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Music in the Control of Human Pain

CARLENE J. BROWN
DOCTORAL CANDIDATE IN SYSTEMATIC MUSICOLOGY,
SCHOOL OF MUSIC, UNIVERSITY OF WASHINGTON

ANDREW C.N. CHEN
RESEARCH ASSOCIATE PROFESSOR,
DEPARTMENT OF PSYCHIATRY AND BEHAVIORAL SCIENCES,
SCHOOL OF MEDICINE, UNIVERSITY OF WASHINGTON

SAMUEL F. DWORKIN
PROFESSOR OF PSYCHIATRY AND BEHAVIORAL SCIENCES,
SCHOOL OF MEDICINE, UNIVERSITY OF WASHINGTON

Pain is one of the most prevalent and costly national health problems in today's society (Bonica, 1985). In addition to economic loss, pain yields human suffering and personal loss in ways impossible to quantify meaningfully. Pain research has grown rapidly in recent years and has incorporated developments from such diverse disciplines as psychology, sociology, and anthropology, as well as the more obviously related fields of physiology and clinical medicine. While this expanded inquiry has greatly refined our understanding and treatment of pain, there nevertheless remain many unanswered questions about this complex human phenomenon.

The use of music as one cognitive strategy technique to reduce pain perception has received some attention in the medical field; however, many of the accounts of the beneficial influences of music on the alleviation of pain are either anecdotal in nature or lack adequate controls in experimental or clinical studies to elicit much confidence in the results. This is problematic because it is not clear as to which dimensions of pain—psychological or physical—active listening to music may affect, nor does it provide clear evidence that such effects are consistent or reliable. Only through the controlled use of music in an experimental design can the validity of the effectiveness of music as a pain management technique be determined. This article aims to provide a broad spectrum of current knowledge of human pain and its control by music with the intent to suggest proper theoretical background and possible applications of music in pain therapy.

The Definition of Pain

Even though pain is a universal and personal experience, scientists have found it extremely difficult to agree on a satisfactory definition for it. One reason is that the phenomenon of pain is a composite of many factors.

A conventional biophysical approach defines pain as:

> A stimulus which causes or is on the verge of causing tