stressful encounter and as a response to the cessation of aversive conditions.

Folkman and Moskowitz claim that positive affect and negative affect can *co-occur* during chronic stress. They illustrate a case of caregivers to their AIDS partners (Folkman, 1997). Although they had significantly elevated levels of depressive mood throughout care-giving and up to three years after the deaths of their partners, they also reported experiencing positive affect with the exception of the time immediately surrounding the partners' death.

Does positive affect have adaptational significance? The investigators cite empirical evidence of the function of positive affect in promoting creativity and flexibility in thinking and problem solving, in processing self-relevant important information, serving as a buffer against adverse physiological consequence to stress and in decreasing negative affect of distress.

In their longitudinal study of AIDS caregivers (Moskowitz, Folkman, Collette & Vittinghoff, 1996), Folkman and Moskowitz identified three kinds of coping related to the occurrence and maintenance of positive affect: positive reappraisal, goal-directed problem-focused coping and the infusion of ordinary events with positive meaning. First, positive reappraisal was found to be significantly associated with increase in positive affect. Second, problem-focused coping was shown to be positively and significantly related to positive affect three months to one month prior to a partner's death. The investigators claim that the sense of mastery and control engendered by successful problem-focused efforts helps explain caregivers' reports of positive affect in the midst of their distress. Third, the participants in their study reported a positive event in 99.5%

of 1,794 interviews. They claim, therefore, that positive reappraisal, problem-focused coping and the positive events involve creating, reinstating or reinforcing meaning in the midst of stressful situation. They emphasise the importance of coping processes that focus on the creation of situational meaning in the proximal, ongoing stressful context.

Gap between coping research and clinical intervention. There has been a "puzzling and profound lack" of link between research on coping and clinical intervention (Somerfield & McCrae, 2000). Examining intervention literature, Coyne and Racioppo (2000) note that there is little or no consistent positive association between the use of any particular coping strategy and the achievement of positive adaptational outcomes. As briefly discussed earlier in the *What is coping? – measurement* section, they attribute the gap between research and clinical practice to standardised self-report measures such as the Way of Coping Checklists developed by Lazarus and colleagues.

The authors illustrate the problems. First, questions asked in many coping studies are in broad form of "How do you cope with cancer?" by which respondents may fail to report on the key coping strategies or individually focus on such widely different stressful episodes that valid, nontrivial generalisations across respondents are not possible. As Tennen *et al*. earlier noted, the retrospective nature of assessments often lead to recall errors, because retrospective recall makes exceedingly difficult to distinguish between how a stressful situation is resolved and the contribution of individual coping efforts to that resolution. Second, characteristics of individuals are not reflected in the coping checklists. That is, even when asked to report on a well-defined stressor, respondents may draw upon very different stressful episodes with very different goals and opinions for coping. Third, the coping checklists have ignored differences in goals and agendas across situations and persons. Traditionally, the effectiveness of coping has been evaluated in terms of reduction in psychological distress. Reduction in distress is not a goal in itself in many stressful situations.

Along the same line with Tennen *et al*., the authors claim that research should be redirected toward understanding coping as it occurs in relatively circumscribed contexts in which the range of possible coping responses is limited and the criteria for coping effectiveness are explicit. They also address the need for a broader set of outcome criteria, linked to the needs and goals of the individual. Accordingly, they assert that both stressors and coping efforts need to be assessed by instruments tailored to very specific problems to which they will be applied.

Referring to coping interventions, Coyne and Racioppo note that literature examining interventions do not tell whether interventions work, how these interventions work if they do, why they fail when they do and whether the global and specific skills acquired in treatment settings generalise and are maintained in the naturalistic settings in which they are expected to be used. Consequently, it is difficult to specify mechanisms of change, refine techniques of intervention or anticipate and solve problems of generalisation and relapse.

They argue that coping researchers should not depend on existing coping instruments to inform them of what they need to know about the phenomena under study. The call for refinement of specific research questions and the establishment of the content validity. As a problem solver, they introduce the critical incident technique (CIT, Flanagan, 1954). CIT is a systematic approach to describing responses to situations of interest or critical situations, typically by conducting structured interviews with participants having experienced a common stressor. They claim that this method can assist in identifying coping strategies that are used most often and that are relevant and specific to a situation.

In summary, traditionally, coping researchers have frequently utilised cross-sectional, nomothetic methodologies in which several groups of people are compared at the same time, and inferences are made to generalise about a category of people. Moreover, studies of coping have been dominated by contextual models which emphasise coping by a person situated in a particular stressful event (e.g., Lazarus, 1966, 1981, 1993; Lazarus & Launier, 1978; Folkman, Schaefer & Lazarus, 1979; Coyne & Lazarus, 1980; Lazarus, Kanner & Folkman, 1980; Folkman; 1984; Lazarus & Folkman, 1984; Folkman & Lazarus, 1985). Consequently, dispositional approach has generally been abandoned in the field of health psychology in place of situational approach. The four propositions, however, will give us insights into coping research as outlined in the four points below.

First, as shown earlier, Tennen *et al*. call for the need for a process-oriented idiographic-nomothetic method for studying adaptational processes. This is instead of seeking only universal ways of dealing with stress and places more weight than before on individual differences such as personality, individual or social resources and development over the life span (Aldwin, 1994). Hence, it is essential to consider individual differences that may affect the choice of optimal ways of coping.

Second, currently there are two conflicting views on coping: coping as only conscious processes and coping as conscious and unconscious processes. Tennen *et al*. regard coping as conscious processes, whereas Cramer advocates unconscious processes, i.e., defence mechanisms in coping. Cramer gives us plausible accounts of existence of the defensive processes in coping. Nevertheless, since this conceptual issue is far from resolved, there is nothing for it now but to hope for future development in this issue.

Third, Folkman and Moskowitz identify the cognitive processes which generate positive affect: positive reappraisal, goal-directed problem-focused coping and the infusion of ordinary events with positive meaning. According to them, the relationship between positive and negative affect in any given stressful encounter is not important as traditionally discussed: what matters is that positive and negative affect can co-occur and why positive affect is present in any given stressful situation.

Finally, Coyne and Racioppo criticise traditionally used standardised self-report measures, most notably, the Ways of Coping Checklist. As discussed, the method fails to capture person-environment transactions and the coping *processes*.

In all, it seems that, going back to the fundamental questions in coping, discovering what works best for whom under what circumstances requires more conceptually and methodologically sophisticated research than has typified the field in the past.

1-1-5. Dental control

Perceived control

One of much researched psychological factors in pain literature is that of personal control. To be exact, perceived control in stress and coping processes from the perspective of the transactional model of stress elaborated by Lazarus and his colleagues (e.g., Lazarus, 1966, 1981, 1993; Lazarus & Launier, 1978; Folkman, Schaefer & Lazarus, 1979; Coyne & Lazarus, 1980; Lazarus, Kanner & Folkman, 1980; Folkman; 1984; Lazarus & Folkman, 1984; Folkman & Lazarus, 1985). The model describes stress as resulting from a transaction between how a stressor is appraised by an individual and how the individual appraises one's resources to cope with the stressor (see 1-1-4. *Coping – Coping as process: situational approach*).

That is, personal beliefs about control arise from two major forms of appraisal. *Primary appraisal* assesses the potential for harm or challenge from a given stressful situation, while *secondary appraisal* refers to the coping resources an individual feels are available to them in such a situation. *Primary* and *secondary appraisals* are presumed to operate interdependently to produce a person by situational assessment of the threat and challenge of the current situation (Folkman & Lazarus, 1985). Specifically, threat, as opposed to challenge, is assumed to occur if *secondary appraisal* indicates that available coping resources are inadequate to protect the individual from harm or loss indicated by their *primary appraisal*. If, however, the individual deems his or her resources to be adequate to managing the potential dangers of the setting, feelings of control, self-efficacy and challenge are presumed to occur (Tomaka, Blascovich, Kibler & Ernst, 1997). Thus, a stress response is elicited only when the demands exceed one's perceived ability to cope.

People, therefore, may differ considerably in the way they deal with a stressful event during which there is little personal available control such as invasive and painful dental procedures. The coping styles, in turn, may influence the levels of pain and distress which individuals experience. A high sense of perceived control would contribute to a sense of confidence, as one responded to the demands of the situation (Coolidge, Heima, Coldwell, Weinstein, Logan & Milgrom, 2005). In contrast, the lack of personal control has long been associated with elevated levels of clinical and experimental pain and negative treatment outcomes (Litt, 1988; Arntz & Schmidt, 1989; Feldner & Hekmat, 2001; Gedney & Logan, 2007). Along the line, a substantial variation in dental patients' post-operative pain experience and analgesic requirements following identical surgical procedures has been reported (Seymour, Meechan & Blair, 1985; Fong & Kwan, 2005).

Desire for control and felt control

In their studies, Logan, Baron and colleagues (Logan, Baron, Keeley, Law, Moreland & Stein, 1991; Baron & Logan, 1993; Baron, Logan & Hoppe, 1993; Law, Logan & Baron, 1994; Logan, Baron & Kohout, 1995) proposed that it is the discrepancy between the individual's level of *desire for control* (or *desired control*) over a stressful situation such as dentistry and the degree of *felt control* (or *perceived control*) the individual perceives to have, not the absolute levels of perceived control, that is important in understanding individual differences in responses to stressors. Accordingly, their patients are categorised into four subgroups based on how much control they desire to have over the event and how much control they perceive to have by the Iowa Dental Control Index (IDCI; Logan *et al.*, 1991). These subgroups reflect whether patients are high or low on each subscale of *desire for control* and *felt control*: low *desired*/low *felt*; low *desired*/high *felt*; high *desired*/low *felt* and high *desired*/high *felt*.

These researchers maintained that particularly those with low *felt control* are most likely to show aversive reactions if they also have a high *desire for control*. Such patients view dental treatment as particularly threatening and stressful. The researchers have carried out a number of studies with the IDCI, using dental patients as participants, and have indeed consistently found that patients who fall into the high *desired*/low *felt* category are characterised as having more dental fear and distress (Baron & Logan, 1993). Similarly, it was reported that *desired control* was positively correlated with dental fear, while *felt control* was negatively correlated with such fear (Coolidge *et al*., 2005).

The transactional model has interesting implications: high *desire for control* seems quite analogous to a threatening primary appraisal about a looming medical event

(Brunsman, Logan, Patil & Baron, 2003). In contrast, low levels of *felt control* appear closely related to a secondary appraisal revealing few stress-relevant personal and situational resources (Folkman, 1984; Logan *et al*., 1991). Hence, when potential harm is assessed as high and coping resources are assessed as inadequate, elevated levels of stress are probable. Such elevated levels of stress are associated with increased autonomic activity (Chrousos, 2000), and the associated autonomic arousal has been linked with elevated levels of pain (Logan, Lutgendorf, Rainville, Sheffield, Iverson & Lubaroff, 2001)[a] and negative health consequences such as infectious illness symptoms (Logan, Lutgendorf, Kirchner, Rivera & Lubaroff, 2001)[b]. Identification of such "at risk" individuals, therefore, has important clinical implications.

Interventions on individuals with high desired/low felt

Logan, Baron and colleagues claimed that the provision of a coping technique will bring positive effects, particularly for those who have high desire to control and low sense of it. They conducted some intervention studies which will now be examined.

Baron *et al.* (1993) provided threatened and stressed patients having a root canal procedure with sensory-focus intervention (i.e., focusing on physical sensation rather than emotional feelings associated with it). The strategy was based on the Leventhal's (1982, 1990) theory of parallel processing of stress-related stimuli: emotional processing of stressful stimuli is associated with heightened pain and distress, and so it follows that reducing the use of emotional schemas should make aversive procedure easier to tolerate (Baron *et al.*, 1993). The researchers found that those who were instructed to focus on physical sensation (sensory-focus) as opposed to emotional feelings (emotional-focus) during the treatment had a significantly reduced level of self-reported pain. However, this was only among those who were classified as having a strong desire for control and low felt control in dental situations. In contrast, among patients with low desire for control and low felt control, sensory-focus instructions produced greater pain reports than did emotion-focus instructions.

Similarly, Logan *et al.* (1995) investigated the influence of sensory focus strategy and giving information on the procedures during endodontic treatment. The patients were randomly assigned to one of four audio-taped instruction conditions: sensory focus with and without procedural information; procedural information or no-intervention. The sensory focus method instructed the patients to pay attention only to the physical sensation in their mouth and think about these sensations in terms of physical properties. In contrast, the procedural information strategy gave brief explanations of reasons and description of the root canal procedures. It was reported that the high desire-low felt control subgroup's pain scores both in the sensory focus and the sensory focus/procedural information conditions were significantly lower than those subgroup's in the no-intervention condition. Additionally, there was a non-significant trend reported for the low desire-low felt control subgroup in the sensory focus condition to have higher pain scores than those in the no-intervention condition.

Instead, Law *et al.* (1994) gave those with high desire-low felt control group "Stress Inoculation Training" (SIT: Meichenbaum, 1985). The patients were randomly assigned to either the SIT or "a filler video condition". The SIT condition consisted of a six-minute video, depicting an anxious female dental patient receiving coaching and successfully modelling several coping strategies (e.g., deep breathing, self-monitoring and signalling the dentist), followed by a discussion with the experimenter about which of the coping strategies to choose. Whereas, a filler video condition consisted of a six-minute programme about local areas of interest, followed by a discussion with the experimenter about neutral topics (e.g. the weather, sports, gardening). It was found that high desire-low felt control patients in the SIT condition reported significantly less post-therapy pain than those in the filler video condition. In contrast, the low desire-low felt control subgroup in the SIT condition tended to experience more pain than those in the filler video condition.

1-1-6. Pain catastrophizing

The conceptualisation of catastrophizing

Most important psychological predictors of clinical and experimental pain responses may be maladaptive or negative style of coping strategies, the most studied of which is catastrophizing (Sullivan, Thorn, Haythornthwaite, Keefe, Martin, Bradley & Lefebvre, 2001)[a]. Indeed, catastrophizing emerges in the literature as one of the most potent predictors of pain in general (Vlaeyen & Linton, 2000; Sullivan, Rodgers, Wilson, Bell, Murray & Fraser, 2002; Keefe, Rumble, Scipio, Giordano & Perri, 2004). In pain research, catastrophizing has been broadly defined as "an exaggerated negative mental set brought to bear during actual or anticipated pain experience" (Sullivan *et al*., 2001)[a].

Initially, the Coping Strategies Questionnaire (CSQ), developed by Rosentiel and Keefe (1983), had a six-item subscale which assessed dimensions of helplessness and pessimism in the context of pain. In the development of the Pain Catastrophizing Scale (PCS) based on the CSQ, Sullivan, Bishop and Pivik (1995) conceptualised *pain catastrophizing* as unitary construct comprising *rumination* (e.g., "I keep thinking about how much it hurts"), *magnification* (e.g., "I wonder whether something serious may happen") and *helplessness* (e.g., "It's awful and I feel that it overwhelms me"). In sum, individuals who have a tendency to magnify the threat value or seriousness of pain sensation, have perceived inability to divert attention away from pain, and have helplessness and pessimism in relation to ability to deal with pain experience can be classified as *catastrophizers* (Sullivan *et al*., 2001)[a].

The nature of pain catastrophizing

The Fear-Avoidance Model of Musculoskeletal Pain (FAM) describes specific pain cognitions involved in the development and maintenance of chronic pain and disability following injury (Vlaeyen & Linton, 2000; Asmundson, Norton & Vlaeyen, 2004; Leeuw, Goossens, Linton, Crombez, Boersma & Vlaeyen, 2007). *Pain catastrophizing*, pain-related fear, kinesiophobia and anxiety are related but separate psychological factors within the FAM. In the FAM, catastrophizing is described as a cognitive precursor to pain-related fear and tendencies to avoid pain, which may enhance pain intensity and hinder resumption of physical activity.

In addition, fear of pain and catastrophizing have emerged as two of the strongest psychological predictors of pain-related outcomes (Vlaeyen & Linton, 2000; Sullivan *et al*., 2001[a]). Although descriptive characteristics of these two constructs overlap to some degree, catastrophizing has been construed as a cognitive variable while fear of pain has been construed as an emotional variable (Sullivan, Thorn, Rodgers & Ward, 2004)[a].

Moreover, catastrophizing could be considered to serve as a coping strategy in terms of displaying distress to achieve attention or help from the social environment (Sullivan, Adams & Sullivan, 2004)[b]. However, other research on the construct of catastrophizing suggests that it is more a response to distress than a coping strategy (Sullivan *et al*, 2001)[a]. Sullivan, Rodgers & Kirsch (2001)[b] also describes catastrophizing as a cognitive determinant of the pain experience. Accordingly, in patients with chronic pain, depression and pain behaviour often improve when catastrophizing thoughts are diminished following treatment (Spinhoven, ter Kuile, Kole-Snijders, Mansfeld, den Ouden & Vlaeyen, 2004). One study on patients with chronic low back pain participating in a pain programme showed that changes in catastrophizing mediated the improvement in disability and pain intensity after treatment (Smeets, Vlaeyen, Kester & Knottnerus, 2006).

Furthermore, it is also known that fear-avoidance and depression are important predictors of pain-intensity and disability (Vlaeyen & Linton, 2000; Pincus, Burton, Vogel & Field, 2002; Woby, Watson, Roach & Urmston, 2004), and there is contradictory opinion as to whether catastrophizing is a unique determinant of pain and disability or simply an expression of some of these other “negative” psychological constructs (Sullivan *et al*., 2001[b]; Woby, Watson, Roach & Urmston, 2004; Hirsh, George, Riley III & Robinson, 2007).

Catastrophizing and pain

Substantial studies have shown that individuals who catastrophize experience more pain and emotional distress in response to a wide range of clinical conditions and aversive experimental procedures than those who do not catastrophize. Indeed, catastrophizing has been reported to account for seven to 31% of the variance in pain ratings (Sullivan *et al*., 2001)[a]. The association between catastrophizing and pain has been demonstrated in various conditions across patients groups and healthy samples.

Examples include: experimental cold pressor task (Sullivan, Tripp, Rodgers & Stanish, 2000); burn dressing changes (Haythornthwaite, Lawrence & Fauerbach, 2001);

menstrual pain (Walsh, LeBlanc & McGrath, 2003); anterior cruciate ligament repair surgery (Pavlin, Sullivan, Freund & Roesen, 2005); elective abdominal surgery (Granot & Goldstein Ferber, 2005); temporal summation of thermal pain experiment (Edwards, Smith, Stonerock & Haythornthwaite, 2006); post-caesarean section (Strulov, Zimmer, Granot, Tamir, Jakobi & Lowenstein, 2007); muscle pain provoked by using a hand grip device (Weissman-Fogel, Sprecher & Pud, 2008); experimental phasic heat stimuli (Kunz, Chatelle, Lautenbacher & Rainville, 2008; Weissman-Fogel *et al*., 2008); headache (Buenaver, Edwards, Smith, Gramling & Haythornthwaite, 2008); shoulder pain (George, Wallace, Wright, Moser, Greenfield III, Sack, Herbstman & Fillingim, 2008); chronic widespread musculoskeletal pain in chronic fatigue syndrome patients in a bicycle ergometric test (Nijs, Van de Putte, Louckx, Truijen & De Meirleir, 2008); labour pain (Flink, Mroczek, Sullivan & Linton, 2009); osteoarthritis of the knee (Somers, Keefe, Pells, Dixon, Waters, Riordan, Blumenthal, McKee, LaCaille, Tucker, Schmitt, Caldwell, Kraus, Sims, Shelby & Rice, 2009); rheumatoid arthritis (Edwards, Giles, Bingham III, Campbell, Haythornthwaite & Bathon, 2010); hypersensitivity to cold stimuli in whiplash injuries (Rivest, Côté, Dumas, Sterling & De Serres, 2010); hand fracture pain (Keogh, Book, Thomas, Giddins & Eccleston, 2010); knee arthroplasty (Riddle, Wade, Jiranek & Kong, 2010) and evoked pain intensity ratings during neurodynamic testing (Beneciuk, Bishop & George, 2010).

Catastrophizing, pain behaviour and disability

Catastrophizing is widely recognised as a crucial risk factor, not only for enhanced pain reports, but also for adverse pain-related outcomes. *Catastrophizers* display longer recovery after surgery from total knee replacement (Kendell, Saxby, Farrow & Naisby, 2001), more symptom numbers and severity in upper respiratory tract illness (Devoulyte & Sullivan, 2003), more specialist consultation, use of pain medication and absenteeism or work disability in musculoskeletal pain (Severeijns, Vlaeyen, van den Hout & Picavet, 2004), higher levels of functional disability/reduced daily activities (Whyte & Carroll, 2004; Swinkels-Meewisse, Roelofs, Oostendorp, Verbeek & Vlaeyen, 2006; Somers *et al*., 2009), decreased postnatal social functioning (Goldstein Ferber, Granot & Zimmer, 2005), greater attentional interference in an auditory discrimination task (Vancleef & Peters, 2006), more communicative and protective pain behaviours in chronic musculoskeletal pain sufferers in a simulated occupational lifting task (Thibault, Loisel, Durand, Catchlove & Sullivan, 2008), poor physical recovery after labour (Flink *et al*., 2009), greater emotional distress in musculoskeletal pain (Turner, Jensen & Romano, 2000; Lee, Wu, Lee, Cheing & Chan, 2008) and in cancer pain (Bishop & Warr, 2003) and higher levels of facial pain expressions/verbalisations in chronic pain (Vervoort, Goubert, Eccleston, Vandenhende, Claeys, Clarke & Crombez, 2009).

Additionally, *pain catastrophizing* is thought to have a communal function. Sullivan introduced the idea that catastrophizing also has interpersonal consequences because those who catastrophize about pain, experience pain as threatening, and feel helpless in dealing with it, they may seek to solicit social support and empathic reactions from people close to them (Sullivan *et al*., 2001)[a]. Pain behaviour, such as guarding or holding, may then be the vehicle through which high *catastrophizers* attract the attention of others and promote others' proximity and care (Sullivan *et al*, 2004[b]; Sullivan, Martel, Tripp, Savard & Crombez, 2006). *Catastrophizers* are also more likely to feel entitled to pain related support (Cano, Leong, Heller & Lutz, 2009). Interestingly, however, they ironically elicit negative responses from close others (*ibid*.).

The effects of pain catastrophizing on dental pain

As stated earlier, catastrophizing is one of robust determinants of intensified pain in general, and surgical removal of third molar is the most common procedure in oral surgery (Yusa *et al*, 2004). Nevertheless, there have been limited studies on how *pain catastrophizing* influences perception of pain in dental settings. The following are the studies by Sullivan and colleagues (Sullivan & Neish, 1998; 1999; Sullivan *et al*., 2004[a]), showing that catastrophizing is a significant predictor of pain also during dental treatments.

Sullivan and Neish (1998) studied the influences of catastrophizing over pain perception during dental scaling procedure. The researchers also looked at whether catastrophizing was distinct from well-established dental anxiety in predicting physical and emotional distress, and if this is the case, which construct of catastrophizing can be a determinant of dental pain. Dental patients scheduled for a scaling procedure filled in the measures for catastrophizing, dental anxiety and pain intensity after their treatments. It was shown that catastrophizing significantly accounted for pain ratings beyond dental anxiety. The *rumination* construct was found to be the strongest predictor of pain intensity.

Sullivan and Neish (1999) also evaluated the effects of emotional disclosure on dental pain in *catastrophizers* and *non-catastrophizers*. Patients having a scaling and root planing procedure were assigned to a disclosure condition or to a control condition prior to their treatments. In a disclosure condition, patients were asked to write about the thoughts and feelings they found most distressing during typical dental treatments. It was shown that in the control condition *catastrophizers* reported more pain than *non-*

catastrophizers, whereas in the disclosure condition *catastrophizers* and *non-catastrophizers* no longer differed in their pain ratings.

Sullivan *et al*. (2004, study 2)[a] explored how anxiety, fear of pain and catastrophizing have their impact on pain experience in dental patients undergoing hygiene scaling procedure. Patients completed measures of state/trait anxiety, fear of pain and catastrophizing one week prior to their treatment. It was found that catastrophizing was correlated with, but independent construct from fear of pain, and was predictive of pain over and above fear of pain.

Reason to study pain catastrophizing

It is evident from the many preceding examples that catastrophizing leads to greater pain, disability and a decrease in activity. It seems to be a better predictor of ability to adapt to pain experience than severity of illness, pain intensity, age, sex, depression or anxiety (Sullivan *et al*., 2001[a], Keefe *et al*., 2004). Moreover, a study with fMRI has shown that catastrophizing had an impact on the cerebral activity involved in pain modulation. For example, fibromyalgia sufferers with high catastrophizing tendencies, as opposed to low catastrophizers, displayed unique neural activation as responses to blunt pressure in the contralateral ACC and the contralateral and ipsilateral lentiform (Gracely, Geisser, Giesecke, Grant, Petzke, Williams & Clauw, 2004). For that reason, it is essential to identify catastrophizers to develop an intervention directed at reducing catastrophizing thoughts for pain management.

1-1-7. Expectation of pain

Anticipated dental pain

Fear of any anticipated pain can be worse than the actual pain itself. People, in particular anxious individuals, tend to overestimate the severity of aversive experience such as pain. It is widely accepted that acute pain experience is influenced by contextual information. That is, negative contextual information and memory can give rise to cognitive exaggeration of pain perception by affecting expectation, attention, arousal, stress and mood. Accordingly, a thought about going to the dentist or the sound of a dental drill may evoke autonomic representation of dental pain without any underlying condition or actual treatment stimuli. Interestingly, a recent functional neuroimaging study (Said Yekta, Vohn & Ellrich, 2009) revealed a corresponding activation of pain-sensitive brain areas in the absence of noxious stimuli in subjects experiencing a virtual dental treatment. The simulation of dental treatment induced a cortical activation pattern that was associated with the pain-related neural network such as the cingulate cortex, the IC, S1 and S2.

Factors contributing to overprediction of pain

It has been suggested that overprediction of anticipated dental pain can be the results of distortion in recall of pain-free treatment, intermittent experience of sudden severe pain, expecting pain in order to reduce its impact, or uncertainty about treatment (Lindsay & Jackson, 1993).

Expected pain and experienced pain

Research into the prediction of acute dental pain suggests that the tendency to overpredict aversive stimuli is ubiquitous.

Arntz, van Eck and Heijmans (1990) investigated the relationships between expectations and experiences of pain in patients going through extensive dental treatments which consisted of placement of crowns, root canal work and placement of fillings. There were found to be more cases of over-predictions than under-predictions of pain. Especially, anxious patients expected more pain and anxiety than they experienced.

The relationship between gender, dental pain prediction and pain memory under periodontal surgery treatment was studied by Eli, Baht, Kozlovsky and Simon (2000). In all, those patients, having single tooth crown lengthening, were found to predict higher levels of pain than they recalled to have experienced. Interestingly, men, more than women, tended to overpredict pain pre-operatively and underevaluate it post-operatively.

Watkins, Logan and Kirchner (2002) compared the levels of anticipated and experienced pain of patients who received endodontic therapy. It was reported that on the whole, patients actually experienced less pain and unpleasantness than they anticipated. Before the therapy 43% of all patients anticipated high outcome levels, yet only 22% experienced high pain levels, and only 18% experienced high unpleasantness levels.

As seen in the study by Klages *et al*.'s (2004) in 1-1-3. *Dental anxiety* section, the authors also showed that patients undergoing tooth extractions and root canal treatments expected more affective, sensory and intensity of pain than they subsequently experienced.

Similarly, Klages *et al*. (2006) looked at the interaction effects of anxiety sensitivity and dental fear over expected and experienced pain in patients having restorative dental procedures such as excavation and filling. They concluded that especially those with elevated anxiety sensitivity are prone to exaggerated pain expectations when the anticipated challenge situation is perceived as fear relevant.

van Wijk and Hoogstraten (2005) looked at patients having periodontal probing. It was found that patients expected more pain than they experienced, and that this effect is stronger in a group with higher dental anxiety scores.

Muglali and Komerik (2008) examined factors causing dental anxiety in patients undergoing minor oral surgery. Amongst those factors, the researchers reported that the patients' perceived pain experience during the operation was significantly lower than their pain expectation.

1-1-8. Social desirability (defensiveness)

Social desirability

The amount of pain that individual people report is different, even when in the same or similar situations or conditions. Their reports vary considerably both in a clinical setting and in an experiment. While a patient's or a subject's self-report remains as the primary means of assessing pain, there is increasing evidence to suggest that this methodology may not be a satisfactory way of eliciting information. It is, therefore, essential to explore factors likely to influence the quality of this information for a better understanding of the sufferer's overall pain experience.

One such factor is *social desirability*. *Social desirability* can be viewed as a tendency to present oneself favourably, or to obtain approval by responding in a culturally and socially acceptable manner (Crowne & Marlowe, 1960). Or else, a style of responding to questionnaire items that results in an inaccurate self assessment due to some combination of minimising negative qualities by denial of common faults and maximising positive qualities by endorsement of uncommon virtues (Kurtz, Tarquini & Iobst, 2008). Overall, socially desirable responding (SDR) was characterised by "conventional, polite, acceptable behaviour" (Crowne & Marlowe, 1964).

The construct has evolved over time, and has been used to indicate either (1) a characteristic of certain fake responses, or (2) an individual response style that is characterised by underreporting of negative aspects to obtain approval and acceptance from others (Willebrand, Wikehult & Ekselius, 2005). However, later Crowne and Marlowe (1964), the authors of the Marlowe-Crowne Social Desirability Scale (M-C SDS; Crowne & Marlowe, 1960), considered the socially desirable responses to their scale to represent a personality trait. In other words, *social desirability* can be regarded as a stable tendency of the individual that could be associated with other individual difference variables (Gravdal & Sandal, 2006). Indeed, *social desirability* seems to be more evident among women (Lane, Merikangas, Schwartz, Huang & Prusoff, 1990) and among well-educated individuals (Porter, Phillips, Dickens & Kiyak, 2000). According to the authors, their scale reflects the individual's habitual response style and the goals and expectations that are aroused in situations of self-evaluation. They considered that a single construct underlies their scale and named it *need for approval*. The scale purportedly puts the individual in an evaluation situation, and his/her needs for approval are measured by the way he/she responds to the scale (Crowne & Marlowe, 1964).

Social desirability scales

Naturally, SDR confounds research results by creating false relationships or obscuring relationships between variables. As a result, *social desirability* scales were developed to detect, minimise and correct for SDR in order to improve the validity of questionnaire-based research. Amongst them, the most widely used and cited *social desirability* response scale is the M-C SDS which measures one form of response bias: *social desirability* (Crowne & Marlowe, 1964). The M-C SDS became a popular alternative to the *social desirability* scales, such as the Edwards Social Desirability Scale (Edwards, 1957), derived from items on the well-known clinical instrument, the Minnesota Multiphasic Personality Inventory (MMPI; Dahlstrom & Walsh, 1960).

Nevertheless, the lack of clear dimensionality in the *social desirability* scales has been a concern since the early days of *social desirability* measurement (Uziel, 2010). More recently, Paulhus (1984, 2002) identified and labelled two largely orthogonal dimensions of socially desirable responding: *self-deception enhancement* (SDE) and *impression management* (IM). The Balanced Inventory of Desirable Responding (Paulhus, 1984; 1998) was developed specifically to measure conscious and unconscious deception by these two separate scale components. Paulhus (1991) defined SDE as the tendency to give honest but positively biased self-reports and IM as the intentional faking of responses to create a socially desirable image. However, recently, Paulhus (2002) modified the definition of IM to a habitual presentation of a favourable public image, which implies that both of these constructs are stable personality traits. Most recently, the redefinition for IM was proposed by Uziel (2010) as interpersonally oriented self-control that identifies individuals who demonstrate high levels of self-control, especially in social contexts.

The effects of social desirability on health

It has been well documented that *social desirability* can influence physiology. Examples include: increased antibody titers to Epstein-Barr viral capsid antigen (Esterling, Antoni, Kumar & Schneiderman, 1993); heightened skin conductance levels (Benjamins, Schuurs & Hoogstraten, 1994); increased basal salivary cortisol levels (Brown, Tomarken, Orth, Loosen, Kalin & Davidson, 1996); elevated resting blood pressures in daily hassles and life events (Nyklíček, Vingerhoets, van Heck & van Limpt, 1998); raised naloxone (opioid antagonism)-induced hyperalgesia and resting plasma β-endorphin levels in electrocutaneous stimulation (Jamner & Leigh, 1999) and lowered levels of natural killer cells in the immune system (Benight, Harper, Zimmer, Lowery, Sanger & Laudenslager, 2004). *Social desirability* has also been linked to high arousal during colonoscopy (Fox, O'Boyle, Lennon & Keeling, 1989) and poorer perceived health after burn injuries (Willebrand, Wikehult & Ekselius, 2005).

The effects of social desirability on pain perception

There has been evidence which indicates that *social desirability* may influence how pain is perceived. Four studies found are shown below.

Marino, Gwynn and Spanos (1989) investigated cognitive mediators in reducing cold pressor pain in healthy individuals. Subjects were assessed for their pain expectancy and "self-presentation". After the first cold pressor task, they were given one of four cognitive strategies: neutral-distraction/neutral-imagery; negative-distraction/positive-imagery; positive distraction/negative-imagery and a control, for the following tasks. It was reported that for subjects given positive or neutral expectancy information, *social* *desirability* predicted significant amounts of variance in pain reduction scores on the imagery and distraction trials.

Deshields, Tait, Gfeller and Chibnall (1995) looked at the role of *social desirability* in self-reported chronic pain of low back, neck and extremities. Subjects with greater *social desirability* reported less distress and higher levels of pain than less defensive individuals. More defensive individuals presented themselves as more disabled by pain.

Jamner and Leigh (1999) examined whether self-deception and defensiveness would be associated with pain perception and these associations would be reversible through opioid blockade by naloxone. Judgments of the painfulness of ascending series of electrocutaneous stimulation applied to the forearm were determined before and after the administration of naloxone and placebo in healthy subjects. For those scoring high on self-deception, naloxone significantly lowered the thresholds for discomfort and pain. This effect was not present in low self-deceptors, or under placebo conditions.

Greenberg, Dowling, Hatcher, Cox, Marcus and Paget (1999) examined whether "emotion-management styles" predict higher pain and disability in fibromyalgia patients. It was reported that repressors reported more baseline pain than non-repressors.

In all, *social desirability* appears to be positively related to pain severity in chronic pain patients, but negatively related to pain perception in acute pain sufferers. This could be because acute experimental pain sufferers with high *social desirability* may fail to manifest the nociceptive sensation in order to preserve their favourable images as a healthy and well-maintained person. In contrast, defensive chronic pain sufferers may not hesitate in exhibiting their physical distress to seek support from others. As originally promoted by Freud, individuals who were unable to express feelings of fear, sadness and anger would reveal their sufferings in the form of physical pain through a process of *conversion* (Breuer & Freud, 1955). Similarly, it is claimed that when chronic pain sufferers fail to express emotional distress, physical pain becomes a more comfortable reason than emotional pain to secure attention from others (Szasz, 1957). Articulating physical suffering, therefore, does not taint those defensive sufferers' socially desirable self-images.

The effects of social desirability in dentistry

Individuals with high degree of *social desirability* have shown short-term tolerance of acute experimental pain but long-term sensitivity to chronic pain. It is interesting to know, therefore, how these defensive people cope with acute clinical pain which may cause real harm. There has been no studies on how *social desirability* influences specifically dental pain for the last five decades since the M-C SDS was developed by Crowne and Marlowe (1960). One study, however, have looked at the effects of *social desirability* on dental distress.

Similarly, Benjamins *et al*. (1994) explored the relationship between self-reported dental anxiety, Marlowe-Crowne defensiveness and electrodermal activity in patients who had a dental check-up. The patients were categorised into four groups: *low defensive-low anxious*; *high defensive-low anxious*; *low defensive-high anxious* and *high defensive-high anxious*. The patients were assessed just before a dental check-up (stress measure) and two months later (baseline measure). The authors found that the *high defensive-low anxious* group had a significantly higher skin-conductance level and frequency of non-specific fluctuations during baseline and stress measurements than the *low defensive-low anxious* group. In contrast, *the low defensive-high anxious* group showed significantly more non-specific spontaneous fluctuations than the high defensive-high anxious group.

Reasons to study social desirability

As research findings suggest, *social desirability* appears to have negative effects on health outcomes by influencing bodily processes. Moreover, individuals with high *social desirability* may distort results in questionnaire-based health psychology studies by answering many self-report measures in a positive fashion. *Social desirability* bias may be particularly potent when patients complete self-report forms as part of their initial contact with the medical team, as is typically the case in most pain clinic settings (Deshields *et al*, 1995). This, in turn, could interfere with outcomes of studies and clinical treatments. It is, therefore, essential to explore the effects of *social desirability* on how the physical complaint, in this case, pain is perceived, interpreted and expressed.

1-1-9. Monitor-blunter style coping

Monitors and blunters

Theories on the topic of coping have identified two characteristic ways that individuals respond cognitively, emotionally and behaviourally to potentially distressing or threatening information: “attention” and “avoidance” (Bijttebier, Vertommen & Steene, 2001) in terms of information seeking and information avoidance. While there are other theoretical frameworks corresponding to these conceptions such as *sensitization-repression* (Byrne, 1961), *attention-rejection* (Mullen & Suls, 1982) and *vigilance-*

cognitive avoidance (Krohne, 1986), the construct of *monitoring* and *blunting* coping styles was developed by Miller (e.g., Miller, 1980). Hence, the Miller Behavioral Style Scale (MBSS; Miller, 1979, 1987) assesses levels of *monitoring* (i.e., the tendency to seek out knowledge about the threat) and levels of *blunting* (i.e., the tendency to distract oneself from threat relevant information).

For example, if an individual encounters an aversive situation such as major surgery they react with arousal depending on the amount of attention they direct to the stressor. They can lower such arousal by reducing the impact of threat cues by using such strategies as distraction, denial or re-interpretation. These strategies are called *blunting* and appear to be adaptive if the situation is out of control of the individual. On the other hand, *monitoring* strategies appear to be more adaptive if some degree of control over the situation is available. The strategies in this case include seeking information about the stressor, *monitoring* the source of stress. *Monitoring* strategies tend to be more effective because although they cause initially increased arousal they allow the individual to gain control over the stressor in the long term and therefore reduce the impact of threat. Miller (1996) established that in the face of a health threat, those who have been identified as *monitors* wanted to know more and those identified as *blunters* wanted to know less.

Although the styles are conceptualised as opposite tendencies, Miller (Miller, Brody & Summerton, 1988) claims they are independent: individuals can use either at different moments. Among *monitors* and *blunters*, Miller (1987) characterised four groups: high *monitors* (*information seekers*), low *monitors* (*information avoiders*), high *blunters* (*distractors*) and low *blunters* (*non-distractors*).

Conceptualisation of monitoring and blunting

In an attempt to conceptualise the effects of dispositional *monitoring* and *blunting*, Miller (Miller, Roussi, Caputo & Kruus, 1995) developed the Monitoring Process Model (MPM). The MPM proposes that *monitors* and *blunters* differ in the way in which they encode or construe threatening situations. That is, *monitors* are more inclined to scan for internal and external threatening cues and access them readily. This process generates a high degree of intrusive ideation about the stressor. In addition, *monitors* tend to encode neutral or ambiguous information as highly threatening and ruminate on this information, leading to exaggerated perceptions of personal risk. The high level of perceived risk and the high degree of intrusive ideation may result in heightened anxiety and distress.

Measurement of monitoring and blunting

The levels of *monitoring* and *blunting* are measured by the MBSS (see 2-2. *Measures* in CHAPTER 2. *Method* for details). The MBSS consists of four scenarios, e.g., a possible lay-off at work, rough ride on an aeroplane, undergoing dental treatment and being held a hostage. Examples include: "Vividly imagine that, due to a large drop in sales, it is rumoured that several people in your department at work will be laid off". Following the example are eight coping options, half of them reflecting *monitoring* – e.g., "I would talk to my fellow workers to see if they knew anything about what the supervisor's evaluation of me said", and half of them reflect *blunting* – e.g., "I would go to the films to take my mind off things".

One of the problems with the MBSS is that it contains only uncontrollable fictitious situations, where *monitoring* may be unadaptive and *blunting* may be seen as more adaptive in such situations. The concept of *monitoring* and *blunting* is widely applied in the health field, so it may be more sensible to have scenarios reflecting these situations, with some controllable and some uncontrollable.

Monitoring and blunting on pain perception

Hence, patients with continuing pain problems are often assumed to be excessively attentive for their symptoms, and this is referred to as hypervigilance (Van Damme, Legrain, Vogt & Crombez, 2010). Chapman (1978) was one of the first researchers who applied the concept of hypervigilance in the context of pain. He argued that individuals who associate bodily sensations with danger will display a perceptual habit of scanning the body for threat. This idea has been applied in several clinical pain disorders.

For example, it has been claimed that patients with fibromyalgia, characterised by chronic widespread pain and allodynia, are typified by increased attention to a variety of bodily sensations and in particular pain (Peters, Vlaeyen & van Drunen, 2000). A similar mechanism has also been assumed in patients suffering from chronic low back pain. In the Fear-Avoidance Model of Musculoskeletal Pain (Vlaeyen & Linton, 2000), those patients who fear their pain or further injury are at risk for developing chronic problems (see 1-1-5. *Pain catastrophizing – The nature of pain catastrophizing*). This model assumes that fearful patients become increasingly vigilant for signals of bodily threat, which in turn leads to avoidance behaviour and increased disability (Leeuw et al., 2007).

A clinically popular idea is that pain is more intense in persons who are hypervigilant for or bias their attention to pain information (Van Damme *et al*., 2010). Consequently, people generally prefer distraction to other coping strategies because they believe it would help them distracting attention away from pain. Distraction is believed to reduce pain based on two assumptions (McCaul & Malott, 1984): that pain perception is an effortful process that requires attention to the noxious stimulus for it to cause distress and that due to limited attentional capacity, if some task draws enough attention away from the noxious stimulus, less distress should be experienced. Nevertheless, distraction does not always work (Van Damme *et al*., 2010). There is evidence, in fact, that attention to the physical sensations may be more effective for reducing psychological distress under some conditions (see Baron *et al.*, 1993; Logan *et al.*, 1995 in 1-1-4. *Dental control – Interventions on individuals with high desired/low felt*).

The Leventhal's (1982, 1990) theory of parallel processing of stress-related stimuli provides a theoretical framework to explain these controversial findings (see 1-1-4. *Dental control – Interventions on individuals with high desired/low felt*). It asserts that the affective and sensory aspects of the painful stimulus contribute independently to the experience of pain, and that attention can determine which aspect of the experience dominates. Individuals form a schema of the pain experience that functions as an attention selector, determining which aspects of the pain experience will enter focal awareness. As pain is typically associated with distress, this model assumes that, for most people, the pain schema is a distress schema. When an individual's attention is focused on the sensory features of the stimulus, however, the existing schema is overridden and the experience is constructed mainly in terms of its sensory features, with the negative emotional aspect of the experience downplayed.

Positive and negative effects of monitoring and blunting on health

In line with the MPM, the cognitive-social health information-processing (C-SHIP) model proposed by Miller, Shoda and Hurley (1996) describes how individuals process health information cognitively and emotionally and how it, in turn, motivates health behaviours. Further, the C-SHIP model describes the monitor-blunter coping style as a stable individual difference in how individuals attend to and process health information.

Monitors are more concerned and distressed about their risk for disease, including cancer (Miller, Roussi, Altman, Helm & Steinberg, 1994). They scan for and amplify threatening cues in health information and worry about these threats or risks for extended periods of time (Miller, 1995). When facing a health threat, for high *monitors*, information might clarify their situation, enable them to attach appropriate meanings to experiences and to work through their experiences (Miller *et al*., 1988). In other words, *monitors* benefit from the elucidation of present and future health issues (i.e., “predictability”) and may take appropriate actions based on this new-found “controllability” (van Zuuren & Wolfs, 1991). However, they might also remain focused on the negative aspects, thus sustaining high arousal levels (Timmermans, van Zuuren, van der Maazen, Leer & Kraaimaat, 2007). Indeed, *monitors* are reported to experience greater anxiety about health risks and ruminate about threatening information (Miller, Rodoletz, Schroeder, Mangan & Sedlacek, 1996). In addition, interestingly, as to medical consultations, high *monitors* appear not only to desire more extended information than high *blunters*, they also value kindness and respect by their doctors more (Miller *et al*., 1988).

Blunters, in contrast, do not seek detailed information about their health risks or medical condition. They are more likely to follow health and medical directives if provided with less comprehensive information, particularly less-threatening information (Miller, 1995). They generally find a greater quantity of information to be stressful, especially if it includes statistics and risk factors and, therefore, they “blunt” or block it from their attention (Williams-Piehota, Pizarro, Schneider, Mowad & Salovey, 2005). Thus, *blunters* may avoid medical screening procedures or choose not to engage in important health behaviours depending on how health information is presented and, consequently, interpreted by them (Miller, 1996). Accordingly, *blunters,* preferring distraction, relaxation and reinterpretation strategies, benefit from processing the aversive events in a less negative fashion, although uncertainty can remain high (Miller *et al*., 1988). Additionally, *blunters* risk developing pathological avoidance behaviour due to their reluctance to confront the stressor (Timmermans *et al*., 2007).

In general, medical patients appear to fare best when their coping styles are matched with the amount of information provided to them. That is, high *monitors* are less anxious if they receive ample medical information, attention and reassurance, while high *blunters* are content with basic medical information and need little else (Miller & Mangan, 1983; Miller *et al*., 1988; Miller, 1995; Williams-Piehota, Pizarro, Schneider, Mowad & Salovey, 2005). Accordingly, patients benefit from communication that is tailored to their cognitive coping styles.

The effects of monitoring and blunting in dentistry

There have been a limited number of studies investigating the effects of *monitoring* and *blunting*, in particular, in dental treatments for the last 30 years since the styles of coping were conceptualised by Miller (Miller, 1980). Two studies examined the effects of *monitoring* and *blunting* on dental treatments.

Muris, de Jongh, van Zuuren, ter Horst, Deforchaux and Somers (1995) explored the effects of *monitoring* and *blunting* styles of coping measured by the MBSS over dental distress and pain brought by dental procedures such as fillings, a root canal treatment or placement of crowns. Contending that giving a patient a choice of coping strategy according to his/her coping style enhances the effectiveness of intervention, half of the patients were given the possibility of choice, whereas the other half was forced into one of the two strategies without knowing about an alternative strategy. The patients received either *monitoring* or *blunting* instructions through headphones during the treatment. Their dental anxiety, pain levels and self-efficacy were measured. Neither the kind of intervention nor the possibility of choice had a substantial difference in effectiveness on pain perception. However, in general, *monitoring* strategies were found to be more effective in reducing distress during the treatment.

Similarly, the researchers (Muris, de Jongh, van Zuuren & Schoenmakers, 1996) investigated whether *monitoring* and *blunting* coping styles were associated with cognitive symptoms of dental fear. Subjects were dental phobics attending at a dental fear clinic, and were assessed for dental anxiety, negative thinking about dental treatment, cognitive control for negative thoughts and *monitoring* and *blunting* coping styles. It was reported that *monitoring* was positively related to the frequency and believability of negative thoughts about dental treatment, and negatively with the ability to control such thoughts. The opposite pattern was found for *blunting*. That is, *blunting* correlated negatively with the frequency and believability of negative thoughts, whereas a positive association emerged with cognitive control.

1-1-10. Dentists' perception of patients' pain

Expectation or fear of pain in dental treatments has been identified as a major barrier to the seeking of dental care (Dionne, Gordon, McCullagh & Phero, 1998). Naturally, research on dental pain has focused on mainly patients' perioperative pain experience in dental procedures. Patients' perception of pain is often different from their clinicians' ratings. It is important, therefore, to explore and understand dentists' view of their patients' pain in contrast to that of patients. Such an understanding will help clinicians to provide a supporting environment which may, in turn, encourage patients for seeking necessary dental treatments, and improve the outcome of the treatments.

Evidence indicates that there are differences in perceived pain levels between health care providers and patients with the former underestimating their patients' pain in such cases as severe burn injuries (Choinière, Melzack, Girard, Rondeau & Paquin, 1990) and cancer (Grossman, Sheidler, Swedeen, Mucenski & Piantadosi, 1991; Cleeland, Gonin, Hatfield, Edmonson, Blum, Stewart & Pandya, 1994). A previous study shows that dentists also underrate their patients' pain (Watkins *et al*., 2002).

Watkins *et al*. studied patients' pain perception in endodontic therapy. The patients rated the levels of anticipated and experienced pain before and after their treatments, and the dentists evaluated their patients' pain perceived during the treatments. It was found that patients' experienced pain was not parallel to the dentists' ratings with the dentists undervaluing the amount of pain their patients reported.

1-1-11. Mood states

It is argued that one of reasons why more progress has not been made in explaining psychological mechanisms through which people manage stress effectively is the exclusive focus on the coping efficacy in regulating *negative affect* (Folkman & Moskowitz, 2000). It is, indeed, important to explore *positive affect* in order to understand how people manage to minimise the negative consequences of stress and produce positive outcomes. Nevertheless, there are some issues.

It is true that interpretation of situation and events in positive ways and problem-focused coping lead to the occurrence and maintenance of *positive affect*. However, in the first place, what factor/s make people appraise stressful episodes in a positive manner and make them engage in problem-focused coping? Methodologically, it may be more difficult to focus on *positive affect* than looking at *negative affect*, because *positive affect* occurs less commonly than a negative one in adaptational processes. Hence, it is most likely that people under stress suffer from considerable *negative affect* which might make it more difficult to have *positive affect* at the same time (Baumeister, Faber & Wallace, 1999).

Moreover, individuals with positive distortion or illusion may respond to stressful events with an inflated sense of personal control and overly-optimistic expectations about the future (Snyder, Cheavens & Michael, 1999). These individuals may initially appraise an otherwise stressful situation as being non-stressful. In other words, they are not under stress in their own opinion. Thus, positive distortion/illusion can confound the outcomes of coping studies.

More importantly, one of the main methodological challenges is the reciprocal relationship between *positive affect* and coping. On the one hand, *positive affect* may be a predisposed factor, as in the case of people high in optimism. These individuals are more likely to engage in problem-focused coping, which, in turn, is more likely to be related to *positive affect* (Taylor, Kemeny, Aspinwall, Schneider, Rodriguez & Herbert, 1992). On the other hand, *positive affect* may be an outcome of coping efforts. Specifically, coping may influence changes in emotion as found by longitudinal studies (Carver & Scheier, 1994; Holahan, Holahan, Moos & Brennan, 1997; Moskowitz, Folkman, Collette & Vittinghoff, 1996). Hence, successful and adaptive coping can bring about *positive affect*. Consequently, whether *positive affect* in the midst of stressful episodes is a predisposed factor or an outcome of coping efforts is equivocal.

In methodology of studies into *positive affect*, there is another issue of the possible reactivity. It is claimed that monitoring coping behaviours may heighten people's awareness of their coping efforts, which may alter the very coping strategy or mood under study (Marco, Neale, Schwartz, Shiffman & Stone, 1999). In case of especially *positive affect*, self-monitoring may make individuals become anxious to have *positive affect*. Accordingly, when asked to report positive events and positive emotion, participants may feel more obliged to report positive affect than when asked to report a negative one. Thus, reporting positive affect can be more vulnerable to reactivity and also to demand characteristics.

For these reasons, in the current study, *positive affect* and *negative affect* will not be put forth as psychological predictors of dental pain. Still, mood states variables will be measured in order to establish whether they are associated with any other variables in a meaningful way. The measure used will be the Positive and Negative Affect Schedule (Watson, Clark & Tellegen, 1988) which is designed to assess mood states in real-time: "…indicate to what extent you feel this way right now, at this moment".

1-2. Model of psychological factors predicting dental pain

1-2-1. Components of multidimensional model of pain

Pain experience is a result of a multidimensional process involving physical, psychological and social factors. Since the multidimensional model of pain was proposed by Melzack and colleagues, the biopsychosocial conceptualisations of pain perception have played a crucial role in understanding the complex interaction among those factors which contributes to perception of pain. However, the predictive power of these models for pain experience and pain-related outcomes have been inadequate due to the scarcity of evidence that clarifies the relations of, in particular, the interacting psychological model components. That is, it remains unclear whether these factors independently, interactively or serially influence the level of pain which individuals experience. The analytical efficacy of biopsychosocial models, therefore, will increase as research begins to focus on more directly how different model constructs interplay to give rise to pain experience (Sullivan *et al*., 2004)[a]. It is toward this goal that the current line of research is aiming.

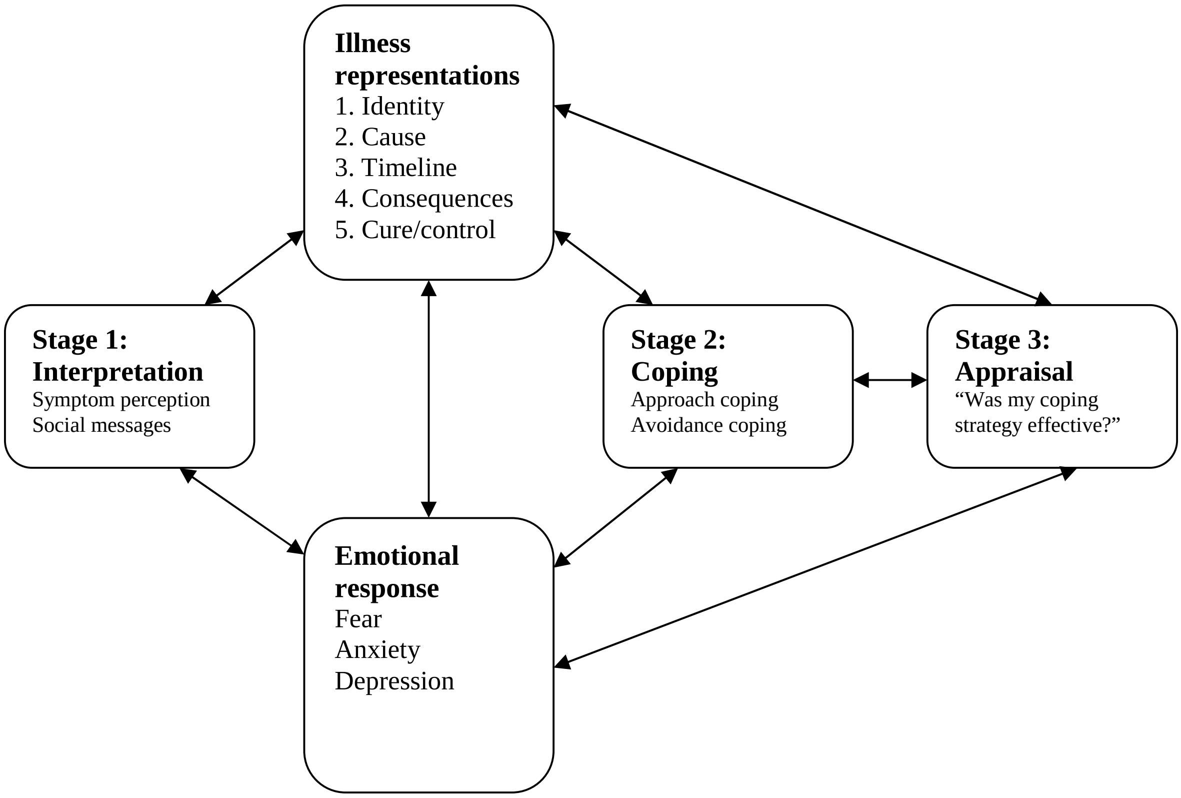
1-2-2. The self-regulation model of health and illness behaviour

The self-regulation model of illness cognition and behaviour, proposed by Leventhal and associates (Leventhal & Nerenz, 1985; Leventhal, Brissette & Leventhal, 2003), has been widely used to specify how illness cognitions (also called illness beliefs or illness representations) guide responses to illness-related experiences. They proposed that these cognitions provide patients with a framework or a schema for *coping with* and *understanding their illness* and *telling them what to look out for if they are becoming ill*. The model is often called the *common-sense model* because of its emphasis on personal, common-sense beliefs about illness.

The model is based on approaches to problem solving and suggests that illness/symptoms are dealt with by individuals in the same way as other problems. It is assumed that, given a problem or a change in the *status quo*, the individual will be motivated to solve the problem and re-establish their state of normality. It describes problem solving in three stages: (1) *interpretation* (making sense of the problem); (2) *coping* (dealing with the problem in order to regain a state of equilibrium) and (3) *appraisal* (assessing how successful the coping sate has been). These three stages will continue until the coping strategies are deemed to be successful and a state of equilibrium has been attained (see Figure 1-2-2: Leventhal's self-regulation model of illness cognition and behaviour).

The model identifies five key components of illness representations: *identity* (e.g., a set of symptoms such as pain, tiredness); *cause* (e.g., "Stress was a major factor in causing my illness"); *timeline* (e.g., "My illness will last a short time"); *consequences* (e.g., "My illness has had major consequences on my life") and *control/cure* (e.g., "There is a lot I can do to control my symptoms"). Illness representations develop from exposure to a variety of social and cultural sources of information – media stories, education in schools, personal experiences of illness in oneself and others and other experience (Cameron & Moss-Morris, 2010).

Figure 1-2-2: Leventhal's self-regulation model of illness cognition and behaviour



1-2-3. The Illness Perception Questionnaire

The Illness Perception Questionnaire (IPQ: Weinman, Petrie, Moss-Morris & Horne, 1996) is a theoretically derived measure comprising five subscales that provides information about the five key components that have been found to underlie the cognitive representation of illness. The questionnaire has been used in studies of illness adaptation in patients with a wide range of conditions, including heart disease, rheumatoid arthritis, cancer, psoriasis, chronic obstructive pulmonary disease, chronic fatigue syndrome, diabetes and Addison's disease (Moss-Morris, Weinman, Petrie, Horne, Cameron & Buick, 2002).

The IPQ was not used in the present study due to the following reasons. First, the IPQ was designed to assess the components of illness representations in chronic illness sufferers. Hence, its questions are not applicable to acute dental pain following a tooth extraction. The post-surgery pain or conditions are temporary, and are not associated with the same degree of threat, uncertainty and life disruption that accompanies the chronic illness conditions. Second, it is possible that the questions change or even form beliefs rather than simply assess them. Patients may not have a belief or an idea about having dental pain in terms of its effects on their daily activities, social life, finances and controllability of the conditions or speed of their recovery until they are asked about it, in particular, when expecting to be given an analgesic. Lastly, the model is complex, and each construct has no clear definition (Ogden, 2007). Hence, they may overlap each other. For example, a belief that "pain has no serious consequences" can be seen as either an illness cognition or a coping strategy.

There is a study (McCarthy, Lyons, Weinman, Talbot & Purnell, 2003) which used the IPQ on dental patients undergoing third molar extractions to establish its usefulness as a framework for predicting recovery outcomes. It was reported that preoperative expectations of symptoms predicted symptom severity after surgery, timeline expectations predicted return to work and expectations that recovery could be controlled predicted quality of healing. However, the conditions of their patients may have been more serious than the present sample, having had general anaesthetic, and were followed up at the seventh postoperative day.

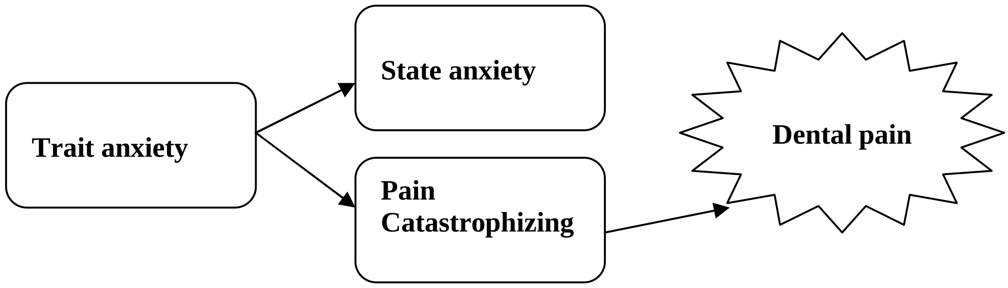
1-2-4. Hypothesised model of dental pain

A body of research points to personal control issues, negative emotional states such as anxiety, *expectation of pain*, *pain catastrophizing*, *social desirability* and coping styles including *monitoring-blunting* in the modulation of the sensory intensity of pain that is experienced.

There have been a few studies which explored specifically the interactions of psychological factors influencing dental pain: studies by Sullivan *et al*. (2004, study 2)[a] and by Gedney and Logan (2007).

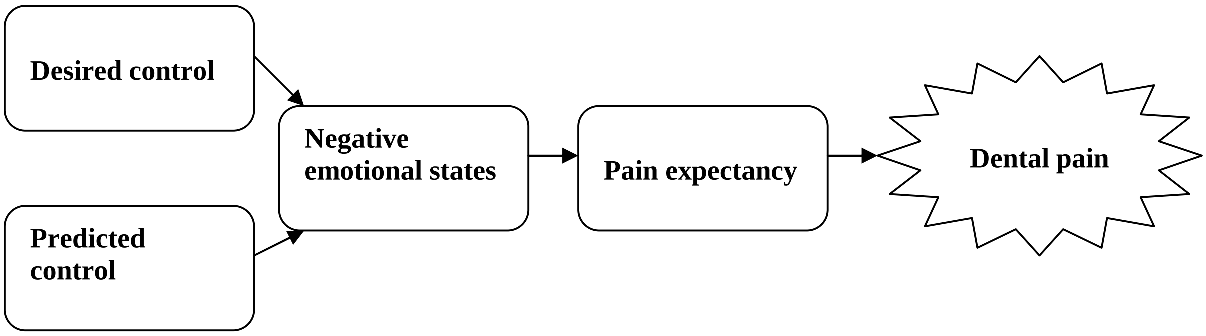
Sullivan *et al*. (2004, study 2)[a] explored how fear of pain and catastrophizing influence pain experience and how trait and state anxiety are related to these two constructs in dental patients undergoing hygiene scaling procedure. Patients completed measures of fear of pain, catastrophizing and state/trait anxiety one week prior to their treatment, and rated their pain intensity after the treatment. It was found that fear of pain and catastrophizing were correlated with pain intensity ratings, and fear of pain and catastrophizing were correlated with each other. Trait anxiety was correlated with catastrophizing but not with fear of pain or pain intensity. In particular, path analyses revealed significant paths from trait anxiety to state anxiety, from trait anxiety to catastrophizing and from catastrophizing to pain intensity (see Figure 1-2-4a: Sullivan *et al*.'s model of dental pain). Referring to a diathesis-stress model of chronic pain proposed by Turk (2002), the authors suggested that certain predisposing individual variables such as trait anxiety may increase the likelihood of a fear reaction and other interpretive cognitive process such as catastrophizing following surgery, thus increasing the likelihood of disability.

Figure 1-2-4a: Sullivan *et al.*'s model of dental pain



Gedney and Logan (2007) examined the mutual simultaneous association of psychological factors in the experience of dental extraction pain. The factors were: perception of personal control (i.e., desired control and predicted control); negative emotional states (i.e., state anxiety and negative affect) and pain expectancy. Patients having tooth extraction were assessed for these variables before their treatment, and they rated their level of worst pain after the treatment. It was shown that desire for control and predicted control contributed to negative emotional states which in turn predicted pain expectancy and ultimately pain intensity (see Figure 1-2-4b: Gedney and Logan's model of dental pain). The researchers claim from the view of the transactional model of stress developed by Lazarus and his colleagues that desire for control is analogous to a primary appraisal of threat about a stressful invasive procedure, and predicted control is analogous to a secondary appraisal of personal resources to tolerate the stressful exposure (see 1-1-1. *Dental control – Perceived control*). Accordingly, they argue that appraisals of threat (i.e., desire for personal control during treatment) and personal coping resources (i.e., prediction of having personal control during treatment) introduced risk for elevated pain through a pathway that includes negative emotional states and expected pain.

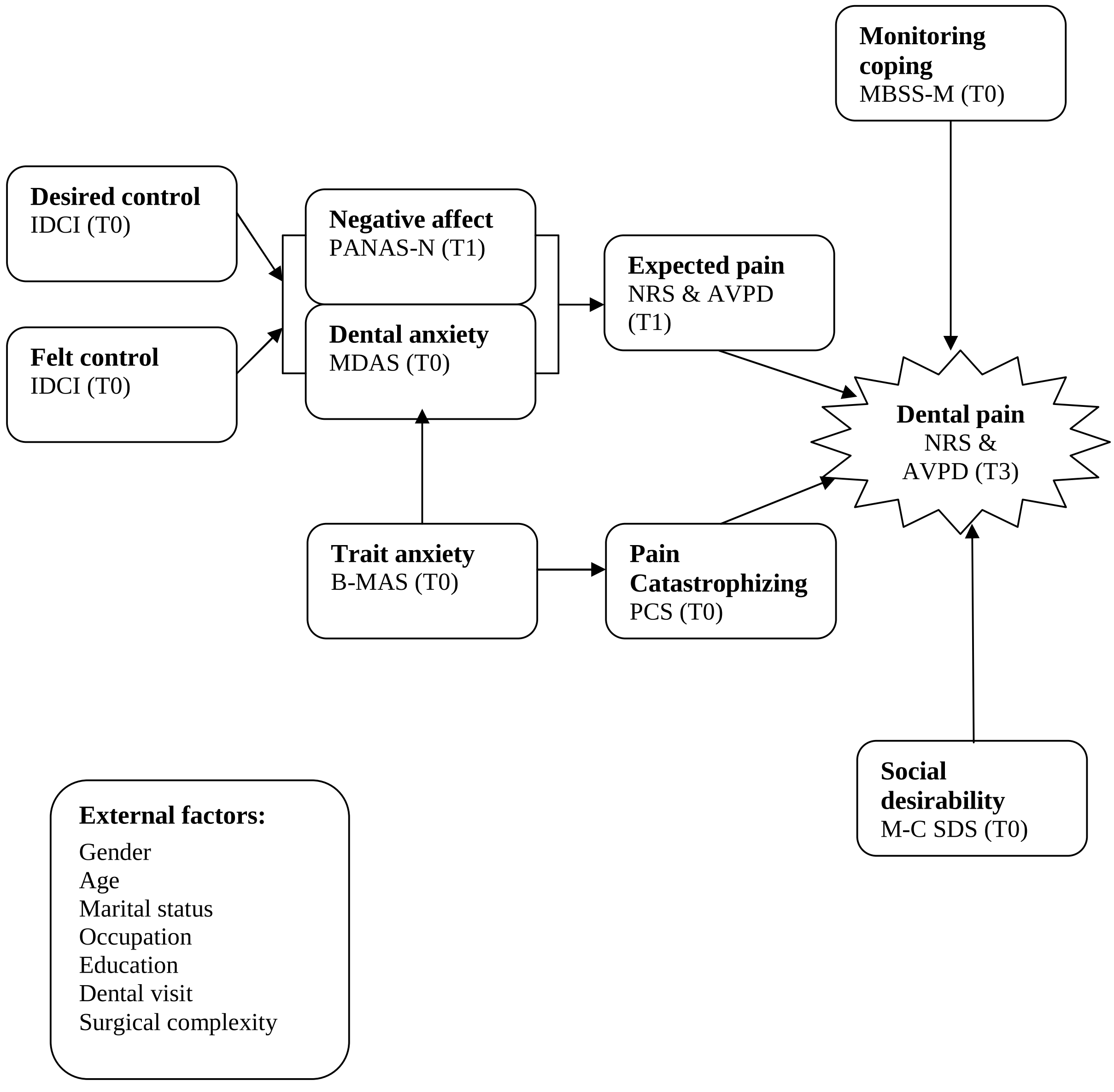
Figure 1-2-4b: Gedney and Logan's model of dental pain



The current model of dental pain perception is based on these two studies (see Figure 1-2-4c: Model of psychological factors predicting dental pain).

It was hypothesised that each of the psychological factors (e.g., *trait anxiety*, *negative affect*, *dental anxiety*, *dental control*, *pain catastrophizing*, *expectation of pain*, *social desirability* and *monitor-blunter style coping*) would independently predict the levels of dental pain experienced. From the studies by Sullivan *et al.*'s and Gedney and Logan it was hypothesised that *pain catastrophizing* and *expectation of pain* would be two of the strongest psychological predictors of dental pain. To date there have been no published studies combining all these factors in a causative model of pain perception. Accordingly, the structural relationships of the psychological variables were explored to identify causal pathways linking the key variables with dental pain intensity.

Figure 1-2-4c: Model of psychological factors predicting dental pain



1-3. Objectives of the study

1-3-1. To explore the effects of psychological factors on dental pain

It is now well-established that psychological variables play an important role in an individual's perception of pain. A dental surgery, involving anaesthetic injection and tooth removal such as in the present study, provides a more ecologically-sound setting for the investigation of naturalistic stress responses to pain. The dental procedures involve necessary and short-term discomfort, and therefore, are neither contrived nor unethical (O'Boyle & Fox, 1989).

Hence, this study is set to examine how various psychological factors influence patients' pain perception in an invasive dental procedure, i.e., tooth extraction. Specifically, such factors are *dental anxiety*, *dental control*, *pain catastrophizing*, *social desirability*, *monitor-blunter style coping* and *expectation of pain.* The study ultimately aims to identify psychological factor/s which most contributes to the levels of heightened pain perception. It is also to investigate how these psychological factors interact to bring to the elevated perception of pain.

1-3-2. Research questions

1. Which factor most contributes to the heightened levels of dental pain? Is it pain specific catastrophizing tendencies as in *pain catastrophizing*? Or, is it expectation of pain?

2. How does each psychological factor influence dental pain? What are the inter-relationships among these psychological factors?

1-4. Hypotheses

1-4-1. Effects of psychological factors on dental pain

It was hypothesised that:-

1. ***Dental anxiety***

   Patients with higher dental anxiety would report more pain than those with lower dental anxiety.

2. ***Dental control***

   Patients with higher desired control would report more pain than those with lower desired control. In comparison, patients with higher felt control would report less pain than those with lower felt control.

3. ***Pain catastrophizing***

   Patients with higher *pain catastrophizing* would report more pain than those with lower *pain catastrophizing*.

4. ***Expected sensory pain***

   Patients with higher sensory pain expectation would report more sensory pain than those with lower pain expectation.

5. ***Social desirability***

Patients with higher defensiveness would report less pain than those with lower defensiveness.

6. ***Monitor-blunter style coping***

Patients with higher monitoring tendencies would report more pain than those with lower monitoring tendencies. In contrast, patients with higher blunting tendencies would report less pain than those with lower blunting tendencies.

7. ***Dentists' perception of pain***

Dental surgeons would rate the levels of their patients' sensory pain lower than the patients would report.

1-4-2. Psychological predictors of dental pain

Pain catastrophizing and *expected sensory pain* would be the most robust psychological predictors of dental pain.

CHAPTER 2: Method

2-1. Pilot study

A pilot study was conducted to establish if the proposed study was viable in terms of the completion of the lengthy first set of questionnaires by participants in a busy hospital setting. The sets of questionnaires were given to 43 non-clinical subjects from the general population (26 male and 17 female) with the mean age of 31.68. The mean time they took to fill in the set of the questionnaires was 13 minutes 20 seconds. Accordingly, the participants were informed that the completion of the questionnaires would take about 15 minutes.

2-2. Ethics approval

Ethical approval to carry out this study was granted by the Eastman Dental Institute and Hospital Joint Research and Ethics Committee (UCLH Project ID Number: 03/E005) in April, 2003. A written consent to the study was obtained from each participant prior to their participation.

2-3. Participants

The sample consisted of 306 participants (144 male and 162 female) who were referred by their local dental practitioners for the surgical removal of tooth/teeth under local anaesthetic at the unit of Oral and Maxillofacial surgery at UCL Eastman Dental Institute in central London between June, 2003 and June, 2004. The tooth/teeth which needed extractions were not limited to the third molars. The reasons for the extractions varied, including caries, periodontal disease and recurrent infection.

Recruitment inclusion/exclusion criteria. The participants were to meet the following criteria: (1) between 18 and 65 years of age; (2) absence of any psychiatric disorder, evident depression, dementia or learning difficulties; (3) absence of any medical condition other than tooth/teeth-related and (4) proficiency in both written and spoken English. The absence of any medical or psychiatric condition is important, since psychosocial conditions derived from those illnesses other than the psychological factors in question may well influence the perception of pain.

For more detailed description of participants, see 3-2. *Descriptive statistics*/3-2-1. *Participants* section in CHAPTER 3: *Results*.

2-4. Measures: description and previous findings

The questionnaires used are described as follows.

2-4-1. Demographic information

The General Demographic Questionnaire (GDQ/Appendix 1) was designed by the author of the present study to obtain personal information such as gender, age, marital status (“Single/Living with a partner/Married/Separated/Divorced/Widowed”), occupation, education levels (“What is your highest educational qualification?) and the previous experiences of Eastman Dental Institute (“Have you ever come to this hospital before?” – “If yes, how often? – “Once/A few times/Several times/Often”).

The occupation was classified into 11 categories according to *The National Statistics Socio-economic Classification version No. 1.2*. (The Office for National Statistics, 2004). They included: 1. *Higher managerial and professional occupations*; 2. *Lower managerial and professional occupations*; 3. *Intermediate occupations*; 4. *Small employers and own account workers*; 5. *Lower supervisory and technical occupations*; 6. *Semi-routine occupations*; 7. *Routine occupations*; 8. *Never worked and long-term unemployed*; 9. *Full-time students*; 10. *Not Classified* and 11. *Retired*.

The educational qualification section was categorised into: 1. Doctorate and professional qualifications; 2. MPhil and Master’s degree; 3. Bachelor’s degree; 4. A-levels and HND; 5. GCSE and O-levels and 6. No education. The question on educational levels was asked, since a study (Maggirias & Locker, 2002) showed that dental patients with higher levels of education were more likely to report pain than those with a lower educational level.

2-4-2. Dental anxiety

The Modified Dental Anxiety Scale (MDAS: Humphris *et al*., 1995/Appendix 2) consists of five items to measure patients' trait anxiety in such hypothetical situations as dentistry. The MDAS was developed from The Corah Dental Anxiety Scale (CDAS; Corah, 1969) with four items. The respondent is asked to express his/her emotional reaction to a dental visit, waiting for treatment, drilling, scaling and local anaesthetic injection (e.g., "If you went to your dentist for treatment, how would you feel?"). Each response is scored by a simple numerical value ranging from 1 ("Not Anxious") to 5 ("Extremely Anxious"). The MDAS was chosen in place of the Corah's version, since the former includes a reference to a respondent's feelings towards a local anaesthetic injection which is ranked almost as highly as the drill in terms of causing fear and anxiety (Humphris *et al*., 1995). Similarly, the sight of the dental injection needle and the feeling of being injected are reported to be the most fear-producing stimuli (Erten *et al*., 2006; Vika *et al*., 2006; Vika *et al*., 2008). Further, the new multiple-choice answering method is succinctly the same for each question and is in clearer order of anxiety levels, unlike the CDAS in which answers differ among the questions, thus making them difficult to compare.

Reliability of the MDAS reported is good with the internal consistency as above 0.80 (Humphris *et al*., 1995; Humphris, Freeman, Campbell, Tuutti & D'Souza, 2000), and the test-retest reliability as also above 0.80 (Humphris *et al*., 1995). Furthermore, the concurrent validity of the scale is demonstrated by a high correlation coefficient of 0.85 between the CDAS and the MDAS (*ibid*.). Cronbach's alpha (Cronbach, 1951) of the MDAS in the present study was 0.88.

2-4-3. Dental control

The Iowa Dental Control Index (IDCI: Logan *et al*., 1991/Appendix 3) contains four items which measure patients' degree of desired and their felt (i.e., perceived) control over their dental treatments. Two items each are for the *Desire for Dental Control* subscale (e.g., "To what degree would you like control over what will happen to you in the dental chair?") and the *Felt Dental Control* subscale (e.g., "Do you feel that you have control of what will happen to you when you are in a dental chair?"). Each four item utilises a five-point Likert scale, the ends of which are labelled by polar opposite, e.g., "None" and "Total control". A respondent is instructed to rate how much control he/she desires to have and how much control he/she feels to have over the dental treatments. He/she receives a score on each subscale, and on the basis of median splits is then assigned to one of four categories: low *desired*/low f*elt*; low *desired*/high *felt*; high *desired*/low *felt* and high *desired*/high *felt*.

Felt control has been found to have high internal reliability with Cronbach's alphas=0.83 and 0.80 (Coolidge *et al*., 2005). However, the internal reliability of *desired control* has shown a greater variation with alphas=0.68 and 0.23 (Logan et al., 1991; Baron *et al*., 1993). The test–retest correlations were 0.51 for *desired control* and 0.36 for *felt control* (Brunsman *et al*., 2003). The alpha coefficients of the IDCI *desired* and *felt* subscales in the present study was 0.59 and 0.86 respectively.

In addition, the IDCI has been reported to have good discriminant and convergent validity (Coolidge *et al*., 2005). *Desired control* is positively correlated (r=0.36) with dental fear (Dental Fear Survey, DFS; Kleinknecht *et al*, 1973), while *felt control* is negatively correlated with such fear (DFS; r=-0.29). Moreover, *desired control* is positively correlated with general anxiety (state: r=0.39/trait: r=0.12, State-Trait Anxiety

Inventory; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983), while *felt control* is negatively correlated with anxiety (state: r=-0.31/trait: r=-0.12). No significant correlations were found for the general desire for control over life's events (Desirability of Control Scale; Burger & Cooper, 1979). With regards to generalised health locus of control (Multidimensional Health Locus of Control; Wallston, Wallston & DeVellis, 1978), no relationship was found for the "external" orientation (Chance and Powerful others). The ''internal'' orientation (Internal) was negatively correlated with *desired control* (r=-0.21) but unrelated to *felt control*. Finally, the scale is neither related to extraversion or neuroticism (Eysenck Personality Inventory; Eysenck & Eysenck, 1964), nor the need for cognition (Need for Cognition scale; Cacioppo, Petty & Kao, 1984). Taken together, these results provide additional evidence that the IDCI is measuring constructs related to the dental situation in particular (Brunsman *et al*., 2003; Coolidge *et al*., 2005).

2-4-4. Pain catastrophizing

The Pain Catastrophizing Scale (PCS: Sullivan *et al*., 1995/Appendix 4) has 13 items to assess a respondent's level of exaggerated negative orientation, i.e., "*catastrophizing*" toward the pain experiences (Sullivan *et al*., 1995; Sullivan & Neish, 1998). The scale asks a respondent to reflect on past pain experiences and to indicate the degree to which he/she experienced each of 13 thoughts or feelings when experiencing pain (e.g., "I worry all the time about whether the pain will end."). Each item is scored on a five-point Likert scale ranging from 1 ("Not at all") through 3 ("To a moderate degree") to 5 ("All the time").

Pain catastrophizing has been conceptualised as a multidimensional construct, consisting of *rumination* ("I keep thinking about how badly I want the pain to stop."), *magnification* ("I wonder whether something serious may happen.") and *helplessness* ("I feel I can't go on.") (*ibid.*). Sullivan *et al*. (1995) has shown that exploratory principal-components analysis with oblique rotation of the 13 items, in a sample of 429 introductory psychology student volunteers, provided support for three factors. The validations of the three-factor structure of the PCS were replicated in college undergraduate samples (Osman, Barrios, Kopper, Hauptmann, Jones & O'Neill, 1997) and sport participants (Sullivan, Tripp, Rodgers & Stanish, 2000).

The internal reliability coefficient of the scale is reported as high as 0.87, whereas the test-retest validity coefficient is claimed to be 0.75 (Sullivan *et al*., 1995). The reliability coefficient of the PCS in the present study was found to be 0.92.

2-4-5. Manifest (trait) anxiety

The short form of the Manifest Anxiety Scale (B-MAS: Bendig, 1956/Appendix 5) was developed from Taylor's (1953) 50-item Manifest Anxiety Scale. The shortened version contains 20 items rating the levels of trait anxiety, i.e., stable individual differences in the tendencies to respond with anxiety (e.g., "I find it hard to keep my mind on a task or job."). A respondent indicates whether he/she feels in that way in general by choosing either "True" or "False". The short form was chosen for its brevity where time restricted the use of the original full-version in a busy clinical situation.

The internal reliability of the scale is reported to be 0.76, and the concurrent validity is found to be 0.93 by the correlation coefficient with the 50-item MAS (Bendig, 1956). Cronbach's alpha for the B-MAS of the present study was 0.84.

2-4-6. Social desirability (defensiveness)

The Marlowe-Crowne Social Desirability Scale (M-C SDS: Crowne & Marlowe, 1960/Appendix 5) is claimed to measure "repressive defensiveness" (Weinberger, 1990), by examining how much a respondent presents himself/herself in a socially appropriate and acceptable manner. The scale asks a respondent to indicate whether his/her attitude or behaviour is applicable to each 33 items by choosing either "True" or "False" (e.g., "Before voting I thoroughly investigate the qualifications of all the candidates."). It does not matter whether a respondent answers truthfully or not. What matters is his/her attitude to the statement.

The internal reliability of the scale is shown to be 0.88, and the test-retest reliability, 0.89 (*ibid*.). The alpha coefficient for the present M-C SDS was 0.74.

2-4-7. Monitor-blunter style coping

The Miller Behavioural Style Scale (MBSS: Miller, 1979; Miller, 1987/Appendix 6) identifies different characteristic ways that individuals respond to potentially distressing information under stressful situations, i.e., *monitoring* and *blunting*. The scale consists of four different hypothetical stress-evoking scenarios (i.e., a threat of being laid off work, flying in an aeroplane which has some technical problems, a threat of the dentist and being held hostage by a group of armed terrorists), each carrying eight statements. A respondent is instructed to choose the statements that suggest his/her way of coping in the form of either *monitoring* (e.g., "I would stay alert and try to keep myself from falling asleep.") or *blunting* (e.g., "I would sit by myself and have as many daydreams and fantasies as I could.") for a situation (e.g., "Vividly imagine that you are being held hostage by a group of armed terrorists…”). The MBSS has been extensively used in various medical contexts and populations, e.g. cancer-related settings, dental surgery and patients suffering from HIV (Miller, 1996).

The scores for the *monitoring* and the *blunting* are summed up separately across four situations. Consequently, three independent scores can be derived from the scale: (1) the total *monitoring* score; (2) the total *blunting* score and (3) the total *monitoring* score minus *blunting* score. In the present study, the scoring methods (1) and (2) were used. In addition, using the *monitoring* score, those scoring above the median (or mean) may be termed high *monitors* (or *information seekers*) and those scoring below it may be called low *monitors* (or *information avoiders*). Using the blunting score, those scoring above the median may be termed high *blunters* (or *distractors*) and those scoring below it can be classified as low blunters (*non-distractors*). Likewise, using the *monitoring* minus *blunting* score, those scoring above the median may be termed *monitors* (or *information seekers*) and those scoring below it can be termed *blunters* (or *information avoiders*).

The MBSS has been shown to have adequate test-retest reliability, ranging from 0.70 to 0.80 (Miller & Mangan, 1983). It was reported that, in particular, the *monitoring* subscale possessed good test-retest reliability ($r = 0.71$, $P < 0.005$) and construct validity, both discriminant and convergent, as measured by the univariate associations between *monitoring* behaviour and a demographic questionnaire (Rees & Bath, 2000). Moreover, the internal consistency of the *monitoring* and *blunting* subscales of the MBSS was reported to be 0.65 and 0.41 respectively (*ibid*.). The reliability coefficients for the current MBSS *monitor* and *blunter* subscales were 0.72 and 0.61 respectively.

2-4-8. Sensory intensity of pain

The Numerical Rating Scale (NRS: Downie, Leatham, Rhind, Wright, Branco & Anderson, 1978/Appendix 7 & 12) is the most widely used tool for assessing sensory intensity of pain (Krebs, Carey & Weinberger, 2007). It is designed to quantify the intensity/magnitude of pain sensation. It contains 11 boxes horizontally laid out, each carrying 11 digits from 0 at the left to 10 with each end of the scale representing a verbal description of the relative extreme limits of pain intensity to be evaluated. That is, from 0, "No pain" to 10, "Unbearable pain". Hence, the NRS allows a respondent to rate pain as mild (1-3), moderate (4-6) or severe (7-10), which can indicate a potential disability level for a healthcare provider to attend to. In the present study, a respondent indicated how much pain he/she expected to experience (rated pre-surgery), and how much he/she actually experienced (rated post-surgery) during the procedure.

The alternative to the NRS is the Visual Analogue Scale (VAS). The VAS utilises a straight line, conventionally 10cm long, whose extreme limits are marked by perpendicular lines with a verbal description of each extreme of the symptom to be evaluated from "No pain" to "Unbearable pain. A respondent is asked to mark the line at a position between the two extremes which represents the level of pain.

The NRS has become a more common choice than the VAS because of its ease of use, a broader range of methods of administration and evidence of consistent results across a wide range of languages and cultures (Keller, Bann, Dodd, Schein, Mendoza & Cleeland, 2004). During the course of the present study, the NRS was chosen instead of the VAS, firstly, because it is more easily understood in usage. Secondly, subjective values of pain may be at best captured by the rank ordering system of the box scale rather than by reading too much into the precise VAS score.

The validity of the NRS scale is established by a high correlation (0.88) with a four-point simple descriptive scale (Downie *et al*., 1978). More recently, for chronic pain studies, a consistent relationship between the change in the NRS score and the patient's global impression of change (PGIC) scale was demonstrated regardless of study, disease type, age, sex, study result, or treatment group (Farrar, Young, LaMoreaux, Werth & Poole, 2001).

2-4-9. Affective quality of pain

The Ratio Scale of Affective Verbal Pain Descriptors (AVPDS: Gracely, McGrath & Dubner, 1978/Appendix 8 & 13) measures affective aspect of pain. It depicts 15 adjectives describing increasing levels of suffering imposed by pain from "Bearable" to "Excruciating". A respondent is required to select a single item from the scale to best fit his/her emotional arousal and disruption engendered by the pain experience.

The internal and test-retest reliabilities of the scale are established by the correlation coefficients of 0.98 for both (*ibid*.). The AVPDS have been shown to be sensitive to treatment designed to influence the emotional component of pain (Heft, Gracely & Dubner, 1984; Gracely, Dubner & McGrath, 1988).

2-4-10. State anxiety

The six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI-6: Marteau & Bekker, 1992/Appendix 9) assesses situational and transitory anxiety incurred by threatening demands or dangers. This scale was developed from Spielberger *et al*.'s (Spielberger, Gorsuch & Lushene, 1970) original 20-item scale which measures transitory emotional state of anxiety characterised by subjective, consciously perceived feelings of tension and apprehension and heightened autonomic nervous system activity that may fluctuate over time (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). A respondent rates the extent to which he/she feels in each way "right now, at this moment" (e.g., "I feel calm", "I am tense"). The responses to each item are scored by a numerical value ranging from 1 ("Not at all") to 4 ("Very much"). The short-form was used because of its brevity.

The internal reliability coefficient of the scale is shown as 0.82, and the concurrent validity is reported to be similar to that of the full-version STAI (Marteau & Bekker, 1992). The alpha coefficients of T1 the STAI-6, T2 the STAI-6 and T3 the STAI-6 in the present study were 0.85, 0.80 and 0.87 respectively.

2-4-11. Mood states

The Positive and Negative Affect Schedule (PANAS: Watson *et al*., 1988/Appendix 10) contains 20 adjectives relating to mood factors. Ten items each assesses *positive affect* (e.g., interested, excited, strong) and *negative affect* (e.g., distressed, upset, guilty), which represent dichotomous dimensions. A respondent rates the extent to which he/she feels in each way at various time frames (e.g., "right now", "during the past week", "in general"). For the present study, a present time frame instruction (i.e., "right now, at this moment") was used. Each adjective is rated on a five-point Likert scale ranging from 1 ("Very slightly or not at all") through 3 ("Moderately") to 5 ("Extremely").

The scale reports high internal reliability for both *positive affect* (ranging from 0.86 to 0.90) and *negative affect* (ranging from 0.84 to 0.87) on seven different time frame instructions. Similarly, the test-retest reliability of the general ratings are claimed to be high enough to suggest that they may be used as trait measures of affect (*ibid.*). The scale item validity is shown high by the convergent correlations (ranging from 0.89 to 0.95) with the 60 Zevon and Tellegen mood descriptors (Zevon & Tellegen, 1982) (*ibid*.). The alpha coefficients for the T1 the PANAS-positive, T1 the PANAS-negative, T2 the PANAS-positive, T2 the PANAS-negative, T3 the PANAS-positive and T3 the PANAS-negative were found to be 0.83, 0.88, 0.89, 0.84, 0.91 and 0.88 respectively.

2-4-12. Dental control experienced

The Dental Control Questionnaire (DCQ/Appendix 11) was designed by the author to assess patients' experienced degree of perceived control during the surgery as opposed to the expected levels of control as measured by The IDCI – *Felt Dental Control* subscale. Two items ask to rate how much control the patient feels he/she had over the dental procedure (e.g., "Do you feel that you had control of what happened to you when you were in the dental chair?") on a five-point scale, the ends of which are labelled by polar opposite, e.g., "None" and "Totally"/"Total control". Cronbach's alpha for the DCQ was 0.87.

2-4-13. Surgical complexity

The Surgical Complexity Scale (SCS/Appendix 14) was specifically constructed by the author for the dental surgeons to rate the complexity of the surgical procedure. The factors assessed by the scale include: the amount and place(s) of analgesia given; the difficulty of the treatment methods; the number/location of teeth involved; the complexity/severity of the procedure as a whole and the duration of the procedure.

There were 16 dental surgeons involved in the study, and hence, there may have been inter-individual variations among the surgeons in the ratings, in particular, for the difficulty of the treatment methods and the complexity/severity of the procedure due to the experience of the surgeon.

2-4-14. Dentists' perception of patient's distress

The Stress Rating Scale (SRS/Appendix 15) was created by the author for the dental surgeons to rate how much stress their patients experienced in terms of the levels of *pain*, *anxiety* and *distress*. As in the case of the NRS, each factor is assessed separately on the horizontal box scale, consisting of 11 digits presented in ascending order from 0, "No pain"/"No anxiety"/"No distress" to 10, "Pain as bad as it could be"/"Anxiety as bad as it could be"/"Distress as bad as it could be".

Pain is subjective, yet there are signs of pain which other people can observe, such as grimacing, tensing, writhing and groaning. Likewise, anxiety may be captured by patients' restlessness and agitation. Similarly, distress may be assessed from the patients' behaviours. Dental surgeons were instructed to rate patients' distress in terms of patients', in particular, "cooperativeness", "amount of phonation" and "hand/arm movement". Hence, the box scale allows dental surgeons to quantify their patients' pain, anxiety and distress from the observed behaviours of their patients.

The box scale for pain is identical to the one with which patients rated their sensory pain intensity. Thus, it is easy to compare the pain ratings between patients' and dental surgeons' to explore and understand the differences in their pain perceptions.

While dental surgeons could infer patients' pain from their conditions, the complexity and the types of the procedures, it may be difficult to distinguish between anxiety and distress. For example, patients' uncooperativess can be a result of either his/her anxiety or distress.

2-5. Design

This was a prospective, cross-sectional and questionnaire-based study which investigated the effects of psychological factors over perception of acute pain 24 hours post-tooth extraction. The factors were: *dental anxiety*; *dental control*; *pain catastrophizing*; expectation of pain; *social desirability* and *monitor-blunter* style coping. The study also explored which factor/s best predicted the heightened pain intensity. The amount of pain the patients experienced (during and up to 24 hours after the surgery) was assessed on the following day of the surgery due to the use of anaesthesia which may make the removal of tooth/teeth a relatively painless procedure.

The variables were measured at four different time points: baseline (T0); Time 1 (T1); Time 2 (T2) and Time 3 (T3). That is, on recruitment (baseline: T0), before (T1), after (T2) and the following day (T3) of the dental surgery. The baseline variables assessed by the first set of questionnaires included: demographic information; *dental anxiety*; *dental control*; *pain catastrophizing*; *social desirability*; *manifest* (*trait*) *anxiety* and *monitor-blunter* style coping (T0). The second set of questionnaires was given to examine the patients' anticipated sensory intensity of pain, anticipated affective quality of pain, state anxiety and mood states just before the surgery (T1). The third set of questionnaires, assessing state anxiety and mood states, was administered soon after the surgery (T2). The last set of questionnaires, measuring the amount of perceived control during the surgery, experienced sensory intensity of pain, experienced affective quality of pain, state anxiety and mood states, was given to take home and fill in on the following day of the surgery (T3). The patients sent back the filled questionnaires in a provided self-addressed envelope.

After the surgery, all 16 dental surgeons completed a set of questionnaires, assessing the complexity of the surgical procedure and their perception of the patients' stress during the surgery in terms of pain, anxiety and distress.

2-6. Procedure

All patients were scheduled first for the consultation (first visit), which involved examination, x-ray, decision of appropriate anaesthesia type (general or local) and allocation of a dental surgeon suitable for their subsequent surgery (second visit). Those elected for general anaesthesia were excluded from the study at this point.

On their arrival at the hospital, all potential participants were given an information sheet, and were notified about the present study. Those who agreed to participate in the study were given the first set of questionnaires, asking about their demographic information (GDQ), their anxiety levels for dental treatment (MDAS), the degree of desire and perception of control over dental treatment (IDCI), the *pain catastrophizing* levels (PCS), the degree of *social desirability* (M-C SDS), the levels of trait anxiety (B-MAS) and their tendencies of the *monitor-blunter* coping styles (MBSS).

The first group of 154 patients was recruited by the researcher on their examination day, and the last half (n=152) on their day of surgery.

The first set of questionnaires was administered to the first patients group after the consultation. Some filled them in before they went home, while the others took them home to fill in and bring back on their day of surgery. The last group was given the questionnaire set before the surgery. Some filled them in while waiting before the surgery; the others took the questionnaire home, filled it in and sent it back.

Before their surgery all patients filled in the pre-surgery questionnaires, measuring the levels of expected sensory intensity pain (NRS), anticipated affective quality of pain (AVPDS), their state anxiety levels (STAI-6) and their mood states (PANAS) at the very moment of pre-surgery. Similarly, after the surgery the post-surgery questionnaires were administered, asking the patients' state anxiety levels (STAI-6) and their mood states (PANAS) at the very moment of the post-surgery. The dental surgeons also rated the complexity of the procedures (SCS) and his/her patient's levels of stress experienced during the surgery in terms of pain intensity, anxiety levels and degree of distress (SRS). All dental surgeons were briefed beforehand as to how to fill in the forms – i.e., how to rate the complexity of the surgery and assess the patients' stress. They were blind to their patients' questionnaire scores.

After filling in the post-surgery questionnaires, the patients were given the last set of questionnaires to take home. The questionnaires were to be filled in on the following day after the surgery, and to be sent back by post. The questionnaires completed on the following day measured the levels of control experienced over the surgery (DCQ), the levels of experienced sensory intensity pain (NRS), the experienced affective quality of pain (AVPDS) during and after the surgery, the state anxiety levels (STAI-6) and the mood state (PANAS) at the very moment of filling in the last questionnaire set.

The timing of the administration of the questionnaire sets was described in Figure 2-6: Overview of the questionnaire administration timing.

Figure 2-6: Overview of the questionnaire administration timing

On recruitment (T0)	**Pre-surgery (T1)**	**Post-surgery (T2)**	**Following day (T3)**
Demographic info (GDQ)			
Dental anxiety (MDAS)			
Dental control (IDCI)		Dental control (DCQ)	
Pain catastrophizing (PCS)			
Trait anxiety (B-MAS)			
Social desirability (M-C SDS)			
Monitor-Blunter (MBSS)			
	Sensory pain (NRS)		Sensory pain (NRS)
	Affective pain (AVPDS)		Affective pain (AVPDS)
	State Anxiety (STAI-6)	State Anxiety (STAI-6)	State anxiety (STAI-6)
	Mood (PANAS)	Mood (PANAS)	Mood (PANAS)
		(By the dental surgeon)	
		Surgical complexity (SCS)	
		Distress levels (SRS)	

CHAPTER 3: Results

3-1. Statistical analyses

A total of 386 data were analysed using the Statistical Package for the Social Sciences (SPSS™ Inc, 2005) version 14.0 for Windows.

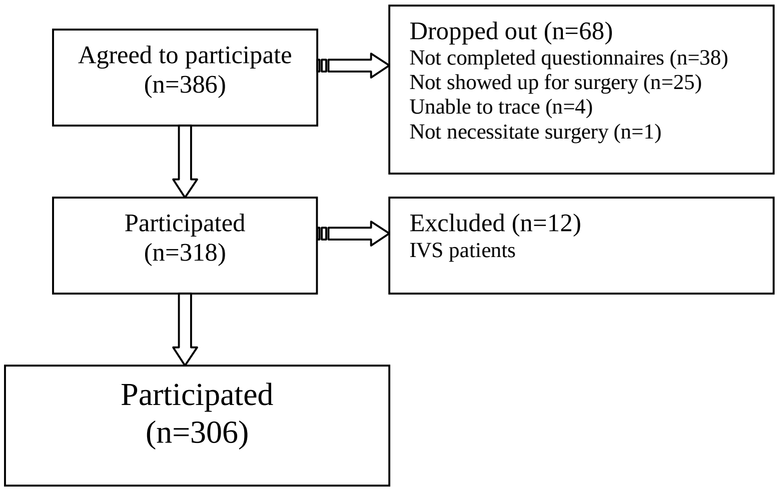
3-2. Descriptive statistics

3-2-1. Participants

The patients were from multi-ethnic and social backgrounds, and their age ranged between 18 years and 62 years with the mean age of 31.82. They were not paid for their participation. Of 306 patients, 154 were signed up for the study at their consultation (at the first visit), and the rest (n=152) were recruited on the day of their surgery (at the second visit).

Originally, a total of 386 patients (179 male and 207 female) were eligible for this study. The attrition group of 68 patients (34 male and 34 female) who did not complete the study included: 38 who failed to fill in the pre- and/or post-surgery questionnaires and/or failed to send back the day-after surgery questionnaires; 25 who did not turn up for the surgery; four who were unable to be traced due to the change of their surgery appointment dates and one whose condition did not after all necessitate the extraction. The baseline differences between the attrition group (i.e., *non-completers*) and the study-completed group (i.e., *completers*) were explored in the 3-5. *Baseline variables*/3-5-1. *Non-completers vs. completers* section in CHAPTER 3: *Results*. Further 12 patients (1 male and 11 female) who had intravenous sedation (IVS) were excluded from the study due to their significantly higher levels of dental anxiety. The baseline differences between the sedated group (i.e., *sedation*) and the non-sedated group (i.e., *non-sedation*) were examined in the 3-5. *Baseline variables*/3-5-2. *Sedation vs. non-sedation* section in CHAPTER 3: *Results*. A flowchart of the sampling process is shown below in Figure 3-2-1.

Figure 3-2-1: Flowchart of the sampling process



3-2-2. Demographic variables

Means, standard deviations (SD), minimum values (Min) and maximum values (Max) of each demographic variable are shown in Table 3-2-2: Descriptive statistics of demographic variables.

Table 3-2-2: Descriptive statistics of demographic variables (n=306)

Variable	%	Mean	SD	Min	Max
Age		31.82	9.10	18	62
Gender					
% female	47.1				
% male	52.9				
Marital status					
% Single	50.0				
% Living with a partner	23.9				
% Married	21.6				
% Separated	1.3				
% Divorced	2.3				
% Widowed	0.7				
Occupation					
% Higher managerial/professional	15.7				
% Lower managerial/professional	26.5				
% Intermediate	16.3				
% Small employers	7.5				
% Lower supervisory/technical	2.3				
% Semi-routine	4.9				
% Routine	2.9				
% Never worked/unemployed	8.2				
% Full-time education	12.1				
% Not classified	2.9				
% Retired	0.7				
Education					
% Doctorate/professional	3.9				
% MPhil/Master’s	14.1				
% Bachelor’s	33.7				
% A-levels/diplomas/HND	31.4				
% GCSE/O-levels	8.5				
% No education	2.3				
Dental visit		0.38	0.87	0	4

3-2-3. Psychological variables

Means, SD, Min, Max and possible ranges of each psychological variable are shown in Table 3-2-3: Descriptive statistics of psychological variables.

Table 3-2-3: Descriptive statistics of psychological variables (n=306)

Variable	Mean	SD	Min	Max	Possible range
T0 Dental anxiety (MDAS)	2.42	0.88	1	4.80	1-5
T0 Desired control (IDCI-D)	3.23	0.95	1	5	1-5
T0 Felt control (IDCI-F)	2.45	1.02	1	5	1-5
T0 Pain catastrophizing (PCS)	2.23	0.74	1	5	1-5
T0 Manifest anxiety (B-MAS)	7.64	4.63	0	19	0-20
T0 Social desirability (M-C SDS)	17.49	5.10	3.43	30	0-33
T0 Monitoring (MBSS-M)	10.37	3.10	0	16	0-16
T0 Blunting (MBSS-B)	4.47	2.56	0	16	0-16
T1 Sensory pain (T1 NRS)	5.61	2.37	0	10	0-10
T1 Affective pain (T1 AVPDS)	5.21	3.23	1	15	1-15
T1 State anxiety (T1 STAI)	2.30	0.71	1	4	1-4
T1 Positive mood (T1 PANAS-P)	2.12	0.66	1	5	1-5
T1 Negative mood (T1 PANAS-N)	1.74	0.65	1	4.40	1-5
T2 Dental control – Felt (T2 DCQ)	2.75	1.10	1	5	1-5
T2 State anxiety (T2 STAI)	2.00	0.64	1	4	1-4
T2 Positive mood (T2 PANAS-P)	2.13	0.81	1	5	1-5
T2 Negative mood (T2 PANAS-N)	1.45	0.52	1	3.70	1-5
T2 Surgical complexity (SCS)	-0.03	0.67	-1.28	3.04	-1.28-3.04
T2 Distress levels (SRS)	2.42	1.67	0	10	0-10
T3 Sensory pain (T3 NRS)	5.01	2.72	0	10	0-10
T3 Affective pain (T3 AVPDS)	4.92	3.45	1	15	1-15
T3 State anxiety (T3 STAI)	1.81	0.68	1	4	1-4
T3 Positive mood (T3 PANAS-P)	2.22	0.84	1	5	1-5
T3 Negative mood (T3 PANAS-N)	1.40	0.54	1	3.90	1-5

3-3. Testing the data

3-3-1. Reliabilities of the measures

To assess the reliabilities of the questionnaires, the internal consistency was examined by Cronbach’s alpha (Cronbach, 1951). The following scales indicated reasonably high levels of reliabilities, having the alpha coefficients of over 7.0 as suggested by Kline (2000) and Nunnaly (1978): the MDAS; the IDCI-felt subscale; the DCQ; the PCS; the

B-MAS; the M-C SDS; the MBSS-monitor; T1 the STAI-6; T2 the STAI-6; T3 the STAI-6; T1 the PANAS-positive subscale; T1 the PANAS-negative subscale; T2 the PANAS-positive subscale; T2 the PANAS-negative subscale; T3 the PANAS-positive subscale; T3 the PANAS-negative subscale; the SCS and the SRS (See Table 3-3-1: Cronbach's alpha coefficients of the measures).

However, relatively low alpha coefficients were found for the two-item IDCI-desire subscale and the 16-item MBSS-blunter subscale with the alpha coefficients of 0.59 and 0.61 respectively. Consequently, the data from these measures will be treated with caution in the subsequent analyses.

Table 3-3-1: Cronbach's alpha coefficients of the measures (n=306)

Questionnaire	**Number of items**	**Alpha**
MDAS	5	0.88
IDCI-desire	2	0.59*
IDCI-felt	2	0.86
DCQ	2	0.87
PCS	13	0.92
B-MAS	20	0.84
M-C SDS	33	0.74
MBSS-monitor	16	0.72
MBSS-blunter	16	0.61*
T1 STAI-6	6	0.85
T2 STAI-6	6	0.80
T3 STAI-6	6	0.87
T1 PANAS-positive	10	0.83
T1 PANAS-negative	10	0.88
T2 PANAS-positive	10	0.89
T2 PANAS-negative	10	0.84
T3 PANAS-positive	10	0.91
T3 PANAS-negative	10	0.88

*****The alpha coefficients were low.

3-3-2. Distributions of the data

The KS-Lilliefors tests were significant ($p<0.05$) for the data from the following scales, indicating that none of them were consistent with a normal distribution in the population: the MDAS; the IDCI-desire subscale; the IDCI-felt subscale; the DCQ; the PCS; the B-MAS; the M-C SDS; the MBSS-monitor subscale; the MBSS-blunter subscale; T1 the NRS; T3 the NRS; T1 the AVPD; T3 the AVPD; T1 the STAI-6; T2 the STAI-6; T3 the STAI-6; T1 the PANAS-positive subscale; T1 the PANAS-negative subscale; T2 the PANAS-positive subscale; T2 the PANAS-negative subscale; T3 the PANAS-positive subscale; T3 the PANAS-negative subscale; the SCS and the SRS.

To explore how far these data were deviated from normality, the skewness of the distribution was examined. The z-scores obtained by dividing the skewness by its standard error were compared against the value of 1.96 above which was considered significantly different from chance occurrence (Field, 2000) (See Table 3-3-2: The z-scored skewness of the measures). The z-scores revealed substantial deviations from normality for the majority of the scales except the following: the IDCI-desired; the DCQ; the M-C SDS and T3 the NRS.

Further, examining the normal Q-Q plot charts of the measures also confirmed that all data had considerable deviation from the normal distribution except the following: the IDCI-desire subscale; the DCQ; the M-C SDS and T3 the NRS.

Consequently, having a majority of data deviated from normality, non-parametric tests were conducted on all data where applicable in the following analyses. Similarly, non-parametric tests were also used for the variable of participants' age since it was found not to be in conformity with the hypothetical distribution.

Table 3-3-2: The z-scored skewness of the measures (n=306)

Questionnaire	Skewness	Standard error	Z-score
MDAS	0.540	0.142	**3.80***
IDCI-desired	-0.050	0.142	**-0.35**
IDCI-felt	0.397	0.142	**2.80***
DCQ	0.218	0.142	**1.54**
PCS	0.665	0.142	**4.68***
B-MAS	0.382	0.142	**2.69***
M-C SDS	-0.113	0.142	**-0.80**
MBSS-monitor	-0.379	0.142	**-2.67***
MBSS-blunter	0.826	0.142	**5.82***
T1 NRS	-0.507	0.142	**-3.57***
T3 NRS	-0.160	0.142	**-1.13**
T1 AVPD	1.149	0.142	**8.09***
T3 AVPD	1.209	0.142	**8.51***
T1 STAI-6	0.314	0.142	**2.21***
T2 STAI-6	0.500	0.142	**3.52***
T3 STAI-6	0.829	0.142	**5.84***
T1 PANAS-positive	0.967	0.142	**6.81***
T1 PANAS-negative	1.242	0.142	**8.75***
T2 PANAS-positive	0.916	0.142	**6.45***
T2 PANAS-negative	1.507	0.142	**10.61***
T3 PANAS-positive	0.899	0.142	**6.33***
T3 PANAS-negative	1.795	0.142	**12.64***
SCS	1.168	0.142	**8.23***
SRS	1.312	0.142	**9.24***

*****The Z-scores significantly deviated from normality.

3-4. Relations among variables

3-4-1. Demographic variables and dental pain

In order to examine the bivariate associations between demographic variables and *experienced sensory pain*, the Spearman rank correlation coefficients were analysed.

Correlation matrix is presented in Table 3-4-1: Correlations of demographic variables and experienced sensory pain.

Only age was negatively associated with *experienced sensory pain* (ρ=-0.22, p<0.01).

Table 3-4-1: Correlations of demographic variables and experienced sensory pain (n=306)

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Age	1								
2. Status	0.41**	1							
3. Occupation	-0.17**	-0.14*	1						
4. Education	0.00	-0.04	0.40**	1					
5. Dental visit	-0.01	0.02	0.06	0.04	1				
6. T1 NRS	-0.15**	-0.07	-0.03	-0.02	0.04	1			
7. T1 AVPDS	0.00	0.08	-0.07	-0.03	0.09	0.48**	1		
8. T3 NRS	-0.22**	-0.00	0.03	0.06	-0.03	0.35**	0.28**	1	
9. T3 AVPDS	-0.22**	0.07	0.02	0.04	0.00	0.21**	0.28**	0.67**	1

** Correlation is significant at the 0.01 level (2-tailed).
*   Correlation is significant at the 0.05 level (2-tailed).

3-4-2. Psychological variables and dental pain

In order to examine the bivariate associations between psychological variables and *experienced sensory pain*, the Spearman rank correlation coefficients were analysed. Correlation matrix is presented in Table 3-4-2: Correlations of psychological variables and experienced sensory pain.

The following psychological factors were associated with *experienced sensory pain*: *dental anxiety* (ρ=0.21, p<0.01); *desired control* (ρ=0.16, p<0.01); *pain catastrophizing* (ρ=0.20, p<0.01); *manifest anxiety* (ρ=0.22, p<0.01); *social desirability* (ρ=-0.13, p<0.05); *monitoring* (ρ=0.19, p<0.01); *expected sensory pain* (ρ=0.35, p<0.01); *expected affective pain* (ρ=0.28, p<0.01); *state anxiety before* (ρ=0.21, p<0.01); *negative mood before* (ρ=0.26, p<0.01); *state anxiety after* (ρ=0.30, p<0.01); *positive mood after* (*ρ*=-0.15, *p*<0.05); *negative mood after* (*ρ*=0.31, *p*<0.01); *surgical complexity* (*ρ*=0.19, *p*<0.01) and *distress levels* (*ρ*=0.34, *p*<0.01).

Table 3-4-2: Correlations of psychological variables and experienced sensory pain (n=306) (cont.)

	1.	2.	3.	4.	5.	6.	7.	8.
1. T0 MDAS	1							
2. T0 IDCI-D	0.45**	1						
3. T0 IDCI-F	-0.19**	0.03	1					
4. T0 PCS	0.43*	0.39**	-0.12*	1				
5. T0 B-MAS	0.28**	0.21**	-0.11	0.43**	1			
6. T0 M-C SDS	-0.06	0.00	0.04	-0.17**	-0.34**	1		
7. T0 MBSS-M	0.12*	0.15**	0.05	0.18**	0.20**	-0.18**	1	
8. T0 MBSS-B	-0.06	-0.07	0.13*	0.04	0.00	0.03	-0.11*	1
9. T1 NRS	0.35**	0.20**	-0.17**	0.24**	0.22**	-0.10	0.21**	0.03
10. T1 AVPDS	0.37**	0.26**	-0.16**	0.26**	0.25**	-0.05	0.13*	-0.02
11. TI STAI	0.50**	0.28**	-0.15*	0.31**	0.39**	-0.12*	0.17**	-0.05
12. T1 PANAS-P	-0.07	0.01	0.05	-0.06	-0.19**	0.14*	0.03	-0.06
13. T1 PANAS-N	0.56**	0.28**	-0.18**	0.38**	0.39**	-0.13*	0.14*	-0.06
14. T2 DCQ	-0.02	0.10	0.49**	-0.07	0.01	0.10	0.00	0.07
15. T2 STAI	0.31**	0.08	-0.21**	0.17**	0.17**	-0.11	0.12*	-0.00
16. T2 PANAS-P	-0.00	0.09	0.10	0.08	-0.11	0.20**	0.06	-0.06
17. T2 PANAS-N	0.31**	0.05	-0.23**	0.21**	0.24**	-0.13*	0.09	0.02
18. T2 SCS	0.06	0.01	0.02	0.13*	0.05	-0.03	-0.03	0.02
19. T2 SRS	0.15*	0.10	-0.10	0.04	0.05	-0.09	-0.07	0.02
20. T3 NRS	0.21**	0.16**	-0.04	0.20**	0.22**	-0.13*	0.19**	-0.01
21. T3 AVPDS	0.15**	0.13*	-0.02	0.15*	0.15**	-0.09	0.16**	0.03
22. T3 STAI	0.20**	0.04	-0.06	0.28**	0.34**	-0.21**	0.15**	-0.06
23. T3 PANAS-P	0.00	0.12*	0.02	0.03	-0.10	0.19**	0.05	0.00
24. T3 PANAS-N	0.27**	0.10	-0.11	0.36**	0.30**	-0.16*	0.10	-0.04

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 3-4-2: Correlations of psychological variables and experienced sensory pain (n=306) (cont'd.)

	9.	10.	11.	12.	13.	14.	15.	16.
1. T0 MDAS								
2. T0 IDCI-D								
3. T0 IDCI-F								
4. T0 PCS								
5. T0 B-MAS								
6. T0 M-C SDS								
7. T0 MBSS-M								
8. T0 MBSS-B								
9. T1 NRS	1							
10. T1 AVPDS	0.48**	1						
11. TI STAI	0.36**	0.44**	1					
12. T1 PANAS-P	-0.11	-0.11	-0.37**	1				
13. T1 PANAS-N	0.39**	0.45**	0.83**	-0.21**	1			
14. T2 DCQ	-0.04	-0.09	-0.10	0.06	-0.11*	1		
15. T2 STAI	0.24**	0.26**	0.45**	-0.25**	0.42**	-0.20**	1	
16. T2 PANAS-P	-0.06	-0.05	-0.18**	0.62**	-0.08	0.13*	-0.44**	1
17. T2 PANAS-N	0.23**	0.25**	0.33**	-0.07	0.46**	-0.22**	0.69**	-0.20**
18. T2 SCS	0.09	-0.01	0.02	0.07	0.04	0.05	0.13*	-0.09
19. T2 SRS	0.13*	0.17**	0.20**	-0.07	0.23**	0.04	0.32**	-0.20**
20. T3 NRS	0.35**	0.28**	0.21**	-0.06	0.26**	-0.05	0.30**	-0.15*
21. T3 AVPDS	0.21**	0.28**	0.22**	-0.11	0.23**	-0.08	0.35**	-0.24**
22. T3 STAI	0.23**	0.26**	0.29**	-0.17**	0.29**	-0.23**	0.38**	-0.20**
23. T3 PANAS-P	-0.11	-0.15**	-0.17**	0.58**	-0.07	0.14*	-0.21**	0.59**
24. T3 PANAS-N	0.22**	0.24**	0.25**	-0.05	0.35**	-0.22**	0.30**	-0.04

	17.	18.	19.	20.	21.	22.	23.	24.
1. T0 MDAS								
2. T0 IDCI-D								
3. T0 IDCI-F								
4. T0 PCS								
5. T0 B-MAS								
6. T0 M-C SDS								
7. T0 MBSS-M								
8. T0 MBSS-B								
9. T1 NRS								
10. T1 AVPDS								
11. TI STAI								
12. T1 PANAS-P								
13. T1 PANAS-N								
14. T2 DCQ								
15. T2 STAI								
16. T2 PANAS-P								
17. T2 PANAS-N	1							
18. T2 SCS	0.10	1						
19. T2 SRS	0.24**	0.30**	1					
20. T3 NRS	0.31**	0.19**	0.34**	1				
21. T3 AVPDS	0.31**	0.25**	0.34**	0.67**	1			
22. T3 STAI	0.42**	0.15**	0.13*	0.49**	0.40**	1		
23. T3 PANAS-P	-0.08	-0.10	-0.16**	-0.29**	-0.30**	-0.42**	1	
24. T3 PANAS-N	0.53**	0.13*	0.13*	0.42**	0.33**	0.76**	-0.24**	1

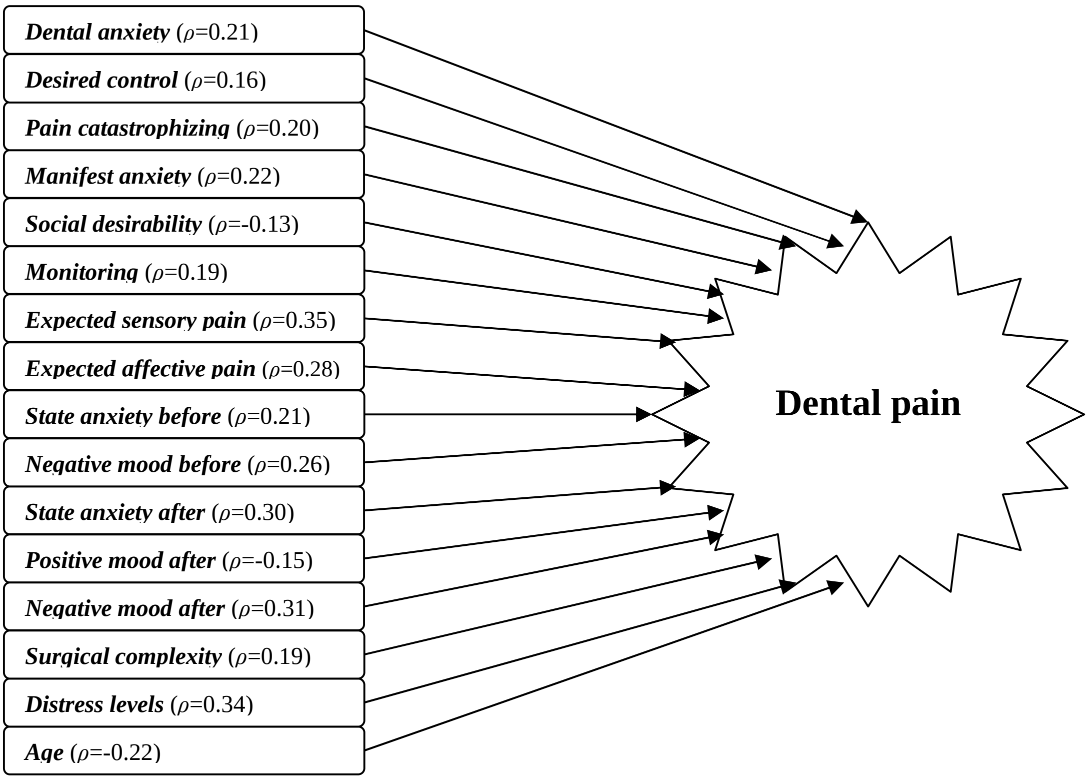
** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

3-4-3. Model of dental pain

Figure 3-4-3 presents the initial structural model (basic model) of predictor variables for dental pain, i.e., *experienced sensory pain*. The model was created as prior pain research has indicated that each of the psychological factors was associated with pain perception as discussed in CHAPTER 1: *Introduction*, and the bivariate associations of those factors with *experienced sensory pain* were significant.

Figure 3-4-3: Basic model of all factors predicting *experienced sensory pain*



3-5. Baseline variables

In this section, first, the baseline variables between those who did not complete the study by failing to fill in the entire sets of questionnaires and those who completed the study were compared. Second, the variables between those who had intravenous sedation and those who did not were compared.

3-5-1. Non-completers vs. completers

In order to examine the differences in the baseline variables between those who did not complete the study (n=68) and those who completed the study (n=318), the following tests were conducted.

The Chi-square tests were carried out on *recruiting time*, *sedation*, *gender* and *marital status* due to the categorical nature of their data.

Recruiting time

The Chi-square test revealed that the recruiting time had a significant effect on whether a participant completed the study or not ($\chi^2 = 3.93$, $df=1$, $p<0.05$). The completion rates were shown to be higher when patients were recruited on the surgery day than the consultation day (see Table 3-5-1a: Number of patients in recruiting time by completion). However, this difference can be disregarded, since the continuity corrected chi-square for a two-by-two design indicated it as non-significant ($\chi^2 = 3.42$, $df=1$, $p>0.05$).

Table 3-5-1a: Number of patients in recruiting time by completion (n=386)

Recruiting time		Non-completers	Completers	Total
At consultation	Number	43	159	202
	% within recruiting time	21.3%	78.7%	100.0%
	% within completion	63.2%	50.0%	52.3%
On surgery day	Number	25	159	184
	% within recruiting time	13.6%	86.4%	100.0%
	% within completion	36.8%	50.0%	47.7%
	Total	68	318	386

Sedation

The Chi-square test found that having sedation had no significant effect on whether a participant completed the study or not (χ^2 =0.06, *df*=1, *p*>0.05) (see Table 3-5-1b: Number of patients in sedation by completion).

Table 3-5-1b: Number of patients in sedation by completion (n=386)

Sedation		Non-completers	Completers	Total
Non-sedation	Number	65	306	371
	% within sedation	17.5%	82.5%	100.0%
	% within completion	95.6%	96.2%	96.1%
Sedation	Number	3	12	15
	% within sedation	20.0%	80.0%	100.0%
	% within completion	4.4%	3.8%	3.9%
	Total	68	318	386

Gender

The Chi-square test indicated that gender had no significant effect on the study completion rates (χ^2 =0.44, *df*=1, *p*>0.05) (see Table 3-5-1c: Number of patients in gender by completion).

Table 3-5-1c: Number of patients in gender by completion (n=386)

Gender		Non-completers	Completers	Total
Male	Number	34	145	179
	% within gender	19.0%	81.0%	100.0%
	% within completion	50.0%	45.6%	46.4%
Female	Number	34	173	207
	% within gender	16.4%	83.6%	100.0%
	% within completion	50.0%	54.4%	53.6%
	Total	68	318	386

Marital status

The Chi-square test revealed no significant effect of marital status on whether a participant completed the study or not (χ^2 =3.38, *df*=5, *p*>0.05) (see Table 3-5-1d: Number of patients in marital status by completion).

Table 3-5-1d: Number of patients in marital status by completion (n=386)

Marital status		Non-completers	Completers	Total
Single	Number	40	160	200
	% within marital status	20.0%	80.0%	100.0%
	% within completion	60.6%	50.5%	52.2%
Living with partner	Number	14	75	89
	% within marital status	15.7%	84.3%	100.0%
	% within completion	21.2%	23.7%	23.2%
Married	Number	9	67	76
	% within marital status	11.8%	88.2%	100.0%
	% within completion	13.6%	21.1%	19.8%
Separated	Number	1	6	7
	% within marital status	14.3%	85.7%	100.0%
	% within completion	1.5%	1.9%	1.8%
Divorced	Number	2	7	9
	% within marital status	22.2%	77.8%	100.0%
	% within completion	3.0%	2.2%	2.3%
Widowed	Number	0	2	2
	% within marital status	0.0%	100%	100.0%
	% within completion	0.0%	0.6%	0.5%
	Total	66	317	383

The Mann-Whitney tests were applied to the data obtained from the following questionnaires: the GDQ; the MDAS; the IDCI; the PCS; the B-MAS; the M-C SDS and the MBSS. Means, SD, *U* values (*U*) and *P* values (*P*) in each variable are tabulated in Table 3-5-1e: Means, SD, *U* and *P* values of baseline variables for completing condition.

Age

The Mann-Whitney test revealed that the non-completers were significantly younger than the completers (U=8406.50, p<0.01).

Previous visit to Eastman Dental Hospital

The Mann-Whitney test revealed that the non-completers visited the hospital significantly more frequently than the completers (U=9282.50, p<0.05).

Occupation

The Mann-Whitney test found no significant difference in the occupational ranks between the groups (U=10376.50, p>0.05).

Educational levels

The Mann-Whitney test showed no significant difference in the educational levels between the groups (U=9140.50, p>0.05).

Dental anxiety

The Mann-Whitney test found that the non-completers had higher levels of dental anxiety than the non-completers (U=9026.00, p<0.05).

Dental control

Desired control. The Mann-Whitney test found no significant difference in the degree of desire to control the situation between the groups (U=9310.00, p>0.05).

Felt (perceived) control before surgery. The Mann-Whitney test found no significant difference in the degree of perceived control between the groups (U=10067.50, p>0.05).

Pain catastrophizing

The Mann-Whitney test showed no significant difference in the levels of *pain catastrophizing* between the groups (U=9574.50, p>0.05).

Monitor-blunter style coping

Monitoring. The Mann-Whitney test found no significant difference in the degree of monitoring tendencies between the groups (U=10379.50, p>0.05).

Blunting. The Mann-Whitney test found no significant difference in the degree of blunting tendencies between the groups (U=10758.50, p>0.05).

Table 3-5-1e: Means, SD, *U* and *P* values of baseline variables for completing condition (n=386)

Variables	Non-completers		Completers		*U*	*P*
	Means	SD	Means	SD		
Age	29.21	9.10	31.68	9.00	8406.50	<0.01
Previous visit	0.50	0.84	0.36	0.86	9282.50	<0.05
*Occupation**	4.41	3.03	4.22	2.96	10376.50	NS
Educational levels	3.40	0.94	3.36	1.04	9140.50	NS
Dental anxiety	2.70	0.90	2.45	0.89	9026.00	<0.05
Desired control	3.44	0.97	3.24	0.94	9310.00	NS
Felt control before	2.35	0.89	2.46	1.01	10067.50	NS
Pain catastrophizing	2.34	0.75	2.23	0.75	9574.50	NS
Manifest anxiety	7.60	4.62	7.63	4.61	10770.00	NS
Social desirability	17.42	5.13	17.40	5.09	10724.50	NS
Monitoring	10.12	3.34	10.39	3.12	10379.50	NS
Blunting	4.47	2.46	4.48	2.55	10758.50	NS

NS=Non-significant
*The lower the figures were, the higher the ranks of occupations were.

In sum, the non-completers were younger, had more UCL Eastman Dental Institute visits and had higher levels of dental anxiety than the completers.

3-5-2. Sedation vs. non-sedation

To examine the differences in the variables between those who had intravenous sedations (n=12) and those who did not (n=306) within the group of completers, the following tests were carried out.

The Chi-square tests were carried out on *recruiting time*, *gender* and *marital status* due to their categorical nature of their data.

Recruiting time

The Chi-square test showed no significant effect of the recruiting time on whether a patient had sedation or not (χ^2 =0.35, *df*=1, *p*>0.05) (see Table 3-5-2a: Number of patients in recruiting time by sedation).

Table 3-5-2a: Number of patients in recruiting time by sedation (n=318)

Recruiting time		Sedation	Non-sedation	Total
At consultation	Number	5	154	159
	% within recruiting time	3.1%	96.9%	100.0%
	% within sedation	41.7%	50.3%	50.0%
On surgery day	Number	7	152	159
	% within recruiting time	4.4%	95.6%	100.0%
	% within sedation	58.3%	49.7%	50.0%
Total		12	306	318

Gender

The Chi-square test found that gender had a significant effect on a patient's requirement of sedation (χ^2 =6.98, *df*=1, *p*<0.01). The sedation rates were higher for female patients than male counterparts (see Table 3-5-2b: Number of patients in gender by sedation).

Table 3-5-2b: Number of patients in gender by sedation (n=318)

Gender		Sedation	Non-sedation	Total
Male	Number	1	144	145
	% within gender	0.7%	99.3%	100.0%
	% within sedation	8.3%	47.1%	45.6%
Female	Number	11	162	173
	% within gender	6.4%	93.6%	100.0%
	% within sedation	91.7%	52.9%	54.4%
Total		12	306	318

Marital status

The Chi-square test revealed that marital status had a significant effect on requirement of sedation (χ^2 =16.11, *df*=5, *p*<0.01). While separated patients more likely required sedation, married patients less likely required one (see Table 3-5-2c: Number of patients in marital status by sedation). However, it should be noted that 50% of the cells had expected frequencies of below 5 with the minimum expected frequency of 0.08, while the acceptance level for the reliabilities is 20% of such with the minimum expected frequency of 1 (Field, 2000). The significant results, therefore, may not be reliable. Accordingly, it can be disregarded.

Table 3-5-2c: Number of patients in marital status by sedation (n=318)

Marital status		Sedation	Non-sedation	Total
Single	Number	7	153	160
	% within marital status	4.4%	95.6%	100.0%
	% within sedation	58.3%	50.2%	50.5%
Living with partner	Number	2	73	75
	% within marital status	2.7%	97.3%	100.0%
	% within sedation	16.7%	23.9%	23.7%
Married	Number	1	66	67
	% within marital status	1.5%	98.5%	100.0%
	% within sedation	8.3%	21.6%	21.1%
Separated	Number	2	4	6
	% within marital status	33.3%	66.7%	100.0%
	% within sedation	16.7%	1.3%	1.9%
Divorced	Number	0	7	7
	% within marital status	0.0%	100.0%	100.0%
	% within sedation	0.0%	2.3%	2.2%
Widowed	Number	0	2	2
	% within marital status	0.0%	100.0%	100.0%
	% within sedation	0.0%	0.7%	0.6%
	Total	12	305	317

The Mann-Whitney tests were conducted for the data obtained from the following questionnaires: the GDQ; the MDAS; the IDCI; the DCQ; the PCS; the B-MAS; the M-C SDS; the MBSS; T1 the NRS; T3 the NRS; T1 the AVPDS; T3 the AVPDS; T1 the STAI-6; T2 the STAI-6; T3 the STAI-6; T1 the PANAS; T2 the PANAS; T3 the PANAS;

the SCS and the SRS. Means, SD, *U* and *P* values in each variable are tabulated in Table 3-5-2d: Means, SD, *U* and *P* values of baseline variables for sedation states.

Age

The Mann-Whitney test found no significant age difference between the two groups (U=1485.50, p>0.05).

Previous visit to Eastman Dental Hospital

The Mann-Whitney test found no significant difference in the frequencies of previous visit to the hospital between the groups (U=1621.00, p>0.05).

Occupation

The Mann-Whitney test revealed no significant difference in the ranks of occupations between the groups (U=1522.50, p>0.05).

Educational levels

The Mann-Whitney test showed no significant difference in the educational levels between the groups (U=1607.50, p>0.05).

Dental anxiety

The Mann-Whitney test showed that the sedation group had significantly higher dental anxiety levels than the non-sedation group (U=989.50, p<0.01).

Dental control

Desired control. The Mann-Whitney test found no significant difference in the degree of desire to control the situation between the groups (U=1600.00, p>0.05).

Felt (perceived) control before surgery. The Mann-Whitney test found no significant difference in the degree of felt control between the groups (U=1525.50, p>0.05).

Felt (perceived) control after surgery. The Mann-Whitney test showed that the sedation group reported significantly lower levels of felt control on the following day of their surgery than the non-sedation group (U=1089.00, p<0.05).

Pain catastrophizing

The Mann-Whitney test found no significant difference in the levels of *pain catastrophizing* between the groups (U=1604.00, p>0.05).

Manifest (trait) anxiety

The Mann-Whitney test found no significant difference in the levels of trait anxiety between the groups (U=1770.50, p>0.05).

Social desirability (defensiveness)

The Mann-Whitney test found no significant difference in the defensiveness levels between the groups (U=1372.50, p>0.05).

Monitor-blunter style coping

Monitoring. The Mann-Whitney test found no significant difference in the degree of monitoring tendencies between the groups (U=1615.00, p>0.05).

Blunting. The Mann-Whitney test found no significant difference in the degree of blunting tendencies between the groups (U=1610.50, p>0.05).

Sensory intensity of pain

Expected sensory pain. The Mann-Whitney test found no significant difference between the groups in the expected sensory pain levels (U=1821.00, p>0.05).

Experienced sensory pain. The Mann-Whitney test found no significant difference between the groups in the experienced sensory pain levels (U=1637.50, p>0.05).

Affective quality of pain

Expected affective pain. The Mann-Whitney test revealed no significant difference between the groups in the expected affective pain levels (U=1284.50, p>0.05).

Experienced affective pain. The Mann-Whitney test revealed no significant difference between the groups in the experienced affective pain levels (U=1602.50, p>0.05).

State anxiety

State anxiety before surgery. The Mann-Whitney test revealed that the sedation group had significantly higher state anxiety levels measured just before the surgery than the non-sedation group (U=1178.50, p<0.05).

State anxiety after surgery. The Mann-Whitney test found that the sedation group had significantly *lower* state anxiety levels assessed just after the surgery than the non-sedation group (U=994.00, p<0.01).

State anxiety day after surgery. The Mann-Whitney test showed no significant difference in the state anxiety levels measured on the following day of the surgery between the groups (U=1811.50, p>0.05).

Mood states

Positive mood before surgery. The Mann-Whitney test found no significant difference in the positive mood levels reported just before the surgery between the groups (U=1716.50, p>0.05).

Negative mood before surgery. The Mann-Whitney test showed that the sedation group reported significantly higher levels of negative mood assessed just before the surgery than the non-sedation group (U=1002.50, p<0.01).

Positive mood after surgery. The Mann-Whitney test found no significant difference in the positive mood levels measured just after the surgery between the groups (U=1832.50, p>0.05).

Negative mood after surgery. The Mann-Whitney test found that the sedation group reported significantly *lower* levels of negative mood measured just after the surgery than the non-sedation group (U=1192.50, p<0.05).

Positive mood day after surgery. The Mann-Whitney test found no significant difference in the positive mood levels assessed on the following day of the surgery between the groups (U=1695.00, p>0.05).

Negative mood day after surgery. The Mann-Whitney test found no significant difference in the negative mood levels assessed on the following day of the surgery between the groups (U=1676.00, p>0.05).

Surgical complexity

The Mann-Whitney test revealed that the sedation group had significantly more complicated surgical procedures than the non-sedation group (U=711.00, p<0.001).

Distress levels

The Mann-Whitney test found that the sedation group had *lower* stress levels rated by dental surgeons than the non-sedation group (U=1128.50, p<0.05).

Table 3-5-2d: Means, SD, *U* and *P* values of baseline variables for sedation states (n=318)

Variables	Sedation		Non-sedation		*U*	*P*
	Means	SD	Means	SD		
Age	28.17	4.41	31.82	9.10	1485.50	NS
Previous visit	0.08	0.29	0.38	0.87	1621.00	NS
*Occupation**	4.75	2.73	4.20	2.97	1522.50	NS
Educational levels	3.50	0.67	3.36	1.05	1607.50	NS
Dental anxiety	3.15	0.85	2.42	0.88	989.50	<0.01
Desired control	3.46	0.84	3.23	0.95	1600.00	NS
Felt control before	2.71	0.78	2.45	1.02	1525.50	NS
Felt control after	1.96	0.89	2.75	1.10	1089.00	<0.05
Pain catastrophizing	2.47	0.92	2.23	0.74	1604.00	NS
Manifest anxiety	7.29	4.19	7.64	4.63	1770.50	NS
Social desirability	15.20	4.30	17.49	5.10	1372.50	NS
Monitoring	10.83	3.61	10.37	3.11	1615.00	NS
Blunting	4.83	2.44	4.47	2.56	1610.50	NS
Expected sensory pain	5.50	3.03	5.61	2.37	1821.00	NS
Experienced sensory pain	4.58	3.45	5.01	2.72	1637.50	NS
Expected affective pain	6.75	2.80	5.21	3.23	1284.50	NS
Experienced affective pain	4.33	3.89	4.92	3.45	1602.00	NS
State anxiety before	2.72	0.60	2.30	0.71	1178.50	<0.05
State anxiety after	1.50	0.70	2.00	0.64	994.00	<0.01
State anxiety day after	1.76	0.58	1.81	0.68	1811.50	NS
Positive mood before	2.20	0.63	2.12	0.66	1716.50	NS
Negative mood before	2.30	0.73	1.74	0.65	1002.50	<0.01
Positive mood after	2.09	0.77	2.13	0.81	1832.50	NS
Negative mood after	1.18	0.30	1.45	0.52	1192.50	<0.05
Positive mood day after	2.32	0.80	2.22	0.84	1695.00	NS
Negative mood day after	1.33	0.28	1.40	0.54	1676.00	NS
Surgical complexity	0.84	0.86	-0.03	0.67	711.00	<0.001
Distress levels	2.08	3.16	2.42	1.67	1128.50	<0.05

NS=Non-significant

*The lower the figures were, the higher the ranks of occupations were.

Overall, more female patients had sedation than male patients. Sedation patients had higher dental anxiety, and reported to have had lower dental control than did non-sedation patients. The sedation group also had higher state anxiety before but lower after the surgery than the non-sedation group. Similarly, the sedation group had more negative mood before but less after the surgery than did the non-sedation group. In addition, sedation patients may have more complex procedures than non-sedation patients.

However, due to the sedation, the sedation group had lower distress levels during the surgery than the non-sedation group.

These differences led to the exclusion of the sedation group from the subsequent data analyses.

3-6. Main analyses

In this section, first, the effects of demographic factors on dental pain were reported. Only variables which significantly influenced dental pain were *gender* and *age*. Secondly, psychological factors significantly influencing dental pain were reported. Finally, those psychological predictors of dental pain and their antecedent factors were shown.

3-6-1. Gender and dental pain

In order to examine the gender differences in perception of sensory and affective pain, the Mann-Whitney tests were carried out for the data obtained from the following questionnaires: T1 the NRS; T3 the NRS; T1 the AVPDS and T3 the AVPDS. Means, SD, *U* and *P* values in each variable are tabulated in Table 3-6-1: Means, SD, *U* and *P* values of the gender differences in sensory and affective pain reports.

Sensory intensity of pain

Expected sensory pain. The Mann-Whitney test found no significant difference between men and women in the expected sensory pain levels (U=10791.50, p>0.05).

Experienced sensory pain. The Mann-Whitney test revealed that women experienced significantly higher levels of sensory pain than men (U=9827.50, p<0.05).

Affective quality of pain

Expected affective pain. The Mann-Whitney test found no significant difference between men and women in the expected affective pain levels (U=10836.00, p>0.05).

Experienced affective pain. The Mann-Whitney test revealed that women experienced significantly higher levels of affective pain than men (U=9228.50, p<0.001).

Table 3-6-1: Means, SD, *U* and *P* values of the gender differences in sensory and affective pain reports (n=306)

Variables	Male		Female		*U*	*P*
	Means	SD	Means	SD		
Expected sensory pain	5.44	2.43	5.76	2.30	10791.50	NS
Experienced sensory pain	4.60	2.73	5.36	2.68	9827.50	<0.05
Expected affective pain	5.09	3.31	5.30	3.17	10836.00	NS
Experienced affective pain	4.44	3.53	5.34	3.33	9228.50	<0.01

NS=Non-significant

Overall, while men and women did not differ in the levels of sensory and affective pain expectation, women reported to have experienced significantly higher levels of sensory and affective pain.

3-6-2. Age and dental pain

In order to examine the effects of age on perception of sensory and affective pain, the Spearman rank correlation coefficients were analysed for the data obtained from the following questionnaires: T1 the NRS; T3 the NRS; T1 the AVPDS and T3 the AVPDS (see Table 3-4-1: *Correlations of demographic variables and experienced sensory pain* in 3-4. *Relations among variables*/3-4-1. *Demographic variables and dental pain* section).

Sensory intensity of pain

Expected sensory pain. There was a significant negative correlation between *age* and *expected sensory pain* (ρ=-0.17, p<0.01).

Experienced sensory pain. There was a significant negative correlation between *age* and *experienced sensory pain* (ρ=-0.26, p<0.01).

Affective quality of pain

Expected affective pain. There was no significant correlation between *age* and *expected affective pain* (ρ=0.02, p>0.05).

Experienced affective pain. There was a significant negative correlation between *age* and *experienced affective pain* (ρ=-0.17, p<0.01).

On the whole, the older patients reported lower levels of expected and experienced sensory pain than did younger patients. Similarly, older patients experienced lower levels of affective pain, while age did not affect affective pain expectation.

3-6-3. Effects of psychological factors on dental pain

To explore the effects of psychological factors on *experienced sensory pain* measured by the T3 the NRS, the Spearman rank correlation coefficients were analysed for the data obtained from the following questionnaires: the MDAS (*dental anxiety*); the IDCI (*dental control*); the PCS (*pain catastrophizing*); the B-MAS (*manifest/trait anxiety*); the M-C SDS (*social desirability*); the MBSS (*monitor-blunter style coping*); T1 the NRS (*expected sensory pain*); T1 the AVPDS (*expected affective pain*) and the SRS-pain (*dentists' perception of pain*). Additionally, the relationship between *monitoring* and mood states was investigated (see Table 3-4-2: *Correlations of psychological variables and experienced sensory pain* in 3-4. *Relations among variables*/3-4-2. *Psychological variables and dental pain* section).

Dental anxiety

There was a significant positive correlation between *dental anxiety* and *experienced sensory pain* (ρ=0.21, p<0.01).

Dental control

The analyses for each separate item from the two-item IDCI-desire subscale were added here in addition to the analysis of the original two-item desire subscale, since relatively low alpha coefficient for the subscale was found (α=0.59). The items were labelled separately as *desire to control* and *desire to prevent pain*.

Desired control. There was a significant positive correlation between *desired control* and *experienced sensory pain* (ρ=0.17, p<0.01).

Desire to control. There was no significant correlation between *desire to control* and *experienced sensory pain* (ρ=0.08, p>0.05).

Desire to prevent pain. There was a significant positive correlation between *desire to prevent pain* and *experienced sensory pain* (ρ=0.20, p<0.01).

Felt (perceived) control before surgery. There was no significant correlation between *felt control* and *experienced sensory pain* (ρ=-0.06, p>0.05).

Pain catastrophizing

There was a significant positive correlation between *pain catastrophizing* and *experienced sensory pain* (ρ=0.17, p<0.01).

Manifest (trait) anxiety

There was a significant positive correlation between *manifest anxiety* and *experienced sensory pain* (ρ=0.22, p<0.01).

Social desirability

There was a significant negative correlation between *social desirability* and *experienced sensory pain* (ρ=-0.16, p<0.01).

Monitor-blunter style coping

Monitoring. There was a significant positive correlation between *monitoring* and *experienced sensory pain* (ρ=0.19, p<0.01).

Blunting. There was no significant correlation between *blunting* and *experienced sensory pain* (ρ=0.01, p>0.05).

Expected sensory pain

There was a significant positive correlation between *expectation of sensory pain* and *experienced sensory pain* (ρ=0.35, p<0.01).

Expected affective pain

There was a significant positive correlation between *expectation of affective pain* and *experienced sensory pain* (ρ=0.29, p<0.01).

Dentists' perception of pain

To address the differences between dental surgeons and patients in the levels of sensory pain ratings, the Wilcoxon Signed-Rank test was conducted. Means, SD, *T* and *P* values in each variable are tabulated in Table 3-6-3: Means, SD, *T* and *P* values of dental surgeons' and patients' sensory pain ratings. It was revealed that dental surgeons' sensory pain ratings were significantly lower than their patients' sensory pain reports (T=-12.85, P<0.001).

Table 3-6-3: Means, SD, *T* and *P* values of dental surgeons' and patients' sensory pain ratings

Variables	Dental surgeons		Patients		*T*	*P*
	Means	SD	Means	SD		
Experienced sensory pain	2.01	1.79	5.01	2.72	-12.85	<0.001

Additionally, *monitoring* was found to be significantly positively associated with *negative affect* before the surgery (ρ=0.13, p<0.05). However, it was not correlated with *positive affect* before, after and following day (ρ=0.04, p>0.05; ρ=0.05, p>0.05; ρ=0.05, p>0.05, respectively) and *negative affect* after and following day (ρ=0.09, p>0.05; ρ=0.10, p>0.05, respectively).

3-6-4. Predicting factors of dental pain

Multiple regression analyses were conducted to examine the contributions of the psychological and demographic factors to the prediction of *experienced sensory pain*. This approach controlled for the inter-correlation of predictors, and made it possible to determine which predictors accounted for significant variance of the criterion, i.e., *experienced sensory pain* above and beyond other predictors.

All predictors of experienced sensory pain

The psychological and demographic factors showing significant associations with *experienced sensory pain* (see Figure 3-4-3: Basic model of all factors predicting *experienced sensory pain* in 3-4. *Relations among variables*/3-4-3. *Model of dental pain* section) were entered in a multiple regression analysis using forward stepwise method (i.e., all predictor variables added at one time). Sixteen variables entered in a model:

dental anxiety; *desired control*; *pain catastrophizing*; *manifest anxiety*; *social desirability*; *monitoring*; *expected sensory pain*; *expected affective pain*; *state anxiety before*; *negative mood before*; *state anxiety after*; *positive mood after*; *negative mood after*; *surgical complexity*; *distress levels* and *age*.

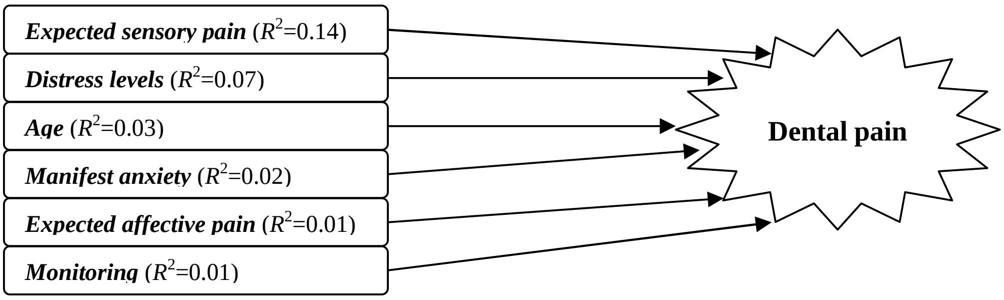
The analysis revealed six models (see Table 3-6-4a: Regression analysis for all predictors of *experienced sensory pain*). First, model 1-1 indicated that *expected sensory pain* had the strongest independent effect on dental pain, yielding a multiple *R* of 0.14, *F* (1, 293)=47.88, $p<0.001$. The second model (model 1-2) had an addition of *distress levels*, contributing an additional 7% of the variance to the prediction of pain, *F* change=24.45, $p<0.001$. Model 1-3 had an addition of *age*, besides *expected sensory pain* and *distress levels*, contributing an additional 3% of the variance, *F* change=11.73, $p<0.01$. Model 1-4 contained *manifest anxiety* in addition to *expected sensory pain*, *distress levels* and *age*, contributing an additional 2% of the variance, *F* change=7.35, $p<0.01$. The fifth model (model 1-5) had an extra predictor of *expected affective pain* as well as *expected sensory pain*, *distress levels*, *age* and *manifest anxiety*, adding 1% of the variance, *F* change=5.58, p<0.05. The last model, model 1-6 included *monitoring* in addition to *expected sensory pain*, *distress levels*, *age*, *manifest anxiety* and *expected affective pain*, adding further 1% of the variance, *F* change=4.67, $p<0.05$. This last combined set of predictors explained 28% variance in *experienced sensory pain* (see Figure 3-6-4a: Model 1 of all factors predicting *experienced sensory pain*).

Accordingly, the probability of experiencing pain during/after dental treatment was higher among those with higher expectation of sensory pain, those with higher distress levels observed by the dental surgeon, those who were younger, those with higher trait anxiety, those with higher expectation of affective pain and those with higher monitoring tendencies. Interestingly, neither *surgical complexity*, *dental/state anxiety* nor *pain catastrophizing* accounted for *experienced sensory pain*.

Table 3-6-4a: Regression analysis for all predictors of *experienced sensory pain*

Model	Predictors	R^2	R^2 change	F change	β	P
1-1	1. *Expected sensory pain*	0.14	0.14	47.88	0.43	<0.001
1-2	1. *Expected sensory pain*	0.21	0.07	24.45	0.40	<0.001
	2. *Distress levels*				0.42	
1-3	1. *Expected sensory pain*	0.24	0.03	11.73	0.37	<0.01
	2. *Distress levels*				0.40	
	3. *Age*				-0.05	
1-4	1. *Expected sensory pain*	0.26	0.02	7.35	0.34	<0.01
	2. *Distress levels*				0.38	
	3. *Age*				-0.06	
	4. *Manifest anxiety*				0.08	
1-5	1. *Expected sensory pain*	0.27	0.01	5.58	0.26	<0.05
	2. *Distress levels*				0.35	
	3. *Age*				-0.06	
	4. *Manifest anxiety*				0.08	
	5. *Expected affective pain*				0.12	
1-6	1. *Expected sensory pain*	0.28	0.01	4.67	0.24	<0.05
	2. *Distress levels*				0.37	
	3. *Age*				-0.06	
	4. *Manifest anxiety*				0.06	
	5. *Expected affective pain*				0.11	
	6. *Monitoring*				0.10	

Figure 3-6-4a: Model 1 of all factors predicting *experienced sensory pain*



Modifiable psychological predictors of experienced sensory pain

To explore psychological predictors which are modifiable for potential psychological interventions, a multiple regression analysis was conducted, using forward stepwise method. That is, *distress levels* rated by the dental surgeons, *age* and *surgical complexity* were excluded. Thirteen variables entered into a model: *dental anxiety*; *desired control*; *pain catastrophizing*; *manifest anxiety*; *social desirability*; *monitoring*; *expected sensory pain*; *expected affective pain*; *state anxiety before*; *negative mood before*; *state anxiety after*; *positive mood after* and *negative mood after*.

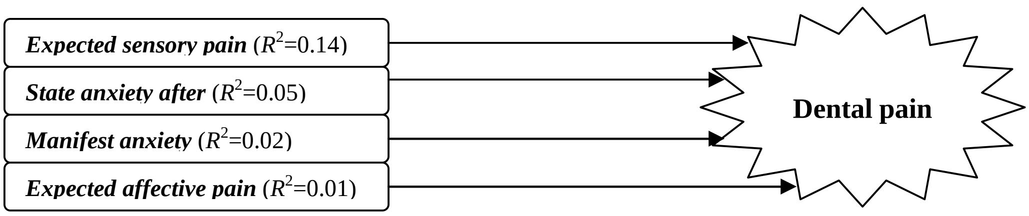
The analysis revealed four models (see Table 3-6-4b: Regression analysis for modifiable psychological predictors of *experienced sensory pain*). First, model 2-1 indicated that *expected sensory pain* had the strongest independent effect on dental pain, yielding a multiple R of 0.14, F (1, 293)=47.88, p<0.001. The second model (model 2-2) had an addition of *state anxiety after,* contributing an additional 5% of the variance to the prediction of pain, F change=16.56, p<0.001. Model 2-3 had an addition of *manifest anxiety*, besides *expected sensory pain* and *state anxiety after*, contributing an additional 1% of the variance, F change=6.19, p<0.05. The last model, model 2-4 contained *expected affective pain* in addition to *expected sensory pain*, *state anxiety after* and *manifest anxiety*, contributing an additional 2% of the variance, F change=4.92, p<0.05. This last combined set of predictors explained 22% variance in *experienced sensory pain* (see Figure 3-6-4b: Model 2 of all factors predicting *experienced sensory pain*). Accordingly, there are four major dental pain predictors: *expected sensory pain*, *state anxiety after*, *trait anxiety* and *expected affective pain*.

In other words, the probability of experiencing pain during/after dental treatment was higher among those with higher expectation of sensory pain, those with higher state anxiety levels after the surgery, those with higher trait anxiety and those with higher expectation of affective pain. Still, interestingly, neither *pain catastrophizing* nor *dental anxiety* predicted *experienced sensory pain*.

Table 3-6-4b: Regression analysis for modifiable psychological predictors of *experienced sensory pain*

Model	Predictors	R^2	R^2 change	F change	β	P
2-1	1. *Expected sensory pain*	0.14	0.14	47.88	0.43	<0.001
2-2	1. *Expected sensory pain*	0.19	0.05	16.56	0.36	<0.001
	2. *State anxiety after*				0.93	
2-3	1. *Expected sensory pain*	0.20	0.02	6.19	0.34	<0.05
	2. *State anxiety after*				0.86	
	3. *Manifest anxiety*				0.08	
2-4	1. *Expected sensory pain*	0.22	0.01	4.92	0.27	<0.05
	2. *State anxiety after*				0.81	
	3. *Manifest anxiety*				0.07	
	4. *Expected affective pain*				0.11	

Figure 3-6-4b: Model 2 of modifiable psychological factors predicting *experienced sensory pain*



3-6-5. Psychological factors preceding the dental pain predictors

In order to investigate which factors influence the major dental pain predictors (i.e., *expected sensory pain*, *state anxiety after*, *trait anxiety* and *expected affective pain*), the psychological factors showing significant associations with each of the major predictors were entered in each of the multiple regression analyses using forward stepwise method.

Expected sensory pain

Seven factors entered into a model: *dental anxiety*; *desired control*; *felt control*; *pain catastrophizing*; *manifest anxiety*; *social desirability* and *monitoring*. The analysis showed three models (see Table 3-6-5a: Regression analyses for psychological factors preceding *expected sensory pain*). First, model 3-1-1 indicated that *dental anxiety* had the strongest independent effect on *expected sensory pain*, yielding a multiple R of 0.35, F (1, 303)=40.1, p<0.001. The second model (model 3-1-2) had an addition of *monitoring*, contributing an additional 4% of the variance to the prediction of *expected sensory pain*, F change=14.08, p<0.001. Model 3-1-3 had an addition of *felt control*, besides *dental anxiety* and *monitoring*, contributing an additional 1% of the variance, F change=4.80, p<0.05. The last combined set of preceding factors explained 17% variance in *expected sensory pain*.

Accordingly, the likelihood of having higher expectation of pain was greater among those with higher dental anxiety, those having monitoring tendencies and those with lower perceived control over the dental surgery.

Table 3-6-5a: Regression analyses for psychological factors preceding *expected sensory pain*

Model	Preceding factors	R^2	R^2 change	F change	β	P
3-1-1	1. *Dental anxiety*	0.12	0.12	40.91	0.93	<0.001
3-1-2	1. *Dental anxiety*	0.16	0.04	14.08	0.88	<0.001
	2. *Monitoring*				0.15	
3-1-3	1. *Dental anxiety*	0.17	0.01	4.80	0.81	<0.05
	2. *Monitoring*				0.16	
	3. *Felt control*				-0.27	

State anxiety after

Five factors entered into a model: *dental anxiety*; *felt control*; *pain catastrophizing*; *manifest anxiety* and *social desirability*. The analysis showed three models (see Table 3-6-5b: Regression analyses for psychological factors preceding *state anxiety after*). First, model 3-2-1 indicated that *dental anxiety* had the strongest independent effect on *state anxiety after*, yielding a multiple R of 0.29, F (1, 300)=28.41, p<0.001. The second model (model 3-2-2) had an addition of *felt control*, contributing an additional 3% of the variance to the prediction of *state anxiety after*, F change=10.71, p<0.01. The last model, model 3-2-3 had an addition of *social desirability*, besides *dental anxiety* and *felt control*, contributing an additional 1% of the variance, F change=4.46, p<0.05. The last combined set of preceding factors accounted for 13% variance in *state anxiety after*.

Accordingly, the likelihood of having higher state anxiety after the dental surgery was greater among those with higher dental anxiety, those with lower perceived control over the surgery and those with lower social desirability.

Table 3-6-5b: Regression analyses for psychological factors preceding *state anxiety after*

Model	Preceding factors	R^2	R^2 change	F change	β	P
3-2-1	1. *Dental anxiety*	0.09	0.09	28.41	0.22	<0.001
3-2-2	1. *Dental anxiety*	0.12	0.03	10.71	0.20	<0.01
	2. *Felt control*				-0.12	
3-2-3	1. *Dental anxiety*	0.13	0.01	4.46	0.19	<0.05
	2. *Felt control*				-0.11	
	3. *Social desirability*				-0.01	

Manifest anxiety

Five factors entered into a model: *dental anxiety*; *desired control*; *pain catastrophizing*; *social desirability* and *monitoring*. The analysis revealed three models (see Table 3-6-5c:

Regression analyses for psychological factors preceding *manifest anxiety*). First, model 3-3-1 showed that *pain catastrophizing* had the strongest independent influence on *manifest anxiety*, yielding a multiple R of 0.42, F (1, 304)=65.17, p<0.001. The second model (model 3-3-2) had an addition of *social desirability*, contributing an additional 9% of the variance to the prediction of *manifest anxiety*, F change=39.04, p<0.001. The third model, model 3-3-3 had an addition of *dental anxiety*, besides *pain catastrophizing* and *social desirability*, contributing an additional 1% of the variance, F change=4.21, p<0.05. The last combined set of preceding factors accounted for 28% variance in *manifest anxiety*.

Therefore, the possibility of having higher trait anxiety was greater among those with higher *pain catastrophizing*, those with lower social desirability and those with higher dental anxiety.

Table 3-6-5c: Regression analyses for psychological factors preceding *manifest anxiety*

Model	Preceding factors	R^2	R^2 change	F change	β	P
3-3-1	1. *Pain catastrophizing*	0.18	0.18	65.17	2.63	<0.001
3-3-2	1. *Pain catastrophizing*	0.27	0.09	39.04	2.34	<0.001
	2. *Social desirability*				-0.28	
3-3-3	1. *Pain catastrophizing*	0.28	0.01	4.21	2.03	<0.05
	2. *Social desirability*				-0.28	
	3. *Dental anxiety*				0.59	

Expected affective pain

Six factors entered into a model: *dental anxiety*; *desired control*; *felt control*; *pain catastrophizing*; *manifest anxiety* and *monitoring*. The analysis revealed two models (see Table 3-6-5d: Regression analyses for psychological factors preceding *expected affective pain*). First, model 3-4-1 showed that *dental anxiety* had the strongest independent influence on *expected affective pain*, yielding a multiple R of 0.33, F (1, 304)=38.01, *p*<0.001. The second model (model 3-4-2) had an addition of *pain catastrophizing*, contributing an additional 3% of the variance to the prediction of *expected affective pain*, *F* change=10.09, *p*<0.01. This set of preceding factors accounted for 14% variance in *expected affective pain*.

Hence, the possibility of having higher expected affective pain was greater among those with higher dental anxiety and those with higher *pain catastrophizing*.

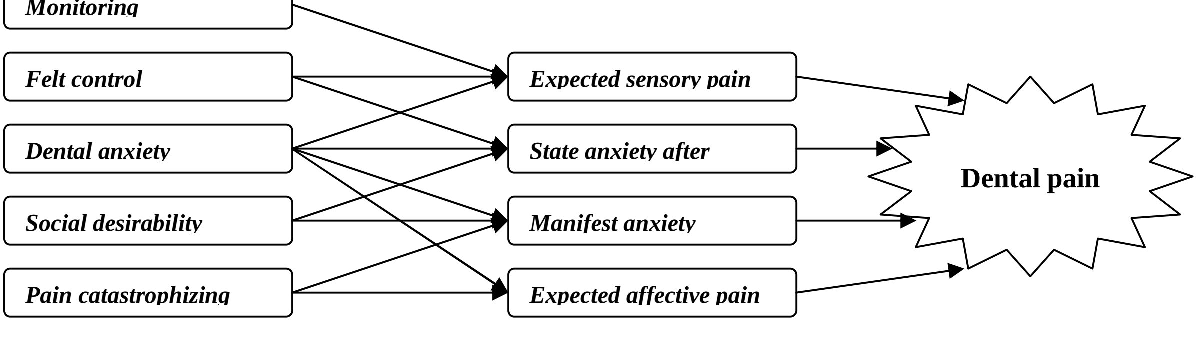
Table 3-6-5d: Regression analyses for psychological factors preceding *expected affective pain*

Model	Preceding factors	R^2	R^2 change	*F* change	*β*	*P*
3-4-1	1. *Dental anxiety*	0.11	0.11	38.01	2.63	<0.001
3-4-2	1. *Dental anxiety*	0.14	0.03	10.09	2.03	<0.01
	2. *Pain catastrophizing*				-0.28	

3-6-6. Model of psychological antecedents to dental pain

Figure 3-6-6 presents the whole picture of psychological antecedents to *experienced sensory pain* (model 3). Model 3 was created from the modifiable psychological predictors (model 2) and its preceding psychological factors.

Figure 3-6-6: Model 3 of psychological antecedents to *experienced sensory pain*



3-6-7. Dental anxiety components contributing to the dental pain predictors

It appears that *dental anxiety* accounts for the variation in some way or other in every dental pain predictor (i.e., *expected sensory pain*, *state anxiety after*, *manifest anxiety* and *expected affective pain*). In order to explore what component/s of *dental anxiety* contribute to these four dental pain predictors, all five items of the MDAS were entered into multiple regression analyses using forward stepwise method. The five items were:-

Item 1: *If you went to your dentist for treatment, how would you feel?*

Item 2: *If you were sitting in the waiting room waiting for treatment, how would you feel?*

Item 3: *If you were about to have a tooth drilled, how would you feel?*

Item 4: *If you were about to have your teeth scaled and polished, how would you feel?*

Item 5: *If you were about to have a local anaesthetic injection in your gum, above an upper back tooth, how would you feel?*

Dental anxiety* and *expected sensory pain

The analysis revealed one model (see Table 3-6-7a: Regression analysis for *dental anxiety* component/s contributing to *expected sensory pain*). The model indicated that Item 5: *local anaesthetic* had the strongest influence on sensory pain expectation, yielding a multiple R of 0.37, F (1, 302)=48.92, p<0.001. None of the other items significantly added power to the prediction of sensory pain expectation. The *local anaesthetic* component alone explained 14% of variance in pain expectation.

Accordingly, the best predictor of having sensory pain expectation was the degree to which patients showed anxiety in having a local anaesthetic.

Table 3-6-7a: Regression analysis for dental anxiety component/s contributing to *expected sensory pain*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Local anaesthetic*	0.14	0.14	48.92	0.73	<0.001

Dental anxiety* and *state anxiety after

The analysis found one model (see Table 3-6-7b: Regression analysis for *dental anxiety* component/s contributing to *state anxiety after*). The model indicated that Item 3: *dental drill* had the strongest effect on post-surgery state anxiety, yielding a multiple R of 0.31, F (1, 299)=31.75, p<0.001. None of the other items significantly added power to the prediction of post-surgery state anxiety. The *dental drill* component alone explained 10% of variance in post-surgery anxiety.

Hence, the best predictor of having post-surgery state anxiety was the degree to which patients showed anxiety in having their tooth drilled.

Table 3-6-7b: Regression analysis for dental anxiety component/s contributing to *state anxiety after*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Dental drill*	0.10	0.10	31.75	0.18	<0.001

Dental anxiety* and *manifest/trait anxiety

The analysis showed one model (see Table 3-6-7c: Regression analysis for *dental anxiety* component/s contributing to *manifest/trait anxiety*). The model specified that Item 3: *dental drill* had the strongest effect on trait anxiety, yielding a multiple R of 0.28, F (1, 304)=25.55, *p*<0.001. None of the other items significantly added power to the prediction of trait anxiety. The *dental drill* component alone accounted for 8% of variance in trait anxiety.

Hence, the best predictor of having trait anxiety was the degree to which patients showed anxiety in having their tooth drilled.

Table 3-6-7c: Regression analysis for *dental anxiety* component/s contributing to *manifest/trait anxiety*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Dental drill*	0.08	0.08	25.55	1.13	<0.001

Dental anxiety **and** ***expected affective pain***

The analysis found two models (see Table 3-6-7d: Regression analysis for *dental anxiety* component/s contributing to *expected affective pain*). The first model showed that *local anaesthetic* had the strongest independent influence on *expected affective pain*, yielding a multiple *R* of 0.35, *F* (1, 303)=42.38, *p*<0.001. The second model had an addition of the *dental drill* component, contributing an additional 1% of the variance to the prediction of *expected affective pain*, *F* change=4.98, *p*<0.05. The *local anaesthetic* and *dental drill* components together accounted for 14% of variance in *expected affective pain*.

Accordingly, the possibility of having higher *expected affective pain* was greater among those who had higher anxiety in having a local anaesthetic injection and dental drill.

Table 3-6-7d: Regression analysis for *dental anxiety* component/s contributing to *expected affective pain*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Local anaesthetic*	0.12	0.12	42.38	0.93	<0.001
2	1. *Local anaesthetic*	0.14	0.01	4.98	0.60	<0.05
	2. *Dental drill*				0.48	

3-6-8. Pain catastrophizing components contributing to the dental pain predictors

It was shown that *pain catastrophizing* accounts for the variations in *manifest anxiety* and *expected affective pain*. To examine what component/s of *pain catastrophizing* contribute to these dental pain predictors, all 13 items of the PCS were entered into multiple regression analyses using forward stepwise method. The 13 items were:-

Item 1: *I worry all the time about whether the pain will end.*

Item 2: *I feel I can't go on.*

Item 3: *It's terrible and I think it's never going to get any better.*

Item 4: *It's awful and I feel that it overwhelms me.*

Item 5: *I feel I can't stand it anymore.*

Item 6: *I become afraid that the pain may get worse.*

Item 7: *I think of other painful experiences.*

Item 8: *I anxiously want the pain to go away.*

Item 9: *I can't seem to keep it out of my mind.*

Item 10: *I keep thinking about how much it hurts.*

Item 11: *I keep thinking about how badly I want the pain to stop.*

Item 12: *There is nothing I can do to reduce the intensity of the pain.*

Item 13: *I wonder whether something serious may happen.*

Pain catastrophizing **and** ***manifest anxiety***

The analysis revealed three models (see Table 3-6-8a: Regression analysis for *pain catastrophizing* component/s contributing to *manifest anxiety*). The first model showed that item 4: *overwhelming* had the strongest independent influence on *manifest anxiety*, yielding a multiple R of 0.38, F (1, 287)=49.63, p<0.001. The second model had an addition of item 10: *keep thinking*, contributing an additional 3% of the variance to the prediction of *manifest anxiety*, F change=11.20, p<0.005. The third model had an addition of item 12: *nothing can be done*, besides item 4: *overwhelming* and item 10: *keep thinking*, contributing an additional 2% of the variance, F change=6.96, p<0.01. The combined set of *pain catastrophizing* components explained 20% of variance in *manifest anxiety*.

Accordingly, the best predictor of trait anxiety was the degree to which patients felt that pain overwhelmed them, kept thinking how much it hurts and felt that there was nothing they could do to reduce the intensity of the pain.

Table 3-6-8a: Regression analysis for *pain catastrophizing* component/s contributing to *manifest anxiety*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Overwhelming*	0.15	0.15	65.17	1.90	<0.001
2	1. *Overwhelming* 2. *Keep thinking*	0.18	0.03	39.04	1.36 0.95	<0.005
3	1. *Overwhelming* 2. *Keep thinking* 3. *Nothing can be done*	0.20	0.02	4.21	1.19 0.78 0.71	<0.01

Pain catastrophizing and *expected affective pain*

The analysis found two models (see Table 3-6-8b: Regression analysis for *pain catastrophizing* component/s contributing to *expected affective pain*). The first model showed that item 5: *can't stand it* had the strongest independent influence on *expected affective pain*, yielding a multiple R of 0.28, F (1, 287)=24.15, p<0.001. The second model had an addition of item 13: *something serious may happen,* contributing an additional 1% of the variance to the prediction of *expected affective pain*, F change=4.90, p<0.05. The *can't stand it* and *something serious may happen* components together accounted for 9% of variance in *expected affective pain*.

Hence, the best predictor of *expected affective pain* was the degree to which patients felt they could not stand pain any more and wonder whether something serious may happen.

Table 3-6-8b: Regression analysis for *pain catastrophizing* component/s contributing to *expected affective pain*

Model	Preceding factors	R^2	R^2 change	F change	β	P
1	1. *Can't stand it*	0.08	0.78	24.15	0.91	<0.001
2	1. *Can't stand it* 2. *Something serious may happen*	0.09	0.16	4.90	0.71 0.40	<0.05

CHAPTER 4: Discussion

First, this chapter will discuss the differences between the study non-completers and the completers. Then, it will look at the effects of demographic factors on dental pain, i.e., gender and age – only demographic variables which significantly influenced dental pain in the present study. Secondly, it will look at psychological factors influencing dental pain. Finally, contributing psychological factors to dental pain will be examined.

4-1. Demographic factors and dental pain

4-1-1. Non-completers vs. completers

The non-completers were found to be younger, visited UCL Eastman Dental Institute more frequently, and had higher levels of dental anxiety than the completers.

Age. Those who completed the study were older than those who did not. It can be said that older people, compared to younger ones, seem to have more patience, commitment or sense of responsibility to complete a task. Hence, the present study may have represented more older people than younger ones.

Dental visits. It may be possible that from their more frequent dental institute visits, the non-completers felt that completing the study was less important compared to how the completers regarded the task, knowing that there were some other occasions when there was no research taking place at the dental institute. In contrast, the completers may have seen the study as sort of a part of the treatment package, and felt the importance of completing it. Accordingly, whether one completed the study or not was not meaningfully influenced by the frequency of the dental visit.

Dental anxiety. Even having completed the first set of questionnaires which could be filled in at any time, the non-completers were too dentally anxious to rate their mood states, state anxiety, levels of sensory and affective pain in real-time. For this reason, patients with high dental anxiety may have been less represented in the study.

4-1-2. Gender and dental pain

In line with previous research, the present study found that while men and women did not differ in the levels of anticipated pain intensity (sensory pain) and unpleasantness (affective pain), women reported that they experienced significantly higher levels of pain intensity and unpleasantness.

Gender differences in pain perception have been well established, with women, on average, reporting more intense pain, more frequent pain and pain of longer duration than men (Unruh, 1996). Similarly, women appear more likely than men to experience pain in multiple body regions (Dao & LeResche, 2000). In addition, women are more worried about pain, while men are more embarrassed by pain (Klonoff & Landrine, 1992). Indeed, the large-to-moderate magnitude of sex differences in experimental pain perception was confirmed in a recent review (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams & Riley III, 2009).

Several factors have been proposed to explain sex differences both in clinical and experimental pain responses. Some studies support psychological and socio-cultural factors, while others support biological mechanisms, such as genes, hormones and cortical brain activity to account for these differences.

For socio-cultural reasons, in general, men are more reluctant to admit their sufferings. It has been well-documented that in experiments men report lower pain intensity ratings, and exhibit greater pain tolerance when the experimenter is a woman. The effect was even amplified when tested by an attractive experimenter with men reporting significantly less pain to the female experimenter than they do to the male experimenter (Levine & De Simone, 1991).

On the other hand, studies of specific noxious stimuli and brain activity indicate that women are better able to discriminate between levels of stimuli compared with men (Feine, Bushnell, Miron & Duncan, 1991). Moreover, despite the fact that both genders had similar bilateral activation of the premotor cortex and several contralateral structures during experimental heat pain, women had a greater activation of the contralateral IC and Th than did men (Paulson, Minoshima, Morrow & Casey, 1998). There is also evidence that the body's natural pain killer system, i.e., the endogenous opioids, works differently in women in comparison to men. For example, in a deep-masseter muscle pain stimulation, PET found less µ-Opioid system activation in the nucleus accumbens of female participants, an area previously associated with hyperalgesic responses to the blockade of opioid receptors in experimental animals (Zubieta, Smith, Bueller, Xu, Kilbourn, Jewett, Meyer, Koeppe & Stohler, 2002).

Accordingly, it is possible that these neurobiological differences may be related to greater pain expression among women. Or, most likely, the interaction between neurobiological mechanisms and psychological factors plays a contributory role in explaining gender differences in pain response (Popescu, LeResche, Truelove & Drangsholt, 2010).

4-1-3. Age and dental pain

The results indicated that an overall decrease in anticipated and experienced pain intensity and unpleasantness experienced across the age span. It is often assumed that aging results in loss of pain sensitivity. However, clinicians should be aware that there are no conclusive data that progressive loss of sensitivity to nociceptive stimuli occurs with age (Walco & Harkins, 1999). The age-related decrease in pain is not thought to be attributable to changes in the physiological pain system (Watkins *et al*. 2002). There is some evidence that stoicism increases with age and potentially accounts for lower pain reports (Gibson, Katz, Corran, Farrell & Helme, 1994) until the final months of life, in which pain reports increase (Thomas & Roy, 1999).

4-2. Psychological factors and dental pain

4-2-1. Dental anxiety

Consistent with previous studies, it was found that higher levels of dental anxiety were associated with more pain experienced during and after the dental surgery. Thus, the hypothesis: patients with high dental anxiety would report more pain than those with low dental anxiety, was supported.

Within the dental context, anxiety and pain exist in a reciprocal relationship. It is, therefore, not surprising that dentally anxious patients reported that they had experienced higher pain intensity. The most obvious explanation is that highly dentally anxious patients must have had a strongly negative experience in dentistry, resulting in a higher "fear of dental pain" score (van Wijk & Hoogstraten, 2005). Indeed, the MDAS asked patients to express their feelings about having, in particular, drilling, scaling and local anaesthetic injection which more likely provoke pain-amplifying thoughts. Consequently, those who scored high on the scale can be seen as highly pain-sensitive individuals. Naturally, dental anxiety, captured by the pain-amplifying questions, has been shown to exert an impact on the perceived pain threshold, leading to more than the inevitable discomfort. This is seen in the 4-1-1. *Non-completers vs. completers* section of 4-1. *Demographic factors and dental pain*.

4-2-2. Dental control (desired/felt)

Desired control

It was revealed that the levels of *desired control* were positively associated with pain levels. This fulfilled the hypothesis: patients with higher *desired control* would report more pain than those with lower *desired control*.

"To what degree would you like control over what will happen to you in the dental chair?" (i.e., *desire to control*) and "To what degree are you concerned about not being able to prevent something which might cause you pain?" (i.e., *desire to prevent pain*) were the desired control subscale questions. It is interesting to find that while *desire to control* was not significantly associated with amount of pain experienced, *desire to prevent pain* was. Dental procedures provide considerably low objective controllability (Logan *et al*., 1991), in particular, in stressful dentistry. Naturally, patients experience a sense of loss of independence because of the passive nature of the situations.

Thus, it could be this difficulty in control that made the patients less concerned with controllability since they regarded having control over their surgery as almost impossible. In other words, whether one is a high-pain reporter or a low-pain reporter, the way one looks at the situation is similar – i.e., almost uncontrollable. In fact, the author was frequently asked by the participants to the study what it means by “control over what will happen in the dental chair” as they filled in the questionnaire.

Coolidge *et al*. (2005) recently revised the IDCI. The *desired control* subscale in the revised version consists of five items including a question about control over one’s thoughts: “How much control would you like to have over your negative thoughts during your dental procedure?”. One may observe possibilities of control over one’s own thoughts rather than over the situation. This, in turn, gives one a chance to desire it. Thus, it is possible that the revised subscale will capture differences amongst people. Accordingly, future research would benefit from the use of this revised version, instead.

In contrast, the *desire to prevent pain* scale item is more pain specific. Those concerned about not being able to prevent something which might cause them pain are somewhat anticipating higher levels of pain. As in Lazarus and his colleagues’ transactional model of stress, high desired control for pain seems quite analogous to a threatening primary appraisal about the threatening pain-provoking medical event. When potential harm is assessed as high, elevated levels of stress are probable. Such elevated levels of stress are associated with autonomic activity (Chrousos, 2000) and the associated autonomic arousal has been linked with elevated levels of pain (Logan *et al*., 2001)[a].

Felt (perceived) control before surgery

It was found that there was no significant correlation between *felt control* and pain intensity. The result, therefore, did not conform to the hypothesis: patients with higher *felt control* would report less pain than those with lower *felt control*.

As discussed in the *Desired control* section above, this could also be due to the nature of controllability in the dental chair as questioned in “Do you feel that you have control of what will happen to you when you are in a dental chair?” and “How much do you think you can control what happens to you in the dental chair?”. It seems that regardless of coping patterns or cognitive orientations, patients’ perception of little direct personal control over the situation made it unable to differentiate those who report higher pain intensity from those who report lower intensity.

Coolidge *et al*.’s (2005) revised version of the *felt control* subscale, renamed as “*predicted control*” subscale, includes an item assessing one’s perceived control over their thoughts: “How much do you think you can control your negative thoughts during dental treatment?”. Similar to *desired control* variable in the revised version, one may feel having more power over one’s thoughts than over the situational factors. Thus, it may give individuals opportunities to feel control. This, therefore, could have differentiated those high-pain reporters from low-pain reporters.

4-2-3. Pain catastrophizing

In accordance with prior research, it was shown that *pain catastrophizing* was positively correlated with pain intensity. Accordingly, the hypothesis: patients with higher *pain catastrophizing* would report more pain than those with lower *pain catastrophizing*, was upheld.

One of the most consistent findings has been that catastrophizing is associated with heightened pain experience (Sullivan *et al*., 2001)[a]. Catastrophizing has been considered as an attention-seeking coping strategy (Sullivan *et al*., 2004)[b], a response to distress (Sullivan *et al*., 2001)[a] and a cognitive determinant of pain experience (Sullivan *et al*., 2001)[b]. Implicit in the present study is the view that catastrophizing is causally related to pain, and the pattern of findings appears to support the causal or, at least, antecedent status of catastrophizing. For example, catastrophizing, assessed while patients were in a pain-free pre-surgery state as in the present study, prospectively predicts pain reports made in response to the aversive dental procedures. Consequently, it may be possible to postulate that *pain catastrophizing* is a cognitive determinant of dental pain, at least, in the present study.

4-2-4. Expectation of pain (sensory/affective)

Sensory pain

It was demonstrated that higher *expected sensory pain* was associated with heightened pain intensity. The result, therefore, supported the hypothesis: patients with higher sensory pain expectation would report more sensory pain than those with lower pain expectation.

It has been claimed that amplified anticipated dental pain can be the results of distortion in recall of pain-free treatment, intermittent experience of sudden severe pain, expecting pain in order to reduce its impact, or uncertainty about treatment (Lindsay & Jackson, 1993). Klages *et al*. (2006) claim that those with elevated anxiety sensitivity are prone to exaggerate pain expectations when the aversive situation is perceived as fear relevant as in the case of *desired control*. Magnified pain expectation similar to elevated levels of stress may lead to autonomic activity, and the associated autonomic arousal has been linked with elevated levels of pain (Logan *et al*., 2001)[a].

Additionally, it is interesting that all patients on average rated both anticipated and experienced sensory pain only slightly above the median point of the 11-point box scale (means=5.61 and 5.01, respectively). This could be due to the local analgesia which patients received. They may have had an assumption over the analgesia blocking or at least controlling their treatment pain (i.e., expected), and it may have actually worked as anticipated during and after the surgery (i.e., experienced). Hence, patients neither expected nor experienced as much pain they may have otherwise complained. Most importantly, patients should not have more than unnecessary pain – this is what local analgesia is for.

Affective pain

The perception of pain is reflected not only in sensory-discriminative component but also in affective aspect. It was revealed that higher affective pain anticipation was associated with heightened pain intensity. Patients with higher anticipated affective pain were those who had emotional arousal and disruption engendered by the sensory dental treatment pain. It is not surprising that as dental anxiety had impact on sensory pain intensity, highly anticipated affective pain may have caused autonomic arousal leading to the heightened levels of the treatment pain.

In addition, the questionnaire which assessed the affective pain carries 15 emotional words describing the unpleasantness of pain from “Bearable” through

“Awful” to “Excruciating”. It is intriguing that all patients on average rated both anticipated and experienced affective pain as not worse than “Oppressive” which was lower than the middle point of the scale marked by “Awful”. Similar to the sensory pain, this could be due to the relatively “moderate” pain intensity controlled by the local analgesia.

4-2-5. Social desirability

It was revealed that *social desirability* was negatively associated with the amount of pain experience. Accordingly, this maintained the hypothesis: patients with higher defensiveness would report less pain than those with lower defensiveness.

Contrary to a lay person’s expectation or common sense, there has been evidence which indicates that chronic pain sufferers with higher defensiveness report rather higher levels of pain than those with lower defensiveness. However, the opposite is true for acute experimental pain sufferers. In the present study, patients’ pain was short-lived with a certain recovery. Thus, defensive individuals did not suffer enough emotional distress to gain attention by magnifying pain intensity. Rather, they showed to be less bothered by their transient pain by downplaying it. Hence, defensive patients seemed to have managed to maintain their stoicism and favourable images as a healthy and well-maintained person.

4-2-6. Monitor-blunter style coping

Monitoring

It was found that higher levels of *monitoring* were correlated with heightened levels of pain. The result was consistent with the hypothesis: patients with higher monitoring tendencies would report more pain than those with lower monitoring tendencies.

Patients with continuing pain problems are often assumed to be excessively attentive for their symptoms, and this is referred to as hypervigilance (Van Damme, Legrain, Vogt & Crombez, 2010). Thus, the result from the present study supported the view that pain is more intense in persons who are hypervigilant for or bias their attention to pain information.

One of most important situational factors affecting coping responses under threat is controllability. Miller (1980) claims that this controllability influences the choice between *monitoring* and *blunting*. When an aversive event is controllable, *monitoring* is the main coping mode, whereas when uncontrollable, *monitoring* which heightens arousal has no instrumental value, and *blunting* becomes main coping mode (*ibid.*). Accordingly, similar to *desired control* and *expectation of pain*, this arousal for *monitors* who “fail” to switch to *blunters* may well leads to elevated levels of pain perception.

According to the classification of *monitors* by the MBSS dental treatment scenario, *monitors* are those who ask the dentist exactly what he/she was going to do, want the dentist to tell when they would feel pain, watch all the dentist’s movements and listen for the sound of the drill, and watch the flow of water from the mouth to see if it contained blood. It is possible that these monitors’ hypervigilant behaviours had brought amplified pain perception.

In addition, it was found that monitoring was shown to be positively associated only with negative mood before the surgery. Although Marco *et al*. (1999) suggested that monitors may become anxious to have *positive affect*. Accordingly, it was argued that when asked to report positive events and positive emotion, those who have *monitoring* tendencies may feel more obliged to report *positive affect* than when asked to report a negative one. Obviously, this was not the case in the present study. This is more likely due to the concept of *monitoring* being utilised by the questionnaire with hypothetical stressful events. The questions about the actions one takes for those stressful episodes are designed to bring out subjective distress and unpleasant engagement. It is, therefore, possible that *monitors* were focusing more on *negative affect* before the surgery than on *positive affect* for possible problem-solving strategies for the subsequent stressful event.

Blunting

It was shown that there was no relationship between *blunting* and pain intensity. Hence, the result was not in line with the hypothesis: patients with higher blunting tendencies would report less pain than those with lower blunting tendencies.

Blunters in the MBSS dental treatment scenario, are those who take a tranquilliser or have a drink before going, try to think about pleasant memories, try to sleep, and do mental puzzles in the mind. Hence, high *blunters* were characterised as *distractors* (Miller, 1987). The term entails rather effortful and purposeful distracting reaction to any negative or threatening information as described by these *blunting* behaviour examples. Yet, someone not attending stressful cues does not always mean that the person is deliberately distracting oneself from the threatening event. It could be possible that the person is simply not attending the potentially aversive cues without intentional effort to shun it.

The MBSS has been criticised for its mainly uncontrollable scenarios (Bijttebier *et al*., 2001). With the questionnaire carrying those uncontrollable scenarios, the influence of situational factors may have overwhelmed that of dispositional coping factors. That is, those uncontrollable situations may have overwhelm even their potential *blunting* efforts by making individuals do nothing as in the case of “freezing”, making the respondents, regardless of their coping patterns, report equally low monitoring tendencies, if not high blunting. The relatively low reliably alpha (α=0.61) of the *blunting* subscale may support this notion.

In view of that, future research could benefit from the use of a revised version of the MBSS, the Frankfurt Monitoring Blunting Scale (FMBS: Voss, Müller & Schermelleh-Engel, 2006) instead, for the new scale contains controllable situational scenarios which are lacking in the conventional MBSS. The FMBS distinguishes between coping behaviour in controllable and uncontrollable situations. The authors claim that this differentiation of control contingencies allows the distinction between rigid and adaptive coping styles and results in a more refined identification of *monitors* and *blunters*. While adaptive coping pertains to the employment of *monitoring* strategies in controllable situations and *blunting* strategies in uncontrollable situations, rigid coping refers to the exclusive utilisation of either *monitoring* or *blunting* strategies in situations implying threat (*ibid*.). This may help to differentiate “effortful” *blunters* defined by the MBSS from the *freezers*.

4-2-7. Dentists' perception of pain

It was confirmed that dental surgeons' sensory pain ratings were significantly lower than their patients' reports. This was consistent with the hypothesis: dental surgeons would rate the levels of their patients' sensory pain lower than the patients would report.

Dental surgeons underevaluated their patients' pain. These findings are similar to previous studies of physicians' and nurses' perceptions of patients' pain (Choinière *et al*., 1990; Grossman *et al*., 1991; Cleeland *et al*., 1994; Unruh, 1996; Watkins *et al*., 2002). This could be due to dental surgeons doing their best to treat their patients, therefore, they did not believe that they were causing as much pain as their patients reported to have experienced. Or, they did not want to overrate their treatment pain intensity, since it may be regarded as being incompetent. Administering the M-C SDS could have helped to investigate further if their defensiveness or tendencies to present themselves in a socially desirable manner would have influenced their pain ratings.

4-3. Psychological predictors of dental pain

Consistent with Gedney and Logan's (2007) study, the results of the present study indicated that *expected sensory pain* plays an important role in the experience of pain following tooth extraction. However, *pain catastrophizing*, claimed as a prime dental pain predictor by Sullivan *et al*. (2004, study 2)[a], failed to directly account for the dental pain reports. The results, therefore, partially confirm the hypothesis: *pain catastrophizing* and *expected sensory pain* would be the most robust psychological predictors of dental pain.

In addition, key findings demonstrated that the sensory pain levels reported by patients were explained by a sequential cascade of psychological factors. That is, *dental anxiety*, *monitoring* and *felt control* modulated *expected sensory pain* which, in turn, predicted *experienced sensory pain*.

Through the use of multiple regression analyses, it was revealed that psychological factors known to be associated with pain reporting do not independently influence the sensory experience of pain, but operate through a sequential pathway. The regression analyses confirmed the best-fit structural pathway of psychological predictors, using an independent large sample of dental patients (n=306) from the heterogeneous socio-economic and ethnic background. Hence, this demonstrates the robustness of the model to a population of dental patients in general.

4-3-1. Predicting factors of dental pain

The initial examination involved simultaneously entering each of the factors into a structural model to predict experienced pain intensity. The factors included: *dental anxiety*; *desired control*; *pain catastrophizing*; *manifest anxiety*; *social desirability*; *monitoring*; *expected sensory pain*; *expected affective pain*; *state anxiety before*; *negative mood before*; *state anxiety after*; *positive mood after*; *negative mood after*; *surgical complexity*; *distress levels* and *age*. The second investigation involved entering only modifiable psychological factors all at once into a model for the benefit of possible future interventions. Hence, this excluded: *surgical complexity*; *distress levels* and *age*. It is remarkable that *expected sensory pain* was shown to be the significant independent predictor of pain experienced amongst all predictors and amongst the modifiable psychological predictors. In addition, *expected sensory pain*, *state anxiety after*, *manifest anxiety* and *expected affective pain* altogether obtained a significant fit to the model – i.e., the dental pain predictors.

In the case of clinical treatment where the implications of pain may be perceived as threatening, the role of expectancy may be a particularly salient outcome factor (Gedney & Logan, 2007). Since patients in this study were having comparatively invasive dental treatments, which most likely cause intense pain provoked by anaesthetic injection and the removal of tooth/teeth, it was reasonable to anticipate a significant structural pathway between pain expectation and the treatment pain. Prediction of this structural pathway is also supported by some evidence implicating pain expectations in the modulation of experienced pain perception (Vase, Price, Verne & Robinson, 2004; Wager, Rilling, Smith, Sokolik, Casey, Davidson, Kosslyn, Rose & Cohen, 2004).

4-3-2. Psychological factors preceding the dental pain predictors

In the next step, the antecedent factors which had an effect on specifically anticipated pain were explored, since *expected sensory pain* was a single most robust dental pain predictor. This is because pain expectancy may be based on a complex analysis of the situation. That is, the person's perception of the situation and the resources available to that person interact to produce an assessment of how much an outcome is desired by the individual and the likelihood of its occurrence as argued by Lazarus and his colleagues in their transactional model of stress. For that reason, in an attempt to better understand pain expectation, factors which were significantly correlated with *expected sensory pain* were entered into a model. Those factors were: *dental anxiety*; *desired control*; *felt control*; *pain catastrophizing*; *manifest anxiety*; *social desirability* and *monitoring*. It was revealed that anticipated sensory pain was predicted by *dental anxiety*, *monitoring* and *felt control*.

Dental anxiety

Dental anxiety was shown to be the significant independent antecedent factor of pain expectation. Additionally, *dental anxiety*, *monitoring* and *felt control* altogether obtained a significant fit to the model for pain expectation. This finding was similar to those of Arntz *et al*.'s (1990) and Litt's (1996) who found distress and anxiety were associated with pain expectations. Their research, therefore, confirmed the predictive utility of the present model.

From the fact that *dental anxiety* was not loaded to the models 1 and 2 (see Figures 3-6-4a and 3-6-4b: Model 1 of all factors/Model 2 of modifiable psychological factors predicting *experienced sensory pain* in CHAPTER 3: *Results* – 3-6-4. *Predicting factors of dental pain*), it is clear that *dental anxiety* did not have a direct impact on pain experience. It affected pain experience by modulating pain anticipation. Instead, *manifest anxiety* was loaded on the models 1 and 2, implying that it is *dental anxiety* that influence *manifest anxiety*, not vice versa, contrary to previous research (Lago-Méndez *et al*., 2009) and the study by Sullivan *et al*. (2004, study 2)[a]. In the present study, *dental anxiety* affected pain intensity only by influencing *manifest anxiety*. Namely, situation-specific dental anxiety influences stable trait anxiety which subsequently modify perception of dental pain.

Moreover, it is noteworthy that dental anxiety was found to be the only antecedent factor which had an impact on all four dental pain predictors: *expected sensory pain*; *state anxiety after*; *manifest anxiety* and *expected affective pain*. Specifically, *local anaesthetic injections* and *dental drill* were found to be the most significant contributors of the dental pain predictors.

"If you were about to have a local anaesthetic injection in your gum, above an upper back tooth, how would you feel?"

Dental injections provide a painful stimulus attributable to type of anaesthetic fluid, amount of injected anaesthetic fluid, injection rate, location of injection, expertise of the dentist, use of surface anaesthesia and methods of injection (van Wijk & Hoogstraten, 2009). Naturally dentally anxious patients are reported to be frequently afraid of having dental injections (Vika *et al*., 2006; Vika *et al*., 2008).

In the present study, it was shown that fear of a local anaesthetic injection heightened anticipation for sensory and affective pain which in turn increases the amount of perceived dental pain during and after the surgery. A recent study (van Wijk & Hoogstraten, 2009) found that "anxiety felt for dental injections" was the best predictor for intensity of pain during the dental injection beyond general dental anxiety in patients undergoing invasive treatments.

Today, the use of local anaesthesia for any type of invasive dental procedure is routine. Dental procedures are, therefore, usually painless unless the anaesthesia fails (van Wijk & Hoogstraten, 2009). However, ironically, it seems that it is the local anaesthetic injection that causes pain in patients.

"If you were about to have a tooth drilled, how would you feel?"

While anaesthetic injections heightened expectation of sensory and affective pain, *dental drill* was found to elevate the levels of post-surgery state anxiety and trait anxiety. Indeed, Boyle *et al*. (2008) found that the best predictors of referral for sedation for dentistry were dental anxiety/fear levels together with an irregular attendance, in particular, fears for seeing, hearing and feeling the vibrations of the dental drill. Namely, the rotary instruments cause bone-conducted vibrations, high-pitched noise of the air turbine, sensitivity of vital dentine, development of high temperatures at the cutting surface leading to thermal stimulation as well as possible over-preparation of the cavity (Banerjee, Watson & Kidd, 2000). These factors are all responsible for bringing about anxiety – state and trait.

Additionally, one should be aware that the dental anxiety scales such as the CDAS and the MDAS were originally developed to tap general dental anxiety. The first two questions about *going to dentist* and *waiting for treatment* are for evaluating *anticipatory dental anxiety*, while the last three items about dental drill, scaling and anaesthetic injection are for assessing *treatment dental anxiety* (Yuan, Freeman, Lahti, Lloyd-Williams & Humphris, 2008). In the current situation, the respondents were due to have their treatments, not only imagining to go to the dentist as asked by the questionnaire. It is possible, therefore, that having already come to the Eastman, the *anticipatory dental anxiety* items did not adequately capture that aspect of general fear of seeing dentist. This may be the reason why only *local anaesthetic injection* and *dental drill* components had influences on the primary dental pain predictors.

Monitoring

Monitoring was found to be the antecedent factor only to *expected sensory pain*. Although monitors' hypervigilant styles were shown to be associated with heightened pain experience as seen earlier in 4-2-6. *Monitor-blunter style coping – Monitoring*, this was only true through amplified pain anticipation. Accordingly, those who are *information seekers* anticipate more pain with their hypervigilant styles. This would consecutively give rise to magnified pain experience.

Felt (perceived) control before surgery

When examining the loading of the IDCI-felt subscale, it is not surprising that *felt control* was a negative antecedent factor of pain expectation. That is, those who had perceived to have lower levels of control over the dental procedure anticipated higher levels of sensory pain. It is interesting to discover that *felt control* was negatively associated with pain expectation, while it did not directly predict pain experience as discussed above in 4-2-2. *Dental control – Felt (perceived) control before surgery*. *Felt control*, therefore, contributed to perception of pain only through the effects of pain expectation. In addition, *felt control* contributed to pain experience by also affecting *state anxiety after*. Having had the surgery, *state anxiety after* may well have been anxiety about having pain when the analgesics wore off, whereas *state anxiety before* could have been anxiety about going through the stressful procedure. Consequently, *felt control* influenced expectancy and anxiety about suffering pain which, in turn, had an effect on actual pain experience.

The reason why the desire subscale did not enter the model was that relatively low alpha coefficient for the subscale was found (α=0.59). As mentioned in 4-2-2.

Dental control – Desired control earlier, the utilisation of the Revised IDCI (Coolidge *et al*., 2005) would help in future studies.

4-3-3. Pain catastrophizing – Where in the model?

In contradiction of expectations, *pain catastrophizing* failed to enter the model as a primary dental pain predictor, despite its significant positive association with pain experience (see 4-2-3. *Pain catastrophizing*). Instead, *pain catastrophizing* modulated levels of *manifest anxiety* and *expected affective pain*, which ultimately influenced perception of pain. That is, *pain catastrophizing* in dental setting impinges on dispositional anxiety and emotional pain anticipation which sequentially affect pain experience.

Indeed, the present findings are in accordance with the Fear-Avoidance Model of Musculoskeletal Pain, where catastrophizing is described as a cognitive precursor to pain-related fear and tendencies to avoid pain, which may enhance pain intensity and hinder resumption of physical activity (see 1-1-5. *Pain catastrophizing – The nature of pain catastrophizing* in CHAPTER 1: *Introduction*). The FAM describes specific pain cognitions involved in the development and maintenance of chronic pain and disability following injury (Vlaeyen & Linton, 2000; Asmundson *et al*., 2004; Leeuw *et al*., 2007). *Pain catastrophizing*, pain-related fear, kinesiophobia and anxiety are associated but all separate psychological factors within the FAM.

It seems that naturally, those with higher levels of dispositional anxiety or emotional pain anticipation are vulnerable to dental pain experience. However, neither this chronic anxiety state alone nor emotional pain anticipation alone does not necessarily cause individuals to have intensified dental pain perception. Instead, pain-related catastrophizing thoughts have to be present to work as a trigger to bring about the chronic anxiety or emotional pain anticipation high enough to intensity perception of pain.

Pain catastrophizing and manifest anxiety. The PCS components contributing to elevated trait anxiety were *feeling of pain overwhelming*, *keep thinking about pain* and *thought about inability to reduce pain* (see Box 4-3-3a: The PCS components contributing to *manifest anxiety*). *Feeling of pain overwhelming* and *thought about inability to reduce pain* are the helplessness components of the PCS, while *keep thinking about pain* is the rumination component. It appears that the helpless thoughts together with ruminating pain experience cause elevated levels of trait anxiety.

Box 4-3-3a: The PCS components contributing to *manifest anxiety*

“*It’s awful and I feel that it overwhelms me.*”

“*I keep thinking about how much it hurts.*”

“*There is nothing I can do to reduce the intensity of the pain.*”

Pain catastrophizing and expected affective pain. The best predicting PCS components of heightened emotional pain anticipation were found to be *feeling of incapability to bear pain* and *fear of something serious happening* (see Box 4-3-3b: The PCS components contributing to *expected affective pain*). The former is the helplessness component, while the latter is the magnification component. The helpless thought about pain and the magnification of pain perception seem to contribute to increased affective pain expectation.

Box 4-3-3b: The PCS components contributing to *expected affective pain*

“*I feel I can’t stand it anymore.*”

“*I wonder whether something serious may happen.*”

It is noteworthy, in particular, that emotional pain anticipation was found to be a direct predictor of dental pain, while *pain catastrophizing* was an indirect one, notwithstanding that they are both similarly pain-related negative cognitions. This may be due to the natures of questions asked in each questionnaire: the AVPD (for *expected affective pain*) and the PCS (for *pain catastrophizing*). The AVPD made respondents predict the unpleasantness of pain caused by specifically the forthcoming dental procedures. In contrast, the instruction of the PCS used for the present study asked respondents to rate the extent to which they experienced certain thoughts and feelings by recalling former experiences with pain (see the box 4-3-3c: The standard instruction set of the PCS below). In other words, *pain catastrophizing* measured in the study was a trait-like variable of a tendency to exaggerate pain experience “in general”, while *expected affective pain* carried more situational-specific emotional aspect of pain, i.e., unpleasantness of the impending treatment pain. As a result, it seems that this trait measure of *pain catastrophizing* failed to adequately account for the variance in pain experience because the referent event in the measure was too distal to the moment of dental pain report (Quartana, Campbell & Edwards, 2009). It is not surprising, therefore, *expected affective pain* better predicted pain experience than did *pain catastrophizing*.

Box 4-3-3c: The standard instruction set of the PCS

> People are often exposed to situations that may cause pain such as illness, injury or surgery. Read each statement and then circle ○ the most appropriate number to the right of the statement to indicate the degree to which you have these thoughts and feelings when you are experiencing pain in general.

Original conceptualisations of catastrophizing in the context of depressive and anxiety disorders advanced by Albert Ellis (Ellis, 1962) and subsequently adapted by Aaron Beck (Beck, Rush, Shaw & Emery, 1979) regarded maladaptive thoughts to be latent and in need of a cue to become manifest (Quartana *et al*., 2009). Consequently, the measures such as the CSQ and the PCS have typically evaluated *pain catastrophizing* as a trait-like or dispositional variable. Along with the same lines, in this study *pain catastrophizing* was treated and assessed as dispositional pain-related catastrophizing tendencies using the standard instruction set of the PCS (see the box 4-3-3c: The standard instruction set of the PCS above). Measuring *pain catastrophizing* in a trait-like manner benefits from the ability to assess an individual's propensity to catastrophize before the induction of pain, providing more information regarding the sequencing of *pain catastrophizing* cognitions (Edwards, Smith, Stonerock & Haythornthwaite, 2006).

However, assessment of pain-related catastrophizing cognitions should be made more relevant to specific pain situations such as stressful dental procedures. Indeed, some studies found that measures of situational-specific *pain catastrophizing* were better predictors of pain experience than trait measures of *pain catastrophizing*. In some studies (Dixon, Thorn & Ward, 2004; Edwards, Campbell & Fillingim, 2005), which involved cold pressor tasks (CPT), state measures of *pain catastrophizing* (i.e., asking participants the extent to which they catastrophized during the CPT that just occurred) given after the

CPT showed more robust correlations with pain ratings than trait measures of *pain catastrophizing* administered before the CPT.

Still, one might argue that by evaluating *pain catastrophizing* in a situation-specific manner, the concept of *pain catastrophizing* as trait-like pain-related catastrophizing tendencies, put forth by Ellis and Beck and elaborated by Sullivan and his colleagues, will be lost. Nonetheless, it is evidently useful to facilitate state measures of *pain catastrophizing* – as in the case of anxiety treated and assessed in both trait and state-specific manners. Accordingly, the dental situation-specific instruction set of the PCS should look as below in the Box 4-3-3d: Dental situation-specific instruction set of the PCS.

Box 4-3-3d: Dental situation-specific instruction set of the PCS

People are often exposed to situations that may cause pain such as illness, injury, surgery or dental procedures. Read each statement and then circle ○ the most appropriate number to the right of the statement to indicate the degree to which you have these thoughts and feelings when you are experiencing pain in the forthcoming dental surgery.

4-4. Implications for future research and interventions

As suggested by the findings of the present study, it appears that patients' anticipated pain and subsequent pain experience are predicted by patients' *dental anxiety*, *monitoring* and *felt control*. Moreover, it is noteworthy that *dental anxiety* contributed to heightened levels of every dental pain predictor (i.e., *expected sensory pain*, *state anxiety after*, *manifest anxiety* and *expected affective pain*).

Accordingly, a clinical implication of this study is that the prediction of having higher levels of dental anxiety, hypervigilant tendencies and lower levels of perceived control during a stressful invasive dental procedure may well provide therapeutic targets for managing not only overall response to treatment but also the cascade of cognitive and emotional events that ultimately influence the patient’s treatment experience and pain perception.

However, it is essential to bear in mind that management interventions designed to reduce the patients’ fear and to exercise their use of cognitive control over situationally-mediated factors in preparation for and during the dental procedures may be more effective than efforts to modulate the patient’s stable trait characteristics such as hypervigilant tendencies. For that reason, firstly, it is crucial to reduce the dentistry-specific peculiar environmental threat by creating friendly and relaxing atmospheres. Examples include friendly, concerned and empathic staff and pleasant surroundings (Gedney & Logan, 2007). Secondly, cognitive-behavioural interventions may well be suited for increasing patients’ sense of having personal control or self-efficacy for such control when faced with invasive clinical treatments such as in the present case of tooth extraction and also in others like root canal, orthodontics work, mammography, spinal tap bone marrow aspiration (*ibid.*).

Commonly these interventions include (see 1-1-3. *Dental anxiety – Interventions on dental anxiety* in CHAPTER1: *Introduction*): modelling (Melamed *et al*., 1975; Getka & Glass, 1992); information-giving (Siegel & Peterson, 1980; Jackson & Lindsay, 1995; de Jongh *et al*., 1995; Ng *et al*., 2004); relaxation (Corah *et al*., 1981; Litt *et al*., 1993; Litt *et al*., 1999; Lahmann *et al*., 2008); music listening (Corah *et al*., 1981; Litt *et al*., 1999; Lahmann *et al*., 2008); distraction in the form of a video ping-pong game (Seyrek *et al*., 1984); biofeedback (Elmore, 1988), hypnosis (Forgione, 1988; Kleinhauz & Eli, 1991); stress inoculation training (Getka & Glass, 1992); pre-treatment dentist interview (Getka & Glass, 1992); self-efficacy enhancement with a galvanic skin response apparatus (Litt *et al*., 1993); videotaped behavioural intervention (Carpenter *et al*., 1994); cognitive restructuring (de Jongh *et al*., 1995); monitoring/blunting (Muris *et al*., 1995); needle desensitization (Litt *et al*., 1999); attention focusing/distraction (Schmid-Leuz *et al*., 2007); audiovisual virtual reality (Frere *et al*., 2001) and the effects of lavender scent (Lehrner *et al*., 2005; Kritsidima *et al*., 2010) and of orange odour (Lehrner *et al*., 2000; Lehrner *et al*., 2005).

Further important future clinical evaluation could assess how these non-invasive interventions can be administered in busy clinical settings, and how they can be best integrated with more conventional pharmacological approaches such as the administration of nitrous oxide and local anaesthesia for producing maximum efficacy for pain and anxiety reduction.

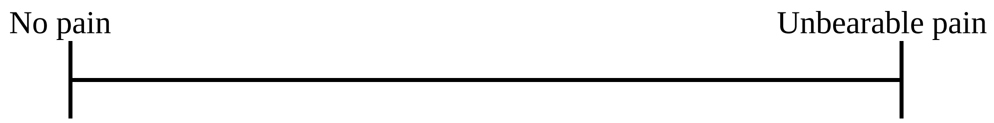
4-5. Limitation of the study

It would be neglectful if the limitations of the present study were not pointed out.

First, in the present study, patients were not asked if they had tooth extraction in the past and/or heard about somebody's such experience, and consequently how they viewed the event, i.e., unpleasantness of the procedure indices. Similarly, information regarding prior negative dental experiences, such as having painful, frightening or embarrassing experience at the dentist, was not collected. These may well have formed determinant variables of dental pain which may have increased the predictive power of the model. In future research, it is useful to add a questionnaire asking about patients' perception of these aversive events.

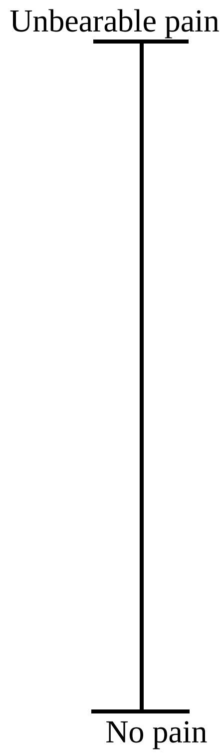
Second, *expected sensory pain* and *experienced sensory pain* were both obtained using identical methods of measurements: a "box scale" carrying 11 boxes horizontally laid out with each end of the scale presenting a verbal description of extreme limits of pain intensity – "No pain" and "Unbearable pain". This allowed a direct and sensitive comparison of ratings of pain before and after the surgery. It may be of concern, however, that this method influenced the patients' pain experience by establishing a "self-fulfilling prophecy" as pointed out by Gedney and Logan (2007) or a "carry-over effect" from one scale to the next (Downie *et al*., 1978). The NRS was used over the VAS (see Figure 4-5a: The Visual Analogue Scale – horizontal) in the present study due to the reason that subjective values of pain may be at best captured by the rank ordering system of the box scale rather than by reading too much into the precise VAS score.

Figure 4-5a: The Visual Analogue Scale – horizontal



Nonetheless, it may be helpful in future studies to administer the VAS as well as the NRS on either occasion to obliterate such "automatic responses". It may be more useful, in that case, that the VAS is laid out vertically to eliminate the illusion of the identicality between the two scales (see Figure 4-5b: The Visual Analogue Scale – vertical).

Figure 4-5b: The Visual Analogue Scale – vertical



Similarly, while the sensory component refers to the intensity of the pain sensation, the affective element refers to the extent of the distress caused by the pain, the influence of nociceptive stimulation on emotions, the way in which emotions affect pain and the consequences of pain for the individual (Price, Riley & Wade, 2001). In the present study, patients were asked to describe “unpleasantness” which they may feel during their surgery and they have felt during and after their surgery. The questionnaire for the affective pain contained 15 words describing the unpleasantness of pain. The words were laid in a rank order of the magnitude of unpleasantness from “Bearable” to “Excruciating”. Consequently, this could have suggested or guided patients which word they should select in relation to their levels of sensory pain intensity which they indicated just before this affective pain was evaluated. In future research, therefore, it may be useful to administer a questionnaire carrying the affective pain descriptors in random order.

Finally, the use of a dental setting-specific model of acute pain may present a limitation in the generalisability of the findings to other aversive or invasive clinical procedures such as lumbar puncture and bone marrow aspiration. Additionally, given that participants volunteered for gratuitous participation in a study which involved an invasive dental treatment, highly fearful individuals may well have declined the opportunity to take part. As a result, those who participated may not represent a general public of tooth-extraction patients.

4-6. Conclusion

In conclusion, by utilising a model of dental-extraction pain, a series of connected pathways where dental pain was predicted by anticipated pain which, in turn, was predicted by *dental anxiety*, *monitoring* and *perceived control* were identified. The major contribution of this study was to demonstrate the vital influence of *dental anxiety*, *monitoring* and *felt control* in establishing pain expectations and ultimately the intensity of dental pain experienced. Future research in which individual differences in these psychological factors are examined in the context of interventions aimed at altering the emotional environment of the dental setting would be worth pursuing. Eventually, then, those intervention methods should be extended to pain perception in a face of acute stressor in any clinical, medical procedures, surgery and oncology.

Man should not suffer unnecessarily.

References

Aartman, I. H., de Jongh, A., Makkes, P. C. & Hoogstraten, J. (2000). Dental anxiety reduction and dental attendance after treatment in a dental fear clinic: a follow-up study. *Community Dentistry and Oral Epidemiology, 28 (6),* 435-442.

Abbot, J. H. & Mercer, S. R. (2002). The natural history of acute low back pain. *The New Zealand Journal of Physiotherapy, 30 (3),* 8-16.

Abraham, C., Conner, M., Jones, F. & O'Connor, D. (2008). *Health psychology: topics in applied psychology*. London: Hodder Education.

Abrahamsson, K. H., Berggren, U., Hakeberg, M. & Carlsson, S. G. (2003). The importance of dental beliefs for the outcome of dental fear treatment. *European Journal of Oral Sciences, 111 (2),* 99-105.

Abrahamsson, K. H., Hakeberg, M., Stenman, J. & Ohrn, K. (2006). Dental beliefs: evaluation of the Swedish version of the revised Dental Beliefs Survey in different patient groups and in a non-clinical student sample. *European Journal of Oral Sciences, 114 (3),* 209-215.

Agdal, M. L., Raadal, M., Skaret, E. & Kvale, G. (2008). Oral health and oral treatment needs in patients fulfilling the DSM-IV criteria for dental phobia: possible influence on the outcome of cognitive behavioral therapy. *Acta Odontologica Scandinavica, 66 (1),* 1-6.

Agdal, M. L., Raadal, M., Skaret, E. & Kvale, G. (2010). Oral health and its influence on cognitive behavioral therapy in patients fulfilling the Diagnostic and Statistical Manual of Mental Disorders-IV criteria for intra-oral injection phobia. *Acta Odontologica Scandinavica, 6, (2),* 98-105.

Aldwin, C. (1994). *Stress, coping and development.* New York: Guilford Press.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th edition)*. Washington, DC: Author.

Anderson, R. A., Baron, R. S. & Logan, H. (1991). Distraction, control and dental stress. *Journal of Applied Social Psychology, 21 (2)*, 156-171.

Apkarian, A. V., Bushnell, M. C., Treede, R-D. & Zubieta, J-K. (2005). Human brain mechanisms of pain perception and regulation in health and disease. *European Journal of Pain, 9 (4)*, 463-484.

Armfield, J. M. (2010)[a]. Development and psychometric evaluation of the index of dental anxiety and fear (IDAF-4C+). *Psychological Assessment, 22 (2)*, 279-287.

Armfield, J. M. (2010)[b]. Towards a better understanding of dental anxiety and fear: cognitions vs. experiences. *European Journal of Oral Sciences, 118 (3)*, 259-264.

Armfield, J. M., Stewart, J. F. & Spencer, A. J. (2007). The vicious cycle of dental fear: exploring the interplay between oral health, service utilization and dental fear. *BMC Oral Health, 7*:1.

Arntz, A. & Schmidt, A. J. (1989). Perceived control and the experience of pain. In A. Steptoe & A. Appels (eds.), *Stress, personal control and health* (pp131-162). Oxford, UK: John Wiley & Sons.

Arntz, A., van Eck, M. & Heijmans, M. (1990). Predictions of dental pain: the fear of any expected evil, is worse than the evil itself. *Behaviour Research and Therapy, 28 (1)*, 29-41.

Asmundson, G. J., Norton, P. J. & Vlaeyen, J. W. S. (2004). Fear-avoidance models of chronic pain. In G. J. Asmundson, J. W. S. Vlaeyen & G. Crombez (eds.), *Understanding and treating fear of pain* (pp3-24). Oxford, England: Oxford University Press.

Ayesh, E. E., Jensen, T. S. & Svensson, P. (2007). Hypersensitivity to mechanical and intra-articular electrical stimuli in persons with painful temporomandibular joints. *Journal of Dental Research, 86 (12),* 1187-1192.

Banerjee, A., Watson, T. F. & Kidd, E. A. M. (2000). Dentine caries excavation: a review of current clinical techniques. *British Dental Journal, 188 (9)*, 476-482.

Bantick, S.J., Wise, R.G., Ploghaus, A., Clare, S., Smith, S. M. & Tracey, I. (2002). Imaging how attention modulates pain in humans using functional MRI. *Brain, 125 (2)*, 310–319.

Baron R. S. & Logan, H. (1993). Desired control, felt control, and dental pain: recent findings and remaining issues. *Motivation and Emotion, 17 (3),* 181-204.

Baron, R. S., Logan, H. & Hoppe, S. (1993). Emotional and sensory focus as mediators of dental pain among patients differing in desired and felt dental control. *Health Psychology, 12 (5),* 381-389.

Baumeister, R. F., Dale, K. & Sommer, K. L. (1998). Freudian defense mechanisms and empirical findings in modern social psychology: reaction formation, projection, displacement, undoing isolation, sublimation and denial. *Journal of Personality, 66 (6)*, 1081-1124.

Baumeister, R. F., Faber, J. E. & Wallace, H. M. (1999). Coping and ego depletion: recovery after the coping process. In C. R. Snyder (ed.), *Coping: the psychology of what works* (pp50-69). Oxford: Oxford University Press.

Beck, A. T., Rush, A. J., Shaw, B. F. & Emery, G. (1979). *Cognitive therapy of depression*. New York: Guilford Press.

Beecher, H. K. (1956). Relationship of significance of wound of the pain experienced. *The Journal of the American Medical Association, 161 (17)*, 1609-1613.

Bendig, A. W. (1956). The development of a short form of the Manifest Anxiety Scale. *Journal of Consulting Psychology, 20 (5)*, 384.

Beneciuk, J. M., Bishop, M. D. & George, S. Z. (2010). Pain catastrophizing predicts pain intensity during a neurodynamic test for the median nerve in healthy participants. *Manual Therapy, 15 (4)*, 370-375.

Benight, C. C., Harper, M. L., Zimmer, D. L., Lowery, M., Sanger, J. & Laudenslager, M. L. (2004). Repression following a series of natural disasters: immune and neuroendocrine correlates. *Psychology and Health, 19 (3)*, 337-352.

Benjamins, C., Schuurs, A. H. B. & Hoogstraten, J. (1994). Skin conductance, Marlowe-Crowne defensiveness and dental anxiety. *Perceptual and Motor Skills, 79 (1)*, 611-622.

Berggren, U. & Meynert, G. (1984). Dental fear and avoidance: causes, symptoms, and consequences. *The Journal of the American Dental Association, 109 (2)*, 247-251.

Bijttebier, P., Vertommen, H. & Steene, G. V. (2001). Assessment of cognitive coping styles: a closer look at situation-response inventories. *Clinical Psychology Review, 21 (1)*, 85-104.

Bingel, U., Lorenz, J., Schoell, E.,Weiller, C. & Büchel, C. (2006). Mechanisms of placebo analgesia: rACC recruitment of a subcortical antinociceptive network. *Pain, 120 (1-2),* 8–15.

Bishop, S. R. & Warr, D. (2003). Coping, catastrophizing and chronic pain in breast cancer. *Journal of Behavioral Medicine, 26 (3),* 265-281.

Borsook, D., Sava, S. & Becerra, L. (2010). The pain imaging revolution: advancing pain into the 21st century. *The Neuroscientist, 16 (2)*, 171-185.

Boyle, C. A., Newton, T. & Milgrom, P. (2009). Who is referred for sedation for dentistry and why? *British Dental Journal, 206 (6)*, E12.

Bradley, M. M., Silakowski, T. & Lang, P. J. (2008). Fear of pain and defensive activation. *Pain, 137 (1),* 156-163.

Breuer, J. & Freud, S. (1893/1955). On the psychical mechanisms of hysterical phenomena: a lecture. In J. Strachery (Ed. & Trans.). *The standard edition of the complete psychological works of Sigmund Freud, Volume III* (pp25-39). London: The Hogarth Press. (Original work published in 1893).

Brooks, J. C., Nurmikko, T. J., Bimson, W. E., Singh, K. D. & Roberts, N.(2002). fMRI of thermal pain: effects of stimulus laterality and attention. *Neuroimage*, *15 (2),* 293–301.

Brown, L. L., Tomarken, A. J., Orth, D. N., Loosen, P. T., Kalin, N. H. & Davidson, R. J. (1996). Individual differences in repressive-defensiveness predict basal salivary cortisol levels. *Journal of Personality and Social Psychology, 70 (2),* 362-371.

Brunsman, B. A., Logan, H. L., Patil, R. R. & Baron, R. S. (2003). The development and validation of the Revised Iowa Dental Control Index (IDCI). *Personality and Individual Differences, 34 (7)*, 1113-1128.

Buenaver, L. F., Edwards, R. R., Smith, M. T., Gramling, S. E. & Haythornthwaite, J. A. (2008). Catastrophizing and pain-coping in young adults: associations with depressive symptoms and headache pain. *The Journal of Pain*, *9 (4),* 311-319.

Burger, J. M. & Cooper, H. M. (1979). The desirability of control. *Motivation and Emotion, 3 (4),* 381-393.

Buscher, H. C. J. L., Wilder-Smith, O. H. G. & van Goor, H. (2006). Chronic pancreatitis patients show hyperalgesia of central origin: a pilot study. *European Journal of Pain, 10 (4),* 363–370.

Byrne, D. (1961). The repression-sensitization scale: rationale, reliability and validity. *Journal of Personality, 29 (3),* 334-349.

Cacioppo, J. T., Petty, R. E. & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment, 48 (3),* 306-307.

Cameron, L. D. & Moss-Morris, R. (2010). Illness-related cognition and behaviour. In D. French, K. Vedhara, A. A. Kaptein & J. Weinman (eds.), *Health psychology (2nd edition)* (pp149-161). West Sussex, UK: BPS Blackwell.

Canakçi, C. F. & Canakçi, V. (2007). Pain experienced by patients undergoing different periodontal therapies. *The Journal of the American Dental Association, 138 (12),* 1563-1573.

Cano, A., Leong, L., Heller, J. & Lutz, J. (2009). Perceived entitlement to pain-related support and pain catastrophizing: Associations with perceived and observed support. *Pain, 147 (1-3)*, 249-254.

Carver, C. S. & Scheier, M. F. (1994). Situational coping and coping dispositions in a stressful transaction. *Journal of Personality and Social Psychology 66 (1),* 184-195.

Carver, C. S., Scheier, M. F. & Weintraub, J. K. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology, 56 (2)*, 267-283.

Carpenter, D. J., Gatchel, R. J. & Hasegawa, T. (1994). Effectiveness of a videotaped behavioural intervention for dental anxiety: the role of gender and the need for information. *Behavioral Medicine, 20 (3)*, 123-132.

Cassidy, J. & Kobak. R. R. (1988). Avoidance and its relation to other defensive processes. In J. Belsky & T. Nezworkski (eds.). *Clinical implications of attachment* (pp300-323). Hillsdale, NJ: Erlbaum.

Chapman, C.R. (1978). Pain: the perception of noxious events. In R. A. Sternbach (ed.), *The psychology of pain* (pp169-202). New York: Raven Press.

Chesney, M. A. & Folkman, S. (1994). Psychological impact of HIV disease and implications for intervention. *Psychiatric Clinics of North America, 17 (1),* 163-182.

Choinière, M., Melzack, R., Girard, N., Rondeau, J. & Paquin, M-J. (1990). Comparisons between patients' and nurses' assessment of pain and medication efficacy in severe burn injuries. *Pain, 40 (2)*, 143-152.

Chrousos, G. P. (2000). Stress, chronic inflammation, and emotional and physical well-being: concurrent effects and chronic sequelae. *Journal of Allergy and Clinical Immunology, 106 (2),* 275-291.

Chung, D. T., Bogle, G., Bernardini, M., Stephens, D., Riggs, M. L. & Egelberg, J. H. (2003). Pain experienced by patients during periodontal maintenance. *Journal of Periodontology, 74 (9)*, 1293-1301.

Cleeland, C. S., Gonin, R., Hatfield, A. K., Edmonson, J. H., Blum, R. H., Stewart, J. A. & Pandya, K. J. (1994). Pain and its treatment in outpatients with metastatic cancer. *The New England Journal of Medicine, 330 (9),* 592–596.

Cohen, S. & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98 (2),* 310-357.

Cooke, L., Eliasziw, M. & Becker, W. J. (2007). Cutaneous allodynia in transformed migraine patients. *Headache, 47 (4)*, 531-539.

Coolidge, T., Heima, M., Coldwell, S. E., Weinstein, P., Logan, H. L. & Milgrom, P. (2005). Reliability and validity of the Revised Iowa Dental Control Index in a non-clinical sample. *Personality and Individual Differences, 38 (4)*, 773-783.

Corah, N. L. (1969). Development of a dental anxiety scale. *Journal of Dental Research, 48*, 596.

Corah, N. L., Gale, E. N., Pace, L. F. & Seyrek, S. K. (1981). Relaxation and musical programming as means of reducing psychological stress during dental procedures. *The Journal of the American Dental Association, 103 (2),* 232-234.

Coyne, J. C. & Calarco, V. (1995). Effects of experience of depression: application of focus group and survey methodologies. *Psychiatry, 58 (2)*, 149-163.

Coyne, J. C. & Gottlieb, B. H. (1996). The mismeasure of coping by checklist. *Journal of Personality, 64 (4)*, 959-991.

Coyne, J. C. & Lazarus, R. S. (1980). Cognitive style, stress perception, and coping. In I. L. Kutash & L. B. Schlesinger (eds.), *Handbook on stress and anxiety: contemporary knowledge, theory, and treatment* (pp144-158). San Francisco: Jossey-Bass.

Coyne, J. C. & Racioppo, M. W. (2000). Never the twain shall meet? Closing the gap between coping research and clinical intervention research. *American Psychologist, 55 (6)*, 655-664

Craig, K. D. & Hadjistavropoulos, T. (2004). Psychological perspectives on pain: controversies. In T. Hadjistavropoulos & K. D. Craig (eds.), *Pain: psychological perspectives* (pp303-326). New Jersey: Lawrence Erlbaum Associates.

Cramer, P. (1965). Recovery of a discrete memory. *Journal of Personality and Social Psychology, 1 (4)*, 326-332.

Cramer, P. (1998). Freshman to senior year: a follow-up study of identity, narcissism and defense mechanisms. *Journal of Research in Personality, 32 (2)*, 156-172.

Cramer, P. (1999). Future directions for the Thematic Apperception Test. *Journal of Personality Assessment, 72 (1)*, 74-92.

Cramer, P. (2000). Defense mechanisms in psychology today: further processes for adaptation. *American Psychologist, 55 (6),* 637-646.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16 (3)*, 297-334.

Croog, S. H., Baume, R. M. & Nalbandian, J. (1995). Pre-surgery psychological characteristics, pain response and activities impairment in female patients with repeated periodontal surgery. *Journal of Psychosomatic Research, 39 (1)*, 39-51.

Crowne, D. P. & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology, 24 (4)*, 349-354.

Crowne, D. P. & Marlowe, D. (1964). *The approval motive*. New York: Wiley.

Dahlstrom, W. G. & Walsh, G. S. (1960). *An MMPZ handbook.* New York: Psychological Corporation.

Dao, T. T. & LeResche, L. (2000). Gender differences in pain. *Journal of Orofacial Pain, 14 (3)*, 169-184.

Decety, J., Echols, S. & Correll, J. (2010). The blame game: the effect of responsibility and social stigma on empathy for pain. *Journal of Cognitive Neuroscience, 22 (5)*, 985-997.

de Jongh, A., Fransen, J., Oosterink-Wubbe, F. & Aartman I. (2006). Psychological trauma exposure and trauma symptoms among individuals with high and low levels of dental anxiety. *European Journal of Oral Sciences, 114 (4)*, 286-292.

de Jongh, A., Muris, P., ter Horst, G., van Zuuren, F., Schoenmakers, N. & Makkes, P. (1995). One-session cognitive treatment of dental phobia: preparing dental phobics for treatment by restructuring negative cognitions. *Behaviour Research and Therapy, 33 (8)*, 947-954.

de Ridder, D. & Schreuers, K. (2001). Developing interventions for chronically ill patients: is coping a helpful concept? *Clinical Psychology Review, 21 (2)*, 205-240.

Descartes, R. (1664). *Traite de l'Homme*. Paris: Angot.

Deshields, T. L., Tait, R., C., Gfeller, J. D. & Chibnall, J. T. (1995). Relationship between social desirability and self-report in chronic pain patients. *The Clinical Journal of Pain, 11 (3),* 189-193.

Devoulyte, K. & Sullivan, M. J. L. (2003). Pain catastrophizing and symptom severity during upper respiratory tract illness. *The Clinical Journal of Pain, 19 (2),* 125-133.

Dionne, R., Gordon, S., McCullagh, L. & Phero, J. (1998). Assessing the need for anesthesia and sedation in the general population. *The Journal of the American Dental Association, 129 (2),* 167-173.

Dixon, K. E., Thorn, B. E. & Ward, L. C. (2004). An evaluation of sex differences in psychological and physiological responses to experimentally-induced pain: a path analytic description. *Pain, 112 (1-2)*, 188-196.

Downie, W. W., Leatham, P. A., Rhind, V. M., Wright, V., Branco, J. A. & Anderson, J. A. (1978). Studies with pain rating scales. *Annals of the Rheumatic Diseases, 37 (4)*, 378-381.

Economou, G. C. (2003). Dental anxiety and personality: investigating the relationship between dental anxiety and self-consciousness. *Journal of Dental Education, 67 (9)*, 970-980.

Edwards, A. L. (1957). *The social desirability variable in personality assessment and research*. New York: Dryden.

Edwards, R. R., Campbell, C. M. & Fillingim, R. B. (2005). Catastrophizing and experimental pain sensitivity: only in vivo reports of catastrophic cognitions correlate with pain responses. *The Journal of Pain, 6 (5)*, 338-339.

Edwards, R. R., Giles, J., Bingham III, C. O., Campbell, C., Haythornthwaite, J. A. & Bathon, J. (2010). Moderators of the negative effects of catastrophizing in arthritis. *Pain Medicine, 11 (4),* 591-599.

Edwards, R. R., Smith, M. T., Stonerock, G. & Haythornthwaite, J. A. (2006). Pain-related catastrophizing in healthy women is associated with greater temporal summation of and reduced habituation to thermal pain. *The Clinical Journal of Pain, 22 (8),* 730-737.

Eli, I., Baht, R., Kozlovsky, A. & Simon, H. (2000). Effect of gender on acute pain prediction and memory in periodontal surgery. *European Journal of Oral Sciences, 108 (2),* 99-103.

Eli, I., Bar-Tal, Y., Fuss, Z. & Silberg, A. (1997). Effect of intended treatment on anxiety and on reaction to electric pulp stimulation in dental patients. *Journal of Endodontics, 23 (11),* 694-697.

Eli, I., Schwartz-Arad, D., Baht, R. & Ben-Tuvim, H. (2003). Effect of anxiety on the experience of pain in implant insertion. *Clinical Oral Implants Research, 14 (1),* 115-118.

Eli, I., Uziel, N., Blumensohn, R. & Baht, R. (2004). Modulation of dental anxiety: the role of past experiences, psychopathologic traits and individual attachment patterns. *British Dental Journal, 196 (11),* 689-694.

Ellis, A. (1962). *Reason and emotion in psychotherapy*. New York: Lyle Stuart.

Elmore, A. M. (1988). Biofeedback therapy in the treatment of dental anxiety and dental phobia. *Dental Clinics of North America, 32 (4),* 735-744.

Enqvist, B. & Fischer, K. (1997). Preoperative hypnotic techniques reduce consumption of analgesics after surgical removal of third mandibular molars: a brief communication. *International Journal of Clinical and Experimental Hypnosis, 45 (2)*, 102-108.

Erten, H., Akarslan, Z. Z. & Bodrumlu, E. (2006). Dental fear and anxiety levels of patients attending a dental clinic. *Quintessence International, 37 (4),* 304-310.

Esterling, B. A., Antoni, M. H., Kumar, M. & Schneiderman, N. (1993). Defensiveness, trait anxiety and Epstein-Barr viral capsid antigen antibody titers in healthy college students. *Health Psychology, 12 (2)*, 132-139.

Eysenck, H. & Eysenck, S. (1964). *Eysenck personality inventory*. San Diego, CA: Education and Industrial Testing Service.

Fairhurst, M., Wiech, K., Dunckley, P. & Tracey, I. (2007). Anticipatory brainstem activity predicts neural processing of pain in humans. *Pain, 128 (1-2)*, 101–110.

Fardal, Ø & Hansen, B. F. (2007). Interviewing self-reported highly anxious patients during periodontal treatment, *Journal of Periodontology, 78 (6),* 1037-1042.

Farrar, J. T., Young, J. P. Jr, LaMoreaux, L., Werth, J. L. & Poole, R. M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*, *94 (2)*, 149-158.

Faul, F. & Erdfelder, E. (1992). *GPOWER: a priori-, post hoc-, and compromise power analyses for MS-DOS* [computer program]. Bonn, Germany: Bonn University.

Feine, J. S., Bushnell, M. C., Miron, D. & Duncan, G. H. (1991). Sex differences in the perception of noxious heat stimuli. *Pain, 44 (3),* 255-262.

Feinmann, C., Ong, M., Harvey, W. & Harris, M. (1987). Psychological factors influencing post-operative pain and analgesic consumption. *British Journal of Oral and Maxillofacial Surgery, 25 (4),* 285-292.

Feldner, M. T. & Hekmat, H. (2001). Perceived control over anxiety-related events as a predictor of pain behaviors in a cold pressor task. *Journal of Behavior Therapy and Experimental Psychiatry, 32 (4),* 191–202.

Fernández-de-las-Peñas, C., de la Llave-Rincón, A. I., Fernández-Carnero, J., Cuadrado, M. L., Arendt-Nielsen, L. & Pareja, J. A. (2009). Bilateral widespread mechanical pain sensitivity in carpal tunnel syndrome: evidence of central processing in unilateral neuropathy. *Brain, 132 (6),* 1472-1479.

Fernández-de-las-Peñas, C, Galán-del-Río, F., Fernández-Carnero, J., Pesquera, J., Arendt-Nielsen, L. & Svensson, P. (2009). Bilateral widespread mechanical pain sensitivity in women with myofascial temporomandibular disorder: evidence of impairment in central nociceptive processing. *The Journal of Pain, 10 (11),* 1170-1178.

Field, A. (2000). *Discovering statistics: using SPSS for Windows*. London: SAGE.

Fields, H. L., Basbaum, A. I. & Heinricher, M. M. (2006). Central nervous system mechanisms of pain modulation. In S. B. McMahon & M. Koltzenburg (eds.), *Wall and Melzack's textbook of pain (2nd edition)* (pp125-142). Philadelphia: Elsevier Limited.

Filatova, E., Latysheva, N. & Kurenkov, A. (2008). Evidence of persistent central sensitization in chronic headaches: a multi-method study. *The Journal of Headache and Pain, 9 (5),* 295-300.

Fillingim, R. B., King, C. D., Ribeiro-Dasilva, M. C., Rahim-Williams, B. & Riley III, J. L. (2009). Sex, gender and pain: a review of recent clinical and experimental findings. *The Journal of Pain, 10 (5),* 447-485.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin, 51 (4),* 327-358.

Flink, I. K., Mroczek, M. Z., Sullivan, M. J. L. & Linton, S. J. (2009). Pain in childbirth and postpartum recovery – The role of catastrophizing. *European Journal of Pain, 13 (3)*, 312-316.

Flor, H. & Turk, D. C. (2006). Cognitive and learning aspects. In S. B. McMahon & M. Koltzenburg (eds.), *Wall and Melzack's textbook of pain (2nd edition)* (pp241-258). Philadelphia: Elsevier Limited.

Folkman, S. (1984). Personal control and stress and coping processes: a theoretical analysis. *Journal of Personality and Social Psychology, 46 (4)*, 839-852.

Folkman, S. (1997). Positive psychological states and coping with severe stress. *Social Science and Medicine, 45 (8)*, 1207-1221.

Folkman, S. & Lazarus, R. (1985). If it changes it must be a process: study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology, 48 (1)*, 150-170.

Folkman, S. & Moskowitz, J. T. (2000). Positive affect and the other side of coping. *American Psychologist, 55 (6)*, 647-654.

Folkman, S., Schaefer, C. & Lazarus, R. S. (1979). Cognitive processes as mediators of stress and coping. In V. Hamilton & D. M. Warburton (eds.), *Human stress and cognition: an information-processing approach* (pp265-298). London: Wiley.

Fong, C. C. & Kwan, A. (2005). Patient-controlled sedation using remifentanil for third molar extraction. *Anaesthesia and Intensive Care, 33 (1)*, 73–77.

Forgione, A. G. (1988). Hypnosis in the treatment of dental fear and phobia. *Dental Clinics of North America, 32 (4)*, 745-761.

Fox, E., O'Boyle, C. A., Lennon, J. & Keeling, P. W. N. (1989). Trait anxiety and coping style as predictors of pre-operative anxiety. *British Journal of Clinical Psychology, 28 (1)*, 89-90.

Frazer, M. & Hampson, S. (1988). Some personality factors related to dental anxiety and fear of pain. *British Dental Journal, 165 (12)*, 436-439.

Frazier, L. (2002). Stability and change in patterns of coping with Parkinson's disease. *International Journal of Aging and Human Development, 55 (3)*, 207-231.

Frere, C. L., Crout, R., Yorty, J. & McNeil, D. W. (2001). Effects of Audiovisual Distraction During Dental Prophylaxis. *The Journal of the American Dental Association, 132 (7),* 1031-1038

Freud, S. (1915/1957). Repression. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud, Volume XIV* (pp146-158). London: The Hogarth Press. (Original work published in 1915).

Furman, E., Jasinevicius, T. R., Bissada, N. F., Victoroff, K. Z., Skillicorn, R. & Buchner, M. (2009). Virtual reality distraction for pain control during periodontal scaling and root planing procedures. *The Journal of the American Dental Association, 140 (12),* 1508-1516.

Gardner, W. J. & Licklider, J. C. (1959). Auditory analgesia in dental operations. *The Journal of the American Dental Association, 59 (6)*, 1144-1149.

Gatchel, R. (1989). The prevalence of dental fear and avoidance: expanded adult and recent adolescent surveys. *The Journal of the American Dental Association, 118 (5)*, 591-593.

Gauthier, J. G., Ricard, S., Morin, B. A., Dufour, L. & Brodeur, J-M. (1991). Adolescents' fear of dental treatment: development and evaluation of a cognitive inventory. *Journal of the Canadian Dental Association, 57 (8)*, 658-662.

Gedney, J. J. & Logan, H. (2007). Perceived control and negative affect predict expected and experienced acute clinical pain: a structural modeling analysis. *Clinical Journal of Pain, 23 (1)*, 35-44.

Geer, J. H. (1965). The development of a scale to measure fear. *Behaviour Research and Therapy, 3 (1)*, 45–53.

George, J. M., Scott, D. S., Turner, S. P. & Gregg, J. M. (1980). The effects of psychological factors and physical trauma on recovery from oral surgery. *Journal of Behavioral Medicine, 3 (3)*, 291-310.

George, S. Z., Wallace, M. R., Wright, T. W., Moser, M. W., Greenfield III, W. H., Sack, B. K., Herbstman, D. M. & Fillingim, R. B. (2008). Evidence for a biopsychosocial influence on shoulder pain: pain catastrophizing and catechol-O-methyltransferase (COMT) diplotype predict clinical pain ratings. *Pain 136 (1-2)*, 53-61.

Getka, E. J. & Glass, C. R. (1992). behavioral and cognitive-behavioral approaches to the reduction of dental anxiety. *Behavior Therapy, 23 (3)*, 433-448.

Gibson, S. J., Katz, B., Corran, T. M., Farrell, M. J. & Helme, R. D. (1994). Pain in older persons. *Disability & Rehabilitation, 16 (3)*, 127-139.

Gidron, Y., McGrath, P. J. & Goodday, R. (1995). The physical and psychosocial predictors of adolescents' recovery from oral surgery. *Journal of Behavioral Medicine, 18 (4)*, 385-399.

Gillett, P. L. & Coe, W. C. (1984). The effects of rapid induction analgesia (RIA), hypnotic susceptibility and the severity of discomfort on reducing dental pain. *American Journal of Clinical Hypnosis, 27 (2)*, 81-90.

Giummarra, M. J., Gibson, S. J., Georgiou-Karistianis, N. & Bradshaw, J. L. (2007). Central mechanisms in phantom limb perception: the past, present and future. *Brain Research Reviews, 54 (1)*, 219-232.

Goldscheider, A. (1884). Die specifische energie der gefühlsnerven der haut. *Monatsschrift für Praktische Dermatologie, 3*, 283-303.

Goldscheider, A. (1920). *Das Schmerz problem*. Berlin: Springer.

Goldstein, L. H., Drew, C., Mellers, J., Mithcell-O'Malley, S. & Oakley, D. A. (2000). Dissociation, hypnotizability, coping styles and health locus of control: characteristics of pseudoseizure patients. *Seizure – European Journal of Epilepsy, 9 (5)*, 314-322.

Goldstein Ferber, S., Granot, M. & Zimmer, E. Z. (2005). Catastrophizing labor pain compromises later maternity adjustments. *American Journal of Obstetrics and Gynecology, 192 (3)*, 826-831.

Gomez, R., Bounds, J., Holmberg, K., Fullarton, C. & Gomez, A. (1999). Effects of neuroticism and avoidant coping style on maladjustment during early adolescence. *Personality and Individual Differences, 26 (2)*, 305-319.

Gottlieb, B. & Gignac, M. (1996). Content and domain specificity of coping among family caregivers of persons with dementia. *Journal of Ageing Studies, 10 (2)*, 137-155.

Gower, P. L., editor (2004). *Psychology of fear*. New York: Nova Science Publishers, Inc.

Gracely, R. H., Dubner, R. & McGrath, P. (1988). Narcotic analgesia: fentanyl reduces the intensity but not the unpleasantness of painful tooth pulp sensations. *Science, 203 (4386)*, 1261-1263.

Gracely, R. H., Geisser, M. E., Giesecke, T., Grant, M. A. B., Petzke, F., Williams, D. A. & Clauw, D. J. (2004) Pain catastrophizing and neural responses to pain among persons with fibromyalgia. *Brain, 127 (4),* 835–843.

Gracely, R. H., McGrath, P. & Dubner, R. (1978). Ratio scales of sensory and affective verbal pain descriptors. *Pain, 5 (1),* 5-18.

Granot, M. & Goldstein Ferber, S. (2005). The Roles of pain catastrophizing and anxiety in the prediction of postoperative pain intensity: a prospective study. *The Clinical Journal of Pain, 21 (5)*, 439-445.

Gravdal, L. & Sandal, G. M. (2006).The two-factor model of social desirability: Relation to coping and defense, and implications for health. *Personality and Individual Differences, 40 (5)*, 1051-1061.

Greenberg, M. A., Dowling, V. L., Hatcher, M, L., Cox, B. J., Marcus, R., E. & Paget, S. A. (1999). Emotion-management predicts health outcomes in fibromyalgia. Poster session presented at the annual meeting of the Society of Behavioural Medicine, San Diego, CA.

Grisart, J. M. & Van der Linden, M. (2001). Conscious and automatic uses of memory in chronic pain patients. *Pain, 94 (3)*, 305–313.

Grossman, S. A., Sheidler, V. R., Swedeen, K., Mucenski, J. & Piantadosi, S. (1991). Correlation of patient and caregiver ratings of cancer pain. *Journal of Pain and Symptom Management, 6 (2)*, 53-57.

Guzeldemir, E., Toygar, H. U. & Cilasun, U. (2008). Pain perception and anxiety during scaling in periodontally healthy subjects. *Journal of Periodontology, 79 (12)*, 2247-2255.

Haan, N. (1965). Coping and defense mechanisms related to personal inventories. *Journal of Consulting Psychology, 29 (4)*, 373-378.

Haan, N. (1992). The assessment of coping, defense and stress. In L. Goldberger & S. Breznitz (eds.), *Handbook of stress: theoretical and clinical aspects* (pp258-273). New York: Free Press.

Hakeberg, M. & Cunha, L. (2008). Dental anxiety and pain related to dental hygienist treatment. *Acta Odontologica Scandinavica, 66 (6)*, 374-379.

Halvorsen, B. & Willumsen, T. (2004). Willingness to pay for dental fear treatment: is supplying dental fear treatment socially beneficial? *The European Journal of Health Economics, 5 (4)*, 299-308.

Haythornthwaite, J. A., Lawrence, J. W. & Fauerbach, J. A. (2001). Brief cognitive interventions for burn pain. *Annals of Behavioral Medicine, 23 (1)*, 42-49.

Heckman, T. G., Kochman, A., Sikkema, K. J., Kalichman, S. C., Masten, J., Bergholte, J. & Catz, S. (2001). A pilot coping improvement intervention for late middle-aged and older adults living with HIV/AIDS in the USA. *AIDS Care, 13 (1)*, 129-139.

Hedlund, S & Rude, S. S. (1995). Evidence of latent depressive schemas in formerly depressed individuals. *Journal of Abnormal Psychology, 104 (3)*, 517-525.

Heft, M. W., Gracely, R. H. & Dubner, R. (1984). Nitrous oxide analgesia: a psychophysical evaluation using verbal descriptor scaling. *Journal of Dental Research, 63 (2)*, 129-132.

Hirsh, A. T., George, S. Z., Riley III, J. L. & Robinson, M. E. (2007). An evaluation of the measurement of pain catastrophizing by the coping strategies questionnaire. *European Journal of Pain, 11 (1)*, 75-81.

Holahan, C. J., Holahan, C. K., Moos, R. H. & Brennan, P. L. (1997). Social context, coping strategies, and depressive symptoms: an expanded model with cardiac patients. *Journal of Personality and Social Psychology, 72 (4)*, 918-928.

Hollins, M. (2010). Somesthetic Senses. *Annual Review of Psychology, 61*, 243-271.

Hollins, M., Harper, D., Gallagher, S., Owings, E. W., Lim, P. F., Miller, V., Siddiqi, M. Q. & Maixner, W. (2009). Perceived intensity and unpleasantness of cutaneous and auditory stimuli: an evaluation of the generalized hypervigilance hypothesis. *Pain, 141 (3)*, 215–221.

Horn, S. & Munafò, M. (1997). *Pain: theory, research and intervention*. Buckingham: Open University Press.

Hoshiyama, M. & Kakigi, R. (2000). After-effect of transcutaneous electrical nerve stimulation (TENS) on pain-related evoked potentials and magnetic fields in normal subjects. *Clinical Neurophysiology, 111 (4)*, 717-724.

Houle, M., McGrath, P. A., Moran, G. & Garrett, O. J. (1988). The efficacy of hypnosis- and relaxation-induced analgesia on two dimensions of pain for cold pressor and electrical tooth pulp stimulation. *Pain, 33 (2)*, 241-251.

Humphris, G. M., Clarke, H. M. M. & Freeman, R. (2006). Does completing a dental anxiety questionnaire increase anxiety? A randomised controlled trial with adults in general dental practice. *British Dental Journal, 201 (1)*, 33-35.

Humphris, G. M., Freeman, R., Campbell, J., Tuutti, H. & D'Souza, V. (2000). Further evidence for the reliability and validity of the Modified Dental Anxiety Scale. *International Dental Journal, 50 (6)*, 367-370.

Humphris, G. & Ling, M. S. (2000). *Behavioural sciences for dentistry*. Edinburgh: Churchill Livingstone.

Humphris, G. M., Morrison, T. & Lindsay, S. J. E. (1995). The Modified Dental Anxiety Scale: validation and United Kingdom norms. *Community Dental Health, 12 (3),* 143-150.

Jackson, C. & Lindsay, S. (1995). Reducing anxiety in new dental patients by means of leaflets. *British Dental Journal, 179 (5),* 163-167.

Jacoby, L. L., Lindsay, D. S. & Toth, J. P. (1992). Unconscious influences revealed: attention, awareness and control. *American Psychologist, 47 (6)*, 802-809.

Jamner, L. D. & Leigh, H (1999). Repressive/defensive coping, endogenous opioids and health: how a life so perfect can make you sick. *Psychiatry Research, 85 (1)*, 17-31.

Jantsch, H. H., Kemppainen, P., Ringler, R., Handwerker, H. O. & Forster, C. (2005). Cortical representation of experimental tooth pain in humans. *Pain, 118 (3)*, 390-399.

Jerjes, W., Hopper, C., Kumar, M., Upile, T., Madland, G., Newman, S. & Feinmann, C. (2007). Psychological intervention in acute dental pain: review. *British Dental Journal, 202 (6)*, 337-343.

Jones, A. K. P., Brown, W. D., Friston, K. J., Qi, L. Y. & Frackowiak, R. S. J. (1991). Cortical and subcortical localization of response to pain in man using positron emission tomography. *Proceedings of the Royal Society of London. Series B, Biological Sciences, 244 (1309)*, 39-44.

Karadottir, H., Lenoir, L., Barbierato, B., Bogle, M., Riggs, M., Sigurdsson, T., Crigger, M. & Egelberg, J. (2002). Pain experienced by patients during periodontal maintenance treatment. *Journal of Periodontology, 73 (5)*, 536-542.

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

Keller, S., Bann, C. M., Dodd, S. L., Schein, J., Mendoza, T. R. & Cleeland, C. S. (2004). Validity of the brief pain inventory for use in documenting the outcomes of patients with noncancer pain. *The Clinical Journal of Pain, 20 (5)*, 309-318.

Kendell, K., Saxby, B., Farrow, M. & Naisby, C. (2001). Psychological factors associated with short-term recovery from total knee replacement. *British Journal of Health Psychology, 6 (1)*, 41-52.

Kennedy, P., Duff, J., Evans, M. & Beedie, A. (2003). Coping effectiveness training reduces depression and anxiety following traumatic spinal cord injuries. *British Journal of Clinical Psychology, 42 (1),* 41-52.

Keogh, E., Book, K., Thomas, J., Giddins, G. & Eccleston, C. (2010). Predicting pain and disability in patients with hand fractures: Comparing pain anxiety, anxiety sensitivity and pain catastrophizing. *European Journal of Pain, 14 (4),* 446-451.

King, C. & Kennedy, P. (1999). Coping effectiveness training for people with spinal cord injury: preliminary results of a controlled trial. *British Journal of Clinical Psychology, 38 (1),* 5-14.

Klages, U., Kianifard, S., Ulusoy, Ö. & Wehrbein, H. (2006). Anxiety sensitivity as predictor of pain in patients undergoing restorative dental procedures. *Community Dentistry and Oral Epidemiology, 34 (2),* 139-145.

Klages, U., Ulusoy, Ö., Kianifard, S. & Wehrbein, H. (2004). Dental trait anxiety and pain sensitivity as predictors of expected and experienced pain in stressful dental procedures. *European Journal of Oral Sciences, 112 (6),* 477-483.

Kleinhauz, M. & Eli, I (1991). Hypnotic induction in dentistry – coping with the fear of losing control (autonomy): a brief communication. *The International Journal of Clinical and Experimental Hypnosis, 34 (3),* 125-128.

Kleinknecht, R. A., Keplac, R. K. & Alexander, L. D. (1973). Origins and characteristics of fear of dentistry. *The Journal of the American Dental Association, 86 (4),* 842-848.

Kline, P. (2000). *Handbook of Psychological Testing (2nd. edition).* London: Routledge.

Klingberg, G. & Broberg, A. G. (2007). Dental fear/anxiety and dental behaviour management problems in children and adolescents: a review of prevalence and concomitant psychological factors. *International Journal of Paediatric Dentistry, 17 (6)*, 391-406.

Klonoff, E. A. & Landrine, H. (1992). Sex roles, occupational roles, and symptom-reporting: a test of competing hypotheses on sex differences. *Journal of Behavioral Medicine, 15 (4)*, 355-364.

Kong, J., Loggia, M. L., Zyloney, C., Tu, P., LaViolette, P. & Gollub, R. L. (2010). Exploring the brain in pain: activations, deactivations and their relation. *Pain, 148 (2)*, 257–267.

Krebs, E. E., Carey, T. S. & Weinberger, M. (2007). Accuracy of the pain numeric rating scale as a screening test in primary care. *Journal of General Internal Medicine, 22 (10)*, 1453-1458.

Kritsidima, M., Newton, T. & Asimakopoulou, K. (2010). The effects of lavender scent on dental patient anxiety levels: a cluster randomized-controlled trial. *Community Dentistry and Oral Epidemiology, 38 (1)*, 83-87.

Krohne, H. W. (1986). Coping with stress: dispositions, strategies and the problem of measurement. In M. H. Appley & R. Trumbull (eds.), *Dynamics of stres*s (pp209-234). New York: Plenum Press.

Kuhajda, M. C., Thorn, B. E., Klinger, M. R. & Rubin, N. J. (2002). The effect of headache pain on attention (encoding) and memory (recognition). *Pain, 97 (3)*, 213–221.

Kunz, M., Chatelle, C., Lautenbacher, S. & Rainville, P. (2008). The relation between catastrophizing and facial responsiveness to pain, *Pain, 140 (1)*, 127-134.

Kurtz, J. E., Tarquini, S. J. & Iobst, E. A. (2008). Socially desirable responding in personality assessment: still more substance than style. *Personality and Individual Differences, 45 (1)*, 22-27.

Kuscu, O. O. & Akyuz, S. (2008). Is it the injection device or the anxiety experienced that causes pain during dental local anaesthesia? *International Journal of Paediatric Dentistry, 18 (2)*, 139-145.

Kvale, G., Berggren, U. & Milgrom, P. (2004). Dental fear in adults: a meta-analysis of behavioral interventions. *Community Dentistry and Oral Epidemiology, 32 (4)*, 250-264.

Lago-Méndez, L., Diniz-Freitas, M., Senra-Rivera, C., Seoane-Pesqueira, G., Gándara-Rey, J. M. & García- García, A. (2009). Postoperative recovery after removal of a lower third molar: role of trait and dental anxiety. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 108 (6)*, 855-860.

Lahmann, C., Schoen, R., Henningsen, P., Ronel, J., Muehlbacher, M., Loew, T., Tritt, K., Nickel, M. & Doering, S. (2008). Brief relaxation versus music distraction in the treatment of dental anxiety: a randomized controlled clinical trial. *The Journal of the American Dental Association, 139 (3)*, 317-324.

Lane, R. D., Merikangas, K. R., Schwartz, G. E., Huang, S. S. & Prusoff, B. A. (1990). Inverse relationship between defensiveness and lifetime prevalence of psychiatric disorder. *The American Journal of Psychiatry, 147 (5)*, 573-578.

Latremoliere, A. & Woolf, C. J. (2009). Central sensitization: a generator of pain by central neural plasticity. *The Journal of Pain, 10 (9)*, 895-926.

Law, A., Logan, H. L. & Baron, R. S. (1994). Desire for control, felt control and stress inoculation training during dental treatment. *Journal of Personality and Social Psychology, 67 (5)*, 926-936.

Lazarus, R. S. (1966). *Psychological stress and the coping process.* New York: McGraw-Hill.

Lazarus, R. S. (1981). The stress and coping paradigm. In C. Eisdorfer, D. Cohen, A. Kleinman & P. Maxim (eds.), *Models for clinical psychopathology* (pp177-214). New York: Spectrum.

Lazarus, R. S. (1993). Coping theory and research: past, present, and future. *Psychosomatic Medicine, 55 (3)*, 234-247.

Lazarus, R. S. (1999). *Stress and emotion: a new synthesis*. New York: Springer Publishing Company, Inc.

Lazarus, R. S. & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer.

Lazarus, R. S., Kanner, A. & Folkman, S. (1980). Emotions: a cognitive-phenomenological analysis. In R. Plutchik & H. Kellerman (eds.), *Theories of emotion* (pp189-217). New York: Academic Press.

Lazarus, R. S. & Launier, R. (1978). Stress-related transactions between person and environment. In L. A. Pervin & M. Lewis (eds.), *Perspectives in interactional psychology* (pp287-327). New York: Plenum Press.

Lee, E-J., Wu, M-Y., Lee, G. K., Cheing, G. & Chan, F. (2008). Catastrophizing as a cognitive vulnerability factor related to depression in workers' compensation patients with chronic musculoskeletal pain. *Journal of Clinical Psychology in Medical Settings, 15 (3)*, 182-192.

Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K. & Vlaeyen, J. W. S. (2007). The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *Journal of Behavioral Medicine, 30 (1)*, 77-94.

Lehrner, J., Eckersberger, C., Walla, P., Pötsch, G. & Deecke, L. (2000). Ambient odor of orange in a dental office reduces anxiety and improves mood in female patients. *Physiology & Behavior, 71 (1-2)*, 83-86.

Lehrner, J., Marwinski, G., Lehr, S., Johren, P. & Deecke, L. (2005). Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office. *Physiology & Behavior, 86 (1-2)*, 92-95.

Leventhal, H. (1982). The integration of emotion and cognition: a view from the perceptual-motor theory of emotion. In M. S. Clark & S. T. Fiske (eds.), *Affect and cognition* (pp121-156). Hillsdale, NJ: Erlbaum.

Leventhal, H. (1990). Emotional and behavioural processes. In M. Johnston & L. Wallace (eds.), *Stress and medical procedures* (pp25-57). New York: Oxford University Press.

Leventhal, H., Brissette, I. & Leventhal, E. A. (2003). The common-sense model of self-regulation of health and illness. In L. D. Cameron & H. Leventhal (eds.), *The self-regulation of health and illness behaviour* (pp42-65). London: Routledge.

Leventhal, H. & Nerenz, D. (1985). The assessment of illness cognition. In P. Karoly (ed.), *Measurement strategies in health psychology* (pp517-554). New York: John Wiley.

Levine, F. M. & De Simone, L. L., (1991). The effects of experimenter gender on pain report in male and female subjects. *Pain, 44 (1)*, 69-72.

Lewicki, P., Hill, T. & Czyzewska, M. (1992). Nonconscious acquisition of information. *American Psychologist, 47 (6)*, 796-801.

Lindsay, S. & Jackson, C. (1993). Fear of routine dental treatment in adults: its nature and management. *Psychology and Health, 8 (2)*, 135-153.

Litt, M. D. (1988). Cognitive mediators of stressful experience: self-efficacy and perceived control. *Cognitive Therapy and Research, 12 (3)*, 241-260.

Litt, M. D. (1996). A model of pain and anxiety associated with acute stressors: distress in dental procedures. *Behaviour Research and Therapy 34 (5-6)*, 459-476.

Litt, M. D., Kalinowski, L. & Shafer, D. (1999). A dental fears typology of oral surgery patients: matching patients to anxiety interventions. *Health Psychology, 18 (6),* 614-624.

Litt, M. D., Nye, C. & Shafer, D. (1993). Coping with oral surgery by self-efficacy enhancement and perceptions of control. *Journal of Dental Research, 72 (8),* 1237-1243.

Locker, D., Thomson, W. M. & Poulton, R. (2001). Psychological disorders and dental anxiety in a young adult population. *Community Dentistry and Oral Epidemiology, 29 (6),* 456-463.

Logan, H. L., Baron, R., S., Keeley, K., Law, A. Moreland, M. & Stein, S. (1991). Desired and felt control as mediators of stress in a dental setting. *Health Psychology, 10 (5),* 352-359.

Logan, H. L., Baron, R. S. & Kohout, F. (1995). Sensory focus as therapeutic treatments for acute pain. *Psychosomatic Medicine, 57 (5),* 475-484.

Logan, H. L., Lutgendorf, S., Kirchner, H. L., Rivera, E. M. & Lubaroff, D. (2001)[b]. Pain and immunologic response to root canal treatment and subsequent health outcomes. *Psychosomatic Medicine, 63 (3),* 453-462.

Logan, H. L., Lutgendorf, S., Rainville, P., Sheffield, D., Iverson, K. & Lubaroff, D, (2001)[a]. Effects of stress and relaxation on capsaicin-induced pain. *Journal of Pain, 2 (3),* 15-25.

Loggia, M. L., Mogil, J. S. & Bushnell, M. C. (2008). Empathy hurts: compassion for another increases both sensory and affective components of pain perception. *Pain, 136 (1-2),* 168–176.

Loggia, M. L., Schweinhardt, P., Villemure, C. & Bushnell, M. C. (2008). Effects of psychological state on pain perception in the dental environment. *Journal of the Canadian Dental Association, 74 (7)*, 651-656.

Lutgendorf, S. K., Antomi, M. H. Ironson, G., Starr, K., Costrllo, N., Zuckerman, M., Klimas, N., Fletcher, A. & Schneiderman, N. (1998). Changes in cognitive coping skills and social support during cognitive behavioral stress management intervention and distress outcome in symptomatic human immunodeficiency virus (HIV) – seropositive gay men. *Psychosomatic Medicine, 60 (2)*, 204-214.

Maggirias, J. & Locker, D. (2002). Psychological factors and perceptions of pain associated with dental treatment. *Community Dentistry and Oral Epidemiology, 30 (2)*, 151-159.

Marcel. A. J. (1983). Conscious and unconscious perception: experiments on visual masking and word recognition. *Cognitive Psychology*, *15 (2)*, 197-237.

Marco, C. A., Neale, J. M., Schwartz, J. E., Shiffman, S. & Stone, A. (1999). Coping with daily events and short-term mood changes: an unexpected failure to observe effects of coping. *Journal of Consulting and Clinical Psychology, 67 (5)*, 755-764.

Marino, J., Gwynn, M. I. & Spanos, N. E. (1989). Cognitive mediators in the reduction of pain: the role of expectancy, strategy use, and self-presentation. *Journal of Abnormal Psychology, 98 (3)*, 256-262.

Marks, I. & Nesse. R. M. (1994). Fear and fitness: an evolutionary analysis of anxiety disorders. *Ethology and Sociobiology, 15 (5-6)*, 247-261.

Marteau, T. M. & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology, 31 (3)*, 301-306.

Martelli, M. M., Auerbach, S. M., Alexander, J. & Mercuri, L. G. (1987). Stress management in the health care setting; matching interventions with patient coping styles. *Journal of Consulting and Clinical Psychology, 55 (2)*, 201-207.

Matthews, R., Ball, R., Goodley, A., Lenten, J., Riley, C., Sanderson, S. & Singleton, E. (1997) The efficacy of local anaesthetics administered by general dental practitioners. *British Dental Journal, 182 (5)*, 175–178.

McCarthy, S. C., Lyons, A. C., Weinman, J., Talbot, R. & Purnell, D. (2003). Do expectations influence recovery from oral surgery? An illness representation approach. *Psychology & Health, 18 (1)*, 109-126.

McCaul, K. D. & Malott, J. M. (1984). Distraction and coping with pain. *Psychological Bulletin*, *95 (3)*, 516-533.

McCullough, M. L., Smith, C. D. & Walker, P. (1976). A note on repression. *Bulletin of the British Psychological Society*, *29*, 235-237.

McGrath, C. & Bedi, R. (2004). The association between dental anxiety and oral health-related quality of life in Britain. *Community Dentistry and Oral Epidemiology, 32 (1)*, 67-72.

McNeil, D. & Berryman, L. (1989). Components of dental fear in adults. *Behaviour Research and Therapy, 27 (3)*, 233-236.

Meeus, M. & Nijs, J. (2007). Central sensitization: a biopsychosocial explanation for chronic widespread pain in patients with fibromyalgia and chronic fatigue syndrome. *Clinical Rheumatology, 26 (4)*, 465–473.

Meeus, M., Nijs, J., Van de Wauwer, N., Toeback, L. & Truijen, S. (2008). Diffuse noxious inhibitory control is delayed in chronic fatigue syndrome: an experimental study. *Pain, 139 (2)*, 439–448.

Mehrstedt, M., Tonnies, S. & Eisentraut, I. (2004). Dental fears, health status, and quality of life. *Anesthesia Progress, 51 (3)*, 90-94.

Meichenbaum, D. (1985). *Stress inoculation training*. New York: Pergamon Press.

Melamed, B. G., Weinstein, D., Hawes, R. & Katin-Borland, M. (1975). Reduction of fear-related dental management problems with use of filmed modelling. *The Journal of the American Dental Association, 90 (4)*, 822-826.

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

Melzack, R. (1989). Phantom limbs, the self and the brain. *Canadian Psychology, 30 (1)*, 1-16.

Melzack, R. (1990). Phantom limbs and the concept of a neuromatrix. *Trends in Neurosciences, 13 (3)*, 88-92.

Melzack, R. (1999). From the gate to the neuromatrix. *Pain*, *82 (Suppl. 1)*, S121-S126.

Melzack, R. (2001). Pain and the neuromatrix in the brain. *Journal of Dental Education, 65 (12)*, 1378-1382.

Melzack, R. (2005). Evolution of the neuromatrix theory of pain. The Prithvi Raj lecture: presented at the Third World Congress of World Institute of Pain, Barcelona 2004. *Pain Practice*, *5 (2)*, 85-94.

Melzack, R & Casey, K. L. (1968). Sensory, motivational, and central control determinants of pain: A new conceptual model. In D.R. Kenshalo (ed.), *The skin senses* (pp423-443). Springfield, IL: Charles C. Thomas.

Melzack, R. & Katz, J. (2004). The gate control theory: reaching for the brain. In T. Hadjistavropoulos & K. D. Craig (eds.), *Pain: psychological perspectives* (pp13-34). New Jersey: Lawrence Erlbaum Associates.

Melzack, R. & Loeser, J. D. (1978). Phantom body pain in paraplegics: evidence for a central "pattern generating mechanism" for pain. *Pain, 4 (3)*, 195-210.

Melzack, R. & Torgerson, W. S. (1971). On the language of pain. *Anesthesiology, 34 (1)*, 50-59.

Melzack, R. & Wall, P. D. (1965). Pain mechanisms: a new theory. *Science, 150 (3699)*, 971-979.

Melzack, R. & Wall, P. D. (1982). *The challenge of pain*. New York: Basic Books.

Merskey, H. & Bogduk, N. (1994). *Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms (2nd edition)*. Seattle: IASP Press.

Michael-Titus, A., Revest, P. & Shortland, P. (2010). *The nervous system. (2nd Edition).* London: Churchill Livingstone.

Milgrom, P., Weinstein, P., Kleinknecht, R. A. & Getz, T. (1985). *Treating fearful dental patients: a clinical handbook.* Reston, VA: Reston Publishing Company.

Miller, S. M. (1979). Unpublished manuscript, monitors vs. blunters: validation of a questionnaire to assess two styles for coping with threat. Pennsylvania: University of Pennsylvania.

Miller, S. M. (1980). When is a little information a dangerous thing?: coping with stressful events by monitoring versus blunting. In S. Levine & H. Ursin (eds.), *Coping and health* (pp145-169). New York: Plenum Press.

Miller, S. M. (1987). Monitoring and blunting: validation of a questionnaire to assess styles of information seeking under threat. *Journal of Personality and Social Psychology, 52 (2)*, 345-353.

Miller, S. M. (1995). Monitoring versus blunting styles of coping with cancer influence the information patients want and need about their disease. Implications for cancer screening and management. *Cancer, 76 (2)*, 167-177.

Miller, S. M. (1996). Monitoring and blunting of threatening information: cognitive interference and facilitation in the coping process. In I. G. Sarason, G. R. Pierce & B. R. Sarason (eds.), *Cognitive interference: theories, methods and findings* (pp175-190). Mahwah, NJ: Lawrence Erlbaum Associates.

Miller, S. M., Brody, D. S. & Summerton, J. (1988). Styles of coping with threat: implications for health. *Journal of Personality and Social Psychology, 54 (1)*, 142-148.

Miller, S. M. & Mangan, C. E. (1983). The interacting effects of information and coping style in adapting to gynaecologic stress: should the doctor tell all? *Journal of Personality and Social Psychology, 45 (1)*, 223-236.

Miller, S. M., Rodoletz, M., Schroeder, C. M., Mangan, C. E. & Sedlacek, T. V. (1996). Applications of the monitoring process model to coping with severe long-term medical threats. *Health Psychology, 15 (3)*, 216-225.

Miller, S. M., Roussi, P., Altman, D., Helm, W. & Steinberg, A. (1994). Effects of coping on psychological reactions of low-income minority women of colposcopy. *Journal of Reproductive Medicine, 39 (9)*, 711-718.

Miller, S. M., Roussi, P., Caputo, C. & Kruus, L. (1995). Patterns of children's coping with an aversive dental treatment. *Health Psychology, 14 (3)*, 236-246.

Miller, S. M., Shoda, Y. & Hurley, K. (1996). Applying cognitive-social theory to health-protective behavior: breast self-examination in cancer screening. *Psychological Bulletin, 119 (1)*, 70-94.

Moore, P. A., Ramsay, D. S., Finder, R. L. & Laverick, W. (1988). Pharmacologic modalities in the management and treatment of dental anxiety. *Dental Clinics of North America, 32 (4)*, 803-816.

Moskowitz, J. T., Folkman, S., Collette, L. & Vittinghoff, E. (1996). Coping and mood during AIDS-related caregiving and bereavement. *Annals of Behavioral Medicine, 18 (1)*, 49-57.

Moss-Morris, R., Weinman, J., Petrie, K. J., Horne, R., Cameron, L. D. & Buick, D. (2002). The revised illness perception questionnaire (IPQ-R). *Psychology and Health, 17 (1),* 1-16.

Muglali, M. & Komerik, N. (2008). Factors related to patients' anxiety before and after oral surgery. *Journal of Oral Maxillofacial Surgery, 66 (5)*, 870-877.

Mullen, B. & Suls, J. (1982). The effectiveness of attention and rejection as coping styles: a meta-analysis of temporal differences. *Journal of Psychosomatic Research, 26 (1)*, 43-49.

Muris, P., de Jongh, A., van Zuuren, F. J. & Schoenmakers, N. (1996). Monitoring-blunting coping styles and cognitive symptoms of dental fear. *European Journal of Personality, 10 (1),* 35-44.

Muris, P., de Jongh, A., van Zuuren, F. J., ter Horst, G., Deforchaux, Y. K. & Somers, P. (1995). Imposed and chosen monitoring and blunting strategies in the dental setting; effects, self-efficacy and coping preference. *Anxiety, Stress, and Coping, 8 (1),* 47-59.

Myers, H. L. & Myers, L. B. (2004). "It's difficult being a dentist": stress and health in the general dental practitioner. *British Dental Journal, 197 (2)*, 89-93.

Myers, L. B., Newman, S. P. & Enomoto, K. (2004). Coping. In A. Kaptein and J. Weinman (eds.), *Health psychology* (pp141-157). Oxford, UK: BPS Blackwell.

Nagasako, E. M., Oaklander, A. L. & Dworkin, R. H. (2003). Congenital insensitivity to pain: an update. *Pain, 101 (3)*, 213-219.

Nakamura, Y., Paur, R., Zimmermann, R. & Bromm B. (2002). Attentional modulation of human pain processing in the secondary somato-sensory cortex: a magnetoencephalographic study. *Neuroscience Letters*, *328 (1)*, 29–32.

Neverlien, P. O. (1990). Assessment of a single-item dental anxiety question. *Acta Odontologica Scandinavica, 48 (6)*, 365-369.

Newton, J. T. & Buck, D. J. (2000). Anxiety and pain measures in dentistry: a guide to their quality and application. *The Journal of the American Dental Association, 131 (10)*, 1449-1457.

Ng, S. K. S., Chau, A. W. L. & Leung, W. K. (2004). The effect of pre-operative information in relieving anxiety in oral surgery patients. *Community Dentistry and Oral Epidemiology, 32 (3)*, 227-235.

Nijs, J., Van de Putte, K., Louckx, F., Truijen, S. & De Meirleir, K. (2008). Exercise Performance and Chronic Pain in Chronic Fatigue Syndrome: The Role of Pain Catastrophizing. *Pain Medicine, 9 (8)*, 1164-1172.

Nijs, J., Van Houdenhove, B. & Oostendorp, R. A. B. (2010). Recognition of central sensitization in patients with musculoskeletal pain: application of pain neurophysiology in manual therapy practice. *Manual Therapy, 15 (2)*, 135-141.

Noback, C. R., Strominger, N. L., Demarest, R. J. & Ruggiero, D. A. (2005). *The human nervous system: structure and function (6th edition)*. New Jersey: Humana Press Inc.

Nunnaly, J. (1978). *Psychometric theory*. New York: McGraw-Hill.

Nyklíček, I., Vingerhoets, A. J. J. M., van Heck, G. L. & van Limpt, M. C. A. M. (1998). Defensive coping in relation to casual blood pressure and self-reported daily hassles and life events. *Journal of Behavioural Medicine, 21 (2),* 145-161.

O'Boyle, C. A. & Fox, E. (1989). Surgical and diagnostic procedures as models in psychopharmacology: assessment of pain and anxiety. In I. Hindmarch & P. D. Stonier (eds.), *Human psychopharmacology: measures and methods*. Chichester: Wiley.

Oettingen, G. (1996). Positive fantasy and motivation. In P. M. Gollwitzer & J. A. Bargh (eds.), *The psychology of action* (pp236-259). New York: Guilford Press.

The Office for National Statistics (2004). *The National Statistics Socio-economic Classification User Manual version No. 1.2*. London: Office for National Statistics.

Ogden, J. (2007). *Health psychology: a textbook (4th edition)*. Berkshire, UK: Open University Press.

Okawa, K., Ichinohe, T. & Kaneko, Y. (2005). Anxiety may enhance pain during dental treatment. *The Bulletin of Tokyo Dental College, 46 (3),* 51-58.

Oosterink, F. M. D., de Jongh, A. & Aartman, I. H. A. (2008). What are people afraid of during dental treatment? Anxiety provoking capacities of 67 stimuli comprising the dental setting. *European Journal of Oral Sciences, 116 (1),* 44–51.

Oosterink, F. M. D., de Jongh, A. & Aartman, I. H. A. (2009). Negative events and their potential risk of precipitating pathological forms of dental anxiety. *Journal of Anxiety Disorders, 23 (4),* 451-457.

Osman, A., Barrios, F. X., Kopper, B. A., Hauptmann, W., Jones, J. & O'Neill, E. (1997). Factor structure, reliability and validity of the pain catastrophizing scale. *Journal of Behavioral Medicine, 20 (6),* 589-605.

Parker, J. D. A. & Endler, N. S. (1996). Coping and defense: A historical overview. In M. Zeidner & N. S. Endler (eds.). *Handbook of Coping: theory, research and applications* (pp3-23). New York: John Wiley & Sons.

Paulhus, D. L. (1984). Two component model of socially desirable responding. *Journal of Personality and Social Psychology, 46 (3)*, 598-609.

Paulhus, D. L. (1991). Measurement and control of response bias. In J. P. Robinson, P. R. Shaver & L. S. Wrightsman (eds.), *Measures of personality and social psychological attitudes* (pp17-59). San Diego, CA: Academic Press.

Paulhus, D. L. (1998). *Manual for the balanced inventory of desirable responding (BIDR-7).* Toronto, Ontario, Canada: Multi-Health Systems.

Paulhus, D. L. (2002). Socially desirable responding: The evolution of a construct. In H. I. Braun, D. N. Jackson & D. E. Wiley (eds.), *The role of constructs in psychological and educational measurement* (pp49-69). Mahwah, NJ: Lawrence Erlbaum.

Paulhus, D. L., Fridhandler, B. & Hayes, S. (1997). Psychological defense: contemporary theory and research. In R. Hogan, J. Johnson & S. Briggs (eds.), *Handbook of personality* (pp544-580). New York: Academic Press.

Paulson, P. E., Minoshima, S., Morrow, T. J. & Casey, K. L. (1998). Gender differences in pain perception and patterns of cerebral activation during noxious heat stimulation in humans. *Pain, 76 (1-2)*, 223-229.

Pavlin, D. J., Sullivan, M J. L., Freund, P. R. & Roesen, K. (2005). Catastrophizing: a risk factor for postsurgical pain. *The Clinical Journal of Pain, 21 (1)*, 83-90.

Peters, M. L., Vlaeyen, J. W. S. & van Drunen, C. (2000). Do fibromyalgia patients display hypervigilance for innocuous somatosensory stimuli? Application of a body scanning reaction time paradigm. *Pain, 86 (3)*, 283-292.

Phillips, M. L., Gregory, L. J., Cullen, S., Cohen, S., Ng, V., Andrew, C., Giampietro, V., Bullmore, E., Zelaya, F., Amaro, E., Thompson, D. G., Hobson, A. R., Williams, S. C. R., Brammer, M. & Aziz. Q. (2003). The effect of negative emotional context on neural and behavioural responses to oesophageal stimulation. *Brain, 126 (3)*, 669–684.

Pierce, G. R., Sarason, B. R. & Sarason, I. G. (1996). *The handbook of social support and the family*. New York: Plenum Press.

Pincus, T., Burton, A. K., Vogel, S. & Field, A. P. (2002). A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine, 27 (5)*, E109-E120.

Popescu, A., LeResche, L., Truelove, E. L. & Drangsholt, M. T. (2010). Gender differences in pain modulation by diffuse noxious inhibitory controls: a systematic review. *Pain, 150 (2)*, 309-318.

Porro, C. A., Baraldi, P., Pagnoni, G., Serafini, M., Facchin, P., Maieron, M. & Nichelli, P. (2002). Does Anticipation of Pain Affect Cortical Nociceptive Systems? *The Journal of Neuroscience, 22 (8)*, 3206–3214.

Porter, L. S., Phillips, C., Dickens, S. & Kiyak, H. A. (2000). Social desirability in patients seeking surgical treatment for dentofacial disharmony: associations with psychological distress and motivation for treatment. *Journal of Clinical Psychology in Medical Settings, 7 (2),* 99-106.

Price, D. D., Riley III, J. L. & Wade, J. B. (2001). Psychological approaches to measurement of the dimensions and stages of pain. In D. C. Turk & R. Melzack (eds.), *Handbook of pain assessment, second edition* (pp53-75). New York, London: Guilford Press.

Price, D. D. & Staud, R. (2005). Neurobiology of fibromyalgia syndrome. *The Journal of Rheumatology, 32 (Suppl. 75)*, S22-S28.

Quartana, P. J., Campbell, C. M. & Edwards, R. R. (2009). Pain catastrophizing: a critical review. *Expert Review of Neurotherapeutics, 9 (5)*, 745-758.

Rachman, S. (1977). The conditioning theory of fear-acquisition: a critical examination. *Behaviour Research and Therapy, 15 (5)*, 375-387.

Ragnarsson, B., Arnlaugsson, S., Karlsson, K. O., Magnusson, T. E. & Arnarson, E. O. (2003). Dental anxiety in Iceland: an epidemiological postal survey. *Acta Odontologica Scandinavica, 61 (5)*, 283-288.

Rainville, P., Bau, Q. V. H. & Chrétien, P. (2005). Pain-related emotions modulate experimental pain perception and autonomic responses. *Pain, 118 (3)*, 306–318.

Rees, C. E. & Bath, P. A. (2000). The psychometric properties of the Miller Behavioural Style Scale with adult daughters of women with early breast cancer: a literature review and empirical study. *Journal of Advanced Nursing, 32 (2)*, 366-374.

Reichling, D. B. & Levine, J. D. (2009). Critical role of nociceptor plasticity in chronic pain. *Trends in Neurosciences, 32 (12)*, 611-618.

Reinert, A., Treede, R. & Bromm, B. (2000). The pain inhibiting pain effect: an electrophysiological study in humans. *Brain Research, 862 (1-2)*, 103–110.

Rhudy, J. L., Williams, A. E., McCabe, K. M., Nguyen, M. A. T. V. & Rambo, P. (2005). Affective modulation of nociception at spinal and suraspinal levels. *Psychophysiology, 42 (5)*, 579–87.

Riddle, D. L., Wade, J. B., Jiranek, W. A. & Kong, X. (2010). Preoperative pain catastrophizing predicts pain outcome after knee arthroplasty. *Clinical Orthopaedics and Related Research, 468 (3)*, 798-806.

Rivest, K., Côté, J. N., Dumas, J-P., Sterling, M. & De Serres, S. J. (2010). Relationships between pain thresholds, catastrophizing and gender in acute whiplash injury. *Manual Therapy, 15 (2),* 154-159.

Roosevelt, F. D. (1933). Inaugural address, March 4, 1933. As published (1938) in S. Rosenman (ed.), *The public papers of Franklin D. Roosevelt, Volume Two: The year of crisis, 1933* (pp11-16). New York: Random House.

Rosentiel, A. K. & Keefe, F. J. (1983). The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. *Pain, 17 (1),* 33-44.

Said Yekta, S., Vohn, R. & Ellrich, J. (2009). Cerebral activations resulting from virtual dental treatment. *European Journal of Oral Sciences, 117 (6),* 711-719.

Sarafino, E. (2008). *Health psychology: biopsychosocial interactions (6th edition).* New Jersey: John Wiley & Sons.

Savelkoul, M., de Witte, L. P., Candel, M. J. J. M., van der Tempel, H. & van den Borne, B. (2001). Effects of a coping intervention on patients with rheumatic diseases: results of a randomized control trial. *Arthritis Care & Research, 45 (1),* 69-76.

Sawamoto, N., Honda, M., Okada, T., Hanakawa, T., Kanda, M., Fukuyama, H., Konishi, J. & Shibasaki, H. (2000). Expectation of pain enhances responses to nonpainful somatosensory stimulation in the anterior cingulate cortex and parietal operculum/posterior insula: an event-related functional magnetic resonance imaging study. *The Journal of Neuroscience, 20 (19),* 7438-7445.

Scheier, M. F., Weintraub, J. K. & Carver, C. (1986). Coping with stress: divergent strategies of optimists and pessimists. *Journal of Personality and Social Psychology, 51 (6),* 1257-1264.

Schmid-Leuz, B., Elsesser, K., Lohrmann, T., Jöhren, P. & Sartory, G. (2007). Attention focusing versus distraction during exposure in dental phobia. *Behaviour Research and Therapy 45 (11)*, 2691–2703.

Schultz, I. Z., Crook, J., Berkowitz, J., Milner, R. & Meloche, G. R. (2005). Predicting return to work after low back injury using the Psychosocial Risk for Occupational Disability Instrument: a validation study. *Journal of Occupational Rehabilitation, 15 (3)*, 365-376.

Severeijns, R., Vlaeyen, J. W. S., van den Hout, M. A. & Picavet, H. S. J. (2004). Pain catastrophizing is associated with health indices in musculoskeletal pain: a cross-sectional study in the Dutch community. *Health Psychology, 23 (1)*, 49-57.

Seymour, R. A., Meechan, J. G. & Blair, G. S. (1985). An investigation into post-operative pain after third molar surgery under local analgesia. *British Journal of Oral and Maxillofacial Surgery, 23 (6)*, 410-418.

Seyrek, S., Corah, N. & Pace, L. (1984). Comparison of three distraction techniques in reducing stress in dental patients. *The Journal of the American Dental Association, 108 (3)*, 327-329.

Siegel, L. J. & Peterson, L. (1980). Stress reduction in young dental patients through coping and sensory information. *Journal of Consulting and Clinical Psychology, 48 (6)*, 785-787.

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J. & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science, 303 (5661)*, 1157-1162.

Smeets, R. J. E. M., Vlaeyen, J. W. S., Kester, A. D. M. & Knottnerus, J. A. (2006). Reduction of pain catastrophizing mediates the outcome of both physical and cognitive-behavioral treatment in chronic low back pain. *The Journal of Pain, 7 (4)*, 261-271.

Smith, T. A. & Heaton, L. J. (2003). Fear of dental care: are we making any progress? *The Journal of The American Dental Association, 134 (8)*, 1101-1108.

Smith, R. E., Lefingwell, T. R. & Ptacek, J. T. (1999). Can people remember how they coped? Factors associated with discordance between same-day and retrospective reports. *Journal of Personality and Social Psychology, 76 (6)*, 1050-1061.

Snyder, C. R., Cheavens, J. & Michael, S. T. (1999) Hoping. In C. R. Snyder (ed.), *Coping: the psychology of what works* (pp205-231). Oxford: Oxford University Press.

Soares, D. P. & Law, M. (2009). Magnetic resonance spectroscopy of the brain: review of metabolites and clinical applications. *Clinical Radiology, 64 (1)*, 12-21.

Somerfield, M. R. & McCrae, R. R. (2000). Stress and coping research: methodological challenges, theoretical advances and clinical applications. *American Psychologist, 55 (6)*, 620-625.

Somers, T. J., Keefe, F. J., Pells, J. J., Dixon, K. E., Waters, S. J., Riordan, P. A., Blumenthal, J. A., McKee, D. C, LaCaille, L., Tucker, J. M., Schmitt, D., Caldwell, D. S., Kraus, V. B., Sims, E. L., Shelby, R. A. & Rice, J. R. (2009). Pain catastrophizing and pain-related fear in osteoarthritis patients: relationships to pain and disability. *Journal of Pain and Symptom Management, 37 (5)*, 863-872.

Spielberger, C. D., Gorsuch, R. L. & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory (Form X) ("Self-Evaluation Questionnaire").* Palo Alto, California: Consulting Psychologists Press.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R. & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory (Form Y) ("Self-Evaluation Questionnaire")*. Palo Alto, California: Consulting Psychologists Press.

Spinhoven, P., ter Kuile, M., Kole-Snijders, A. M. J., Mansfeld, M. H., den Ouden D-J. & Vlaeyen, J. W. S. (2004). Catastrophizing and internal pain control as mediators of outcome in the multidisciplinary treatment of chronic low back pain. *European Journal of Pain, 8 (3),* 211-219.

SPSS Inc. (2005). *SPSS 14.0 for Windows*, Release 14.0.1. Chicago, USA.

Staud, R. (2006). Biology and therapy of fibromyalgia: pain in fibromyalgia syndrome. *Arthritis Research & Therapy, 8 (3),* 208.

Staud, R., Craggs, J. G., Robinson, M. E., Perlstein, W. M. & Price, D. D. (2007). Brain activity related to temporal summation of C-fiber evoked pain. *Pain, 129 (1-2),* 130–142.

Stone, A. A., Schwartz, J. E., Neale, J. M. Shiffman, S., Marco, C. A., Hickcox, M., Paty, J., Porter, L. S. & Cruise, L. J. (1998). A comparison of coping assessed by ecological momentary assessment and retrospective recall. *Journal of Personality and Social Psychology, 74 (6),* 1670-1680.

Stouthard, M. E. A. (1989). *Dental anxiety: development and validation of a questionnaire for research and clinical use.* Amsterdam: De Kreeft.

Stouthard, M. E., Hoogstraten, J. & Mellenbergh, G. J. (1995). A study on the convergent and discriminant validity of the Dental Anxiety Inventory. *Behaviour Research and Therapy, 33 (5),* 589-595.

Stouthard, M. E., Mellenbergh, G. J. & Hoogstraten, J. (1993). Assessment of dental anxiety: a facet approach. *Anxiety, Stress, & Coping, 6 (2),* 89-105.

Strulov, L., Zimmer, E. Z., Granot, M., Tamir, A., Jakobi, P. & Lowenstein, L. (2007). Pain catastrophizing, response to experimental heat stimuli, and post-cesarean section pain. *The Journal of Pain, 8 (3)*, 273-279.

Sullivan, M. J. L., Adams, H. & Sullivan, M. E. (2004)[b]. Communicative dimensions of pain catastrophizing: social cueing effects on pain behaviour and coping. *Pain, 107 (3)*, 220-226.

Sullivan, M. J. L., Bishop, S. R. & Pivik, J. (1995). The pain catastrophizing scale: development and validation. *Psychological Assessment, 7 (4)*, 524-532.

Sullivan, M. J. L., Martel, M. O., Tripp, D. A., Savard, A. & Crombez, G. (2006). The relation between catastrophizing and the communication of pain experience. *Pain, 122 (3)*, 282-288.

Sullivan, M. J. L. & Neish, N. R. (1998). Catastrophizing, anxiety and pain during dental hygiene treatment. *Community Dentistry and Oral Epidemiology, 26 (5)*, 344-349.

Sullivan, M. J. L. & Neish, N. R. (1999). The effects of disclosure on pain during dental hygiene treatment: the moderating role of catastrophizing. *Pain, 79 (2-3)*, 155-163.

Sullivan, M. J. L., Rodgers, W. M. & Kirsch, I. (2001)[b]. Catastrophizing, depression and expectancies for pain and emotional distress. *Pain, 91 (1-2)*, 147-154.

Sullivan, M. J. L., Rodgers, W. M., Wilson, P. M., Bell, G. J., Murray, T. C. & Fraser, S. N. (2002). An experimental investigation of the relation between catastrophizing and activity intolerance. *Pain, 100 (1-2)*, 47-53.

Sullivan, M. J. L., Thorn, B., Haythornthwaite, J. A., Keefe, F., Martin, M., Bradley, L. A. & Lefebvre, J. C. (2001)[a]. Theoretical perspectives on the relation between catastrophizing and pain. *The Clinical Journal of Pain, 17 (1)*, 52-64.

Sullivan, M. J. L., Thorn, B., Rodgers, W. & Ward, L. C. (2004)[a]. Path model of psychological antecedents to pain experience: experimental and clinical findings. *The Clinical Journal of Pain, 20 (3)*, 164-173.

Sullivan, M. J. L., Tripp, D., Rodgers, W. & Stanish, W. (2000). Catastrophizing and pain perception in sports participants. *Journal of Applied Sports Psychology, 12 (2)*, 151-167.

Swendsen, J., Tennen, H., Carney, M. A., Affleck, G., Willard, A. & Hromi, A. (2000). Mood and alcohol consumption; an experience sampling test of the self-medication hypothesis. *Journal of Abnormal Psychology, 109 (2)*, 198-204.

Swinkels-Meewisse, I. E. J., Roelofs, J., Oostendorp, R. A. B., Verbeek, A. L. M. & Vlaeyen, J. W. S. (2006). Acute low back pain: pain-related fear and pain catastrophizing influence physical performance and perceived disability. *Pain, 120 (1-2)*, 36-43.

Szasz, T. S. (1957). *Pain and pleasure: a study of bodily feelings*. London: Tavistock.

Talbot, J. D., Marrett, S., Evans, A. C., Meyer, E., Bushnell, M. C. & Duncan, G. H. (1991). Multiple representations of pain in human cerebral cortex. *Science*, *251 (4999)*, 1355-1358.

Taylor, J. A. (1953). A personality scale of manifest anxiety. *Journal of Abnormal and Social Psychology, 48 (2)*, 285-290.

Taylor, S. E., Kemeny, M. E., Aspinwall, L. G., Schneider, S. G., Rodriguez, R. & Herbert, M. (1992). Optimism, coping psychological distress, and high-risk sexual behavior among men at risk for acquired immunodeficiency syndrome (AIDS). *Journal of Personality and Social Psychology, 63 (3)*, 460-473.

Tennen, H., Affleck, G., Armeli, S. & Carney, M. A. (2000). A daily process approach to coping: linking theory, re-search and practice. *American Psychologist, 55 (6),* 626-636.

Thibault, P., Loisel, P., Durand, M-J., Catchlove, R. & Sullivan, M. J. L. (2008). Psychological predictors of pain expression and activity intolerance in chronic pain patients. *Pain, 139 (1),* 47-54.

Thom, A., Sartory, G. & Jöhren, P. (2000). Comparison between one-session psychological treatment and benzodiazepine in dental phobia. *Journal of Consulting and Clinical Psychology, 68 (3),* 378-387.

Thomas, M. R. & Roy, R. (1999). *The changing nature of pain complaints over the lifespan*. New York: Plenum.

Thomson, W. M., Locker, D. & Poulton, R (2000). Incidence of dental anxiety in young adults in relation to dental treatment experience. *Community Dentistry and Oral Epidemiology, 28 (4),* 289-294.

Timmermans, L. M., van Zuuren, F. J., van der Maazen, R. W. M., Leer, J. W. H. & Kraaimaat, F. W. (2007). Monitoring and blunting in palliative and curative radiotherapy consultations. *Psycho-Oncology, 16 (12),* 1111-1120.

Toates, F. (2007). *Pain*. Oxford: Oxford University Press.

Tomaka, J., Blascovich, J., Kibler, J. & Ernst, J. M. (1997). Cognitive and physiological antecedents of threat and challenge appraisal. *Journal of Personality and Social Psychology, 73 (1),* 63-72.

Tracey, I. (2008). Imaging pain. *British Journal of Anaesthesia, 101 (1),* 32–39.

Tracey, I. & Johns, E. (2010). The pain matrix: reloaded or reborn as we image tonic pain using arterial spin labelling. *Pain, 148 (3),* 359-360.

Tracey, I. & Mantyh, P. W. (2007). The Cerebral signature for pain perception and its modulation. *Neuron, 55 (3),* 377-391.

Tracey, I., Ploghaus, A., Gati, J. S., Clare, S., Smith, S., Menon, R. S. & Matthews, P. M. (2002). Imaging attentional modulation of pain in the periaqueductal gray in humans. *Journal of Neuroscience, 22 (7)*, 2748–2752.

Turk, D. C. (2002). A diathesis-stress model of chronic pain and disability following traumatic injury. *Pain Research & Management, 7 (1),* 9-19.

Turner, J. A., Jensen, M. P. & Romano, J. M. (2000). Do beliefs, coping, and catastrophizing independently predict functioning in patients with chronic pain? *Pain, 85 (1-2)*, 115-125.

Unruh, A. M. (1996). Gender variations in clinical pain experience. *Pain, 65 (2)*, 123-67.

Uziel, L. (2010). Rethinking social desirability scales: from Impression Management to interpersonally oriented self-control. *Perspectives on Psychological Science, 5 (3)*, 243-262.

Vallerand, W. P., Vallerand, A. H. & Heft, M. (1994). The effects of postoperative preparatory information on the clinical course following third molar extraction. *Journal of Oral and Maxillofacial Surgery, 52 (11),* 1165-1170.

Vancleef, L. M. G. & Peters, M. L. (2006). Pain catastrophizing, but not injury/illness sensitivity or anxiety sensitivity, enhances attentional interference by pain. *The Journal of Pain, 7 (1),* 23-30.

van Damme, S., Legrain, V., Vogt, J. & Crombez, G. (2010). Keeping pain in mind: a motivational account of attention to pain. *Neuroscience and Biobehavioral Reviews, 34 (2),* 204-213.

van Wijk, A. J., Duyx, M. P. M. A. & Hoogstraten, J. (2004). The effect of written information on pain experience during periodontal probing. *Journal of Clinical Periodontology, 31 (4)*, 282-285.

van Wijk, A. J. & Hoogstraten, J. (2003). The fear of dental pain questionnaire: construction and validity. *European Journal of Oral Sciences, 111 (1)*, 12-18.

van Wijk, A. J. & Hoogstraten, J. (2005). Experience with dental pain and fear of dental pain. *Journal of Dental Research, 84 (10)*, 947-950.

van Wijk, A. J. & Hoogstraten, J. (2006). Reducing fear of pain associated with endodontic therapy. *International Endodontic Journal, 39 (5)*, 384-388.

van Wijk, A. J. & Hoogstraten, J. (2009). Anxiety and pain during dental injections. *Journal of Dentistry, 37 (9)*, 700-704.

van Wijk, A. & Lindeboom, J. (2008). The effect of a separate consultation on anxiety levels before third molar surgery. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 105 (3)*, 303-307.

van Zuuren, F. J. & Wolfs, H. M. (1991). Styles of information seeking under threat: personal and situational aspects of monitoring and blunting. *Personality and Individual Differences, 12 (2)*, 141-149.

Vase, L., Price, D. D., Verne, G. N. & Robinson, M. E. (2004). The contribution of changes in expected pain levels and desire for pain relief to placebo analgesia. In D. D. Price & M. C. Bushnell (eds.), *Psychological methods of pain control: basic science and clinical perspectives* (pp207-232). Seattle, WA: IASP Press.

Vassend, O. (1993). Anxiety, pain and discomfort associated with dental treatment. *Behaviour Research and Therapy, 31 (7)*, 659-666.

Vervoort, T., Goubert, L., Eccleston, C., Vandenhende, M., Claeys, O., Clarke, J. & Crombez, G. (2009). Expressive dimensions of pain catastrophizing: an observational study in adolescents with chronic pain. *Pain, 146 (1-2)*, 170-176.

Vierck, C. J. (2006). Mechanisms underlying development of spatial distributed chronic pain (fibromyalgia). *Pain*, *124 (3)*, 242-263.

Vika, M., Skaret, E., Raadal, M., Öst, L. G. & Kvale, G. (2008). Fear of blood, injury, and injections, and its relationship to dental anxiety and probability of avoiding dental treatment among 18-yearolds in Norway. *International Journal of Paediatric Dentistry, 18 (3),* 163-169.

Vika, M., Raadal, M., Skaret, E. & Kvale, G. (2006). Dental and medical injections: prevalence of self-reported problems among 18-yr-old subjects in Norway. *European Journal of Oral Sciences, 114 (2),* 122-127.

Vlaeyen, J. W. S. & Linton, S. J. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain, 85 (3)*, 317-332.

von Frey, M. (1895). *Untersuchungen über die sinnesfunctionen der menschlichen haut erste abhandlung: druckempfindung und schmerz*. Leipzig: Hirzel.

Voss, U., Müller, H. & Schermelleh-Engel, K. (2006). Towards the assessment of adaptive vs. rigid coping styles: validation of the Frankfurt Monitoring Blunting Scales by means of confirmatory factor analysis. *Personality and Individual Differences*, *41 (2),* 295-306.

Wager, T. D., Rilling, J. K., Smith, E. E., Sokolik, A., Casey, K. L., Davidson, R. J., Kosslyn, S. M., Rose, R. M. & Cohen, J. D. (2004). Placebo-Induced Changes in fMRI in the anticipation and experience of pain. *Science, 303 (5661),* 1162-1167.

Walco, G. A. & Harkins, S. W. (1999). Lifespan developmental approaches to pain. In R. J. Gatchel & D. C. Turk DC (eds.), *Psychosocial factors in pain* (pp107-117). New York: Guilford Press.

Wallston, K. A., Wallston, B. S. & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) scales. *Health Education Monographs, 6 (2)*, 160-170.

Walsh, T. M., LeBlanc, L. & McGrath, P. J. (2003). Menstrual pain intensity, coping, and disability: the role of pain catastrophizing. *Pain Medicine, 4 (4)*, 352-361.

Wardle, J. (1983). Psychological management of anxiety and pain during dental treatment. *Journal of Psychosomatic Research, 27 (5)*, 399-402.

Watkins, C. A., Logan, H. L. & Kirchner, H. L. (2002). Anticipated and experienced pain associated with endodontic therapy. *The Journal of the American Dental Association, 133 (1)*, 45-54.

Watson, D., Clark, L. A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS Scales. *Journal of Personality and Social Psychology, 54 (6)*, 1063-1070.

Weinberger, D. A. (1990). The construct validity of the repressive coping style. In J. L. Singer (ed.), *Repression and dissociation: implications for personality theory, psychopathology, and health* (pp337-386). Chicago: University of Chicago Press.

Weiner, A. A. & Sheehan, D. V. (1990). Etiology of dental anxiety: psychological trauma or CNS chemical imbalance? *General Dentistry, 38 (1)*, 39–43.

Weinman, J., Petrie, K. J., Moss-Morris, R. & Horne, R. (1996). The illness perception questionnaire: a new method for assessing the cognitive representation of illness. *Psychology & Health, 11 (3)*, 431-445.

Weissman-Fogel, I. Sprecher, E. & Pud, D. (2008). Effects of catastrophizing on pain perception and pain modulation. *Experimental Brain Research, 186 (1)*, 79-85.

Westermeyer, R. (2005). The cognitive model of anxiety. *AddictionInfo.org.* Retrieved from http://www.addictioninfo.org/articles/168/1/The-Cognitive-Model-Of Anxiety/Page1.html

Whyte, A. & Carroll, L. J. (2004). The relationship between catastrophizing and disability in amputees experiencing phantom pain. *Disability and Rehabilitation, 26 (11)*, 649-654.

Wilkinson, F. R. & Cargill, D. W. (1955). Repression elicited by story material based on the Oedipus complex. *Journal of Social Psychology, 42 (2)*, 209-214.

Willebrand, M., Wikehult, B. & Ekselius, L. (2005). Social desirability, psychological symptoms, and perceived health in burn injured patients. *Journal of Nervous and Mental Disease, 193 (12)*, 820-824.

Willert, R. P., Delaney, C., Kelly, K., Sharma, A., Aziz, Q. & Hobson, A. R. (2007). Exploring the neurophysiological basis of chest wall allodynia induced by experimental oesophageal acidification – evidence of central sensitization. *Neurogastroenterology & Motility, 19 (4)*, 270–278.

Williams-Piehota, P., Pizarro, J., Schneider, T. R., Mowad, L. & Salovey, P. (2005). Matching health messages to monitor-blunter coping styles to motivate screening mammography. *Health Psychology, 24 (1)*, 58-67.

Woby, S. R., Watson, P. J., Roach, N. K. & Urmston, M. (2004). Are changes in fear-avoidance beliefs, catastrophizing, and appraisals of control, predictive of changes in chronic low back pain and disability? *European Journal of Pain, 8 (3)*, 201-210.

Yali, A. M. & Lobel, M. (2002). Stress-resistance resources and coping in pregnancy. *Anxiety, Stress & Coping, 15 (3)*, 289-309.

Yoshino, A., Okamoto, Y., Onoda, K., Yoshimura, S., Kunisato, Y., Demoto, Y., Okada, G. & Yamawaki, S. (2010). Sadness enhances the experience of pain via neural activation in the anterior cingulate cortex and amygdala: an fMRI study. *NeuroImage, 50 (3)*, 1194-1201.

Yuan, S., Freeman, R., Lahti, S., Lloyd-Williams, F. & Humphris, G. (2008). Some Psychometric properties of the Chinese version of the Modified Dental Anxiety Scale with cross validation. *Health and Quality of Life Outcomes, 6*, 22.

Yunus, M. B. (2007). Role of central sensitization in symptoms beyond muscle pain, and the evaluation of a patient with widespread pain. *Best Practice and Research Clinical Rheumatology, 21 (3)*, 481–97.

Yusa, H., Onizawa, K., Hori, M., Takeda, S., Takeda, H., Fukushima, S. & Yoshida, H. (2004). Anxiety measurements in university students undergoing third molar extraction. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics, 98 (1)*, 23–27.

Zevon, M. A. & Tellegen, A. (1982). The structure of mood change: an idiographic/nomothetic analysis. *Journal of Personality and Social Psychology, 43 (1)*, 111-122.

Zubieta, J-K, Smith, Y. R., Bueller, J. A., Xu, Y., Kilbourn, M. R., Jewett, D. M., Meyer, C., R., Koeppe, R. A. & Stohler, C. S. (2002). μ-Opioid receptor-mediated antinociceptive responses differ in men and women. *The Journal of Neuroscience, 22 (12)*, 5100-5107.

Appendix: 1

The General Demographic Questionnaire

(The present author / Time 0)

This is a questionnaire about yourself.
Please answer the following questions or circle ○ appropriate answer.
All your responses will be completely confidential.

1	Your Gender	Male / Female
2	Your Age	____________ years old
3	Marital Status	Single / Living with a partner Married / Separated Divorced / Widowed
4	Your Occupation	__________________________ or Retired / Unemployed
5	What is your highest educational qualification?	___________________
6	Have you ever come to this hospital before?	Yes / No
	If yes, how often?	Once / A few times Several times / Often

Appendix: 2

The Modified Dental Anxiety Scale

(Humphris, Morris & Lindsay, 1995 / Time 0)

We are interested in how people feel about going to the dentists. Please circle ○ the most appropriate number to the right of the question.

	Not anxious	Slightly anxious	Fairly anxious	Very anxious	Extremely anxious
1. If you went to your dentist for treatment, how would you feel?	1	2	3	4	5
2. If you were sitting in the waiting room waiting for treatment, how would you feel?	1	2	3	4	5
3. If you were about to have a tooth drilled, how would you feel?	1	2	3	4	5
4. If you were about to have your teeth scaled and polished, how would you feel?	1	2	3	4	5
5. If you were about to have a local anaesthetic injection in your gum, above an upper back tooth, how would you feel?	1	2	3	4	5

Appendix: 3

The Iowa Dental Control Index

(Humphris, Morris & Lindsay, 1995 / Time 0)

We are interested in how people cope with the dental treatments. Please circle ○ the most appropriate number for each question.

(1) To what degree would you like control over what will happen to you in the dental chair?

None — Total control

1	2	3	4	5

(2) To what degree are you concerned about not being able to prevent something which might cause you pain?

Not at all — Extremely concerned

1	2	3	4	5

(3) Do you feel that you have control of what will happen to you when you are in a dental chair?

None — Totally

1	2	3	4	5

(4) How much do you think you can control what happens to you in the dental chair?

None — Total control

1	2	3	4	5

Appendix: 4

The Pain Catastrophizing Scale

(Sullivan, Bishop & Pivik, 1995 / Time 0)

People are often exposed to situations that may cause pain such as illness, injury or surgery. Read each statement and then circle ○ the most appropriate number to the right of the statement to indicate the degree to which you have these thoughts and feelings when you are experiencing pain ***in general***.

When I'm in pain…

	Not at all	To a slight degree	To a moderate degree	To a great degree	All the time
1. I worry all the time about whether the pain will end.	1	2	3	4	5
2. I feel I can't go on.	1	2	3	4	5
3. It's terrible and I think it's never going to get any better.	1	2	3	4	5
4. It's awful and I feel that it overwhelms me.	1	2	3	4	5
5. I feel I can't stand it anymore.	1	2	3	4	5
6. I become afraid that the pain may get worse.	1	2	3	4	5
7. I think of other painful experiences.	1	2	3	4	5
8. I anxiously want the pain to go away.	1	2	3	4	5
9. I can't seem to keep it out of my mind.	1	2	3	4	5
10. I keep thinking about how much it hurts.	1	2	3	4	5
11. I keep thinking about how badly I want the pain to stop.	1	2	3	4	5
12. There is nothing I can do to reduce the intensity of the pain.	1	2	3	4	5
13. I wonder whether something serious may happen.	1	2	3	4	5

Appendix: 5

The short form of the Manifest Anxiety Scale

(Bendig, 1956 / Time 0)

The Marlowe-Crowne Social Desirability Scale

(Crowne & Marlowe, 1960 / Time 0)

Please read each statement and decide whether you feel ***in general*** that it is mostly true or mostly false as applied to you. Please circle ◯ the appropriate word in each statement.

1	I find it hard to keep my mind on a task or job.	*True*	*False*
2	I am sometimes irritated by people who ask favours of me.	*True*	*False*
3	I am happy most of the time.	*True*	*False*
4	Before voting, I thoroughly investigate the qualifications of all the candidates.	*True*	*False*
5	I believe I am no more nervous than most others.	*True*	*False*
6	I sometimes think when people have a misfortune they only got what they deserved.	*True*	*False*
7	I am more sensitive than most other people.	*True*	*False*
8	I like to gossip at times.	*True*	*False*
9	On occasion I have had doubts about my ability to succeed in life.	*True*	*False*
10	There have been occasions when I took advantage of someone.	*True*	*False*
11	I am a highly strung person.	*True*	*False*
12	I have never intensely disliked anyone.	*True*	*False*
13	I cannot keep my mind on one thing.	*True*	*False*
14	I never make a long trip without checking the safety of my car.	*True*	*False*

15	I have had periods of such restlessness that I cannot sit long in a chair.	*True*	*False*
16	I am always courteous, even to people who are disagreeable.	*True*	*False*
17	On a few occasions, I have given up doing something because I thought too little of my ability.	*True*	*False*
18	I am always careful about my manner of dress.	*True*	*False*
19	At times I think I am no good at all.	*True*	*False*
20	I have never felt that I was punished without cause.	*True*	*False*
21	When I don't know something, I don't at all mind admitting it.	*True*	*False*
22	I am usually calm and not easily upset.	*True*	*False*
23	I never resent being asked to return a favour.	*True*	*False*
24	I am not usually self-conscious.	*True*	*False*
25	I sometimes try to get even, rather than forgive and forget.	*True*	*False*
26	If I could get into a film without paying and be sure I was not seen, I would probably do it.	*True*	*False*
27	I work under a great deal of tension.	*True*	*False*
28	I have never deliberately said something that hurt someone's feelings.	*True*	*False*
29	I can remember "playing sick" to get out of something.	*True*	*False*
30	I am inclined to take things hard.	*True*	*False*
31	I sometimes feel resentful when I don't get my way.	*True*	*False*
32	Life is a strain for me much of the time.	*True*	*False*

33	No matter who I am talking to, I am always a good listener.	*True*	*False*
34	I certainly feel useless at times.	*True*	*False*
35	I always try to practise what I preach.	*True*	*False*
36	There have been times when I was quite jealous of the good fortune of others.	*True*	*False*
37	I sometimes feel that I am about to go to pieces.	*True*	*False*
38	I have never been irked when people expressed ideas very different from my own.	*True*	*False*
39	My table manners at home are as good as when I eat out at a restaurant.	*True*	*False*
40	There have been occasions when I have felt like smashing things.	*True*	*False*
41	I have sometimes felt that difficulties were piling up so high that I could not overcome them.	*True*	*False*
42	I never hesitate to go out of my way to help someone in trouble.	*True*	*False*
43	It is sometimes hard for me to go on with my work if I am not encouraged.	*True*	*False*
44	At times I have really insisted on having things my own way.	*True*	*False*
45	I feel anxiety about something or someone almost all the time.	*True*	*False*
46	I am always willing to admit it when I make a mistake.	*True*	*False*
47	There have been times when I felt like rebelling against people in authority even though I knew they were right.	*True*	*False*
48	I frequently find myself worrying about something.	*True*	*False*
49	I have almost never had the urge to tell anyone off.	*True*	*False*
50	I shrink from facing a crisis or difficulty.	*True*	*False*

51	I don’t find it particularly difficult to get on with loud-mouthed obnoxious people.	*True*	*False*
52	I am certainly lacking in self-confidence.	*True*	*False*
53	I would never think of letting someone else be punished for my wrong-doings.	*True*	*False*

Appendix: 6

The Miller Behavioural Style Scale

(Miller, 1979 / Time 0)

Vividly imagine that, due to a large drop in sales, it is rumoured that several people in your department at work will be laid off. Your supervisor has turned in an evaluation of your work for the past year. The decision about lay-offs has been made and will be announced in several days. Tick √ ***all*** of the statements that might apply to you.

	√
• I would talk to my fellow workers to see if they knew anything about what the supervisor's evaluation of me said.	
• I would review the list of duties for my present job and try to figure out if I had fulfilled them all.	
• I would go to the films to take my mind off things.	
• I would try to remember any arguments or disagreements I might have had with the supervisor that would have lowered his/her opinion of me.	
• I would push all thoughts of being laid off out of my mind.	
• I would tell my spouse that I'd rather not discuss my chances of being laid off.	
• I would try to think which employees in my department the supervisor might have thought had done the worst job.	
• I would continue doing my work as if nothing special was happening.	

Vividly imagine that you are on an aeroplane, 30 minutes from your destination, when the plane unexpectedly goes into a deep dive and then suddenly levels off. After a short time, the pilot announces that nothing is wrong, although the rest of the ride may be rough. You, however, are not convinced that all is well. Tick √ ***all*** of the statements that might apply to you.

	√
• I would carefully read the information provided about safety features in the plane and make sure I knew where the emergency exits were.	
• I would make small talk with the passenger beside me.	
• I would watch the end of the film, even if I had seen it before.	
• I would call for the steward/ess and ask him/her exactly what the problem was.	
• I would order a drink or tranquilliser from the steward/ess.	
• I would listen carefully to the engines for unusual noises and would watch the crew to see if their behaviour was out of the ordinary.	
• I would talk to the passenger beside me about what might be wrong.	
• I would settle down and read a book or magazine or write a letter.	

Vividly imagine that you are ***afraid*** of the dentist and have to get some dental work done. Which of the following would you do? Tick √ ***all*** of the statements that might apply to you.

	√
• I would ask the dentist exactly what he/she was going to do.	
• I would take a tranquilliser or have a drink before going.	
• I would try to think about pleasant memories.	
• I would want the dentist to tell me when I would feel pain.	
• I would try to sleep.	
• I would watch all the dentist's movements and listen for the sound of the drill.	
• I would watch the flow of water from my mouth to see if it contained blood.	
• I would do mental puzzles in my mind.	

Vividly imagine that you are being held hostage by a group of armed terrorists in a public building. Which of the following would you do? Tick √ ***all*** of the statements that might apply to you.

	√
• I would sit by myself and have as many daydreams and fantasies as I could.	
• I would stay alert and try to keep myself from falling asleep.	
• I would exchange life stories with the other hostages.	
• If there was a radio present, I would stay near it and listen to the bulletins about what the police were doing.	
• I would watch every movement of my captors and keep an eye on their weapons.	
• I would try to sleep as much as possible.	
• I would think about how nice it's going to be when I get home.	
• I would make sure I knew where every possible exit was.	

Appendix: 7

The Numerical Rating Scale

(Downie, Leatham, Rhind & Wright, 1978 / Time 1)

Please indicate how much pain you expect to experience during today's procedure by circling ○ that number.

No pain										Unbearable pain
0	1	2	3	4	5	6	7	8	9	10
☺					😐					☹

Appendix: 8

The Ratio Scale of Affective Verbal Pain Descriptors

(Gracely, McGrath & Dubner, 1978 / Time 1)

Please circle ○ ***one word only*** which best describes the unpleasantness which you may feel from pain during the procedure.

Bearable

Distracting

Unpleasant

Uncomfortable

Distressing

Oppressive

Miserable

Awful

Frightful

Dreadful

Horrible

Agonizing

Unbearable

Intolerable

Excruciating

Appendix: 9

The six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory

(Marteau & Bekker, 1992 / Times 1, 2 & 3)

Read each statement and then circle ○ the most appropriate number to the right of the statement to indicate how you feel ***right now, at this moment***.

		Not at all	Somewhat	Moderately	Very much
1	I feel calm.	1	2	3	4
2	I am tense.	1	2	3	4
3	I feel upset.	1	2	3	4
4	I am relaxed.	1	2	3	4
5	I feel content.	1	2	3	4
6	I am worried.	1	2	3	4

Appendix: 10

The Positive and Negative Affect Schedule

(Watson, Clark & Tellegen, 1988 / Times 1, 2 & 3)

Read each item and circle ○ the most appropriate number to the right of the word to indicate to what extent you feel this way ***right now***, ***at this moment***.

		Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1	interested	1	2	3	4	5
2	distressed	1	2	3	4	5
3	excited	1	2	3	4	5
4	upset	1	2	3	4	5
5	strong	1	2	3	4	5
6	guilty	1	2	3	4	5
7	scared	1	2	3	4	5
8	hostile	1	2	3	4	5
9	enthusiastic	1	2	3	4	5
10	proud	1	2	3	4	5
11	irritable	1	2	3	4	5
12	alert	1	2	3	4	5
13	ashamed	1	2	3	4	5
14	inspired	1	2	3	4	5
15	nervous	1	2	3	4	5
16	determined	1	2	3	4	5
17	attentive	1	2	3	4	5
18	jittery	1	2	3	4	5
19	active	1	2	3	4	5
20	afraid	1	2	3	4	5

Appendix: 11

The Dental Control Questionnaire

(The present author / Time 2)

We are interested in how people coped with their dental treatments. Please circle ○ the most appropriate number for each question.

(1) Do you feel that you had control of what happened to you when you were in the dental chair?

None				Totally
1	2	3	4	5

(1) How much do you think you could control what happened to you in the dental chair?

None				Total control
1	2	3	4	5

Appendix: 12

The Numerical Rating Scale

(Downie, Leatham, Rhind & Wright, 1978 / Time 3)

Please indicate how much pain you experienced during and after your surgery by circling ○ that number.

No pain   Unbearable pain

0	1	2	3	4	5	6	7	8	9	10
☺					😐					☹

Appendix: 13

The Ratio Scale of Affective Verbal Pain Descriptors

(Gracely, McGrath & Dubner, 1978 / Time 3)

Please circle ○ ***one word only*** which best describes the unpleasantness which pain caused you during and after your surgery.

Bearable

Distracting

Unpleasant

Uncomfortable

Distressing

Oppressive

Miserable

Awful

Frightful

Dreadful

Horrible

Agonizing

Unbearable

Intolerable

Excruciating

Appendix: 14

The Surgical Complexity Scale

(The present author / Time 2)

Please circle ○, tick √ or fill in the appropriate numbers for the surgical procedure.

(1) Anaesthesia

Type	Local			General
	Infiltration		Block	
Location	Buccal Lingual	Palatal	Inferior dental	N. A.
Numbers of injections	(1)	(2)	(4)	N. A.

(2) Surgical Procedure

a. Procedure – Please tick √.

	Surgical procedures		√
1	Simple elevation	(1)	
2	Raise (Reflect flap) + Elevation	(2)	
3	Raise (Reflect flap) + Bone removal + Elevation	(4)	
4	Raise (reflect flap) + Bone removal + Tooth section + Roots division + Elevation	(6)	

b. Number of teeth involved: ___________ tooth/teeth

c. Location of the tooth/teeth involved – Please tick √.

Upper		Lower	
Anterior	Posterior	Anterior	Posterior
(1)	(3)	(1)	(4)

d. Complexity/severity – Please indicate by circling ○ that number.

Low complexity/severity High complexity/severity

0	1	2	3	4	5	6	7	8	9	10

(3) Duration of the procedure

	Duration (minutes)		√
1	Under 20	(1)	
2	21 - 30	(2)	
3	31 - 40	(3)	
4	Longer than 40	(4)	

Appendix: 15

The Stress Rating Scale – distress levels

(The present author / Time 2)

Pain

Please indicate how much ***pain*** you think that the patient experienced during the surgery by circling ○ that number.

No pain — Pain as bad as it could be

0	1	2	3	4	5	6	7	8	9	10

Anxiety

Please indicate how much ***anxiety*** you think that the patient experienced by circling ○ that number.

No anxiety — Anxiety as bad as it could be

0	1	2	3	4	5	6	7	8	9	10

Distress – by behavioural indicators

(such as cooperativeness, amount of phonation, hand/arm movement)

Please indicate how much ***distress*** you think that the patient experienced (from their behavioural signs) by circling ○ that number.

No distress — Distress as bad as it could be

0	1	2	3	4	5	6	7	8	9	10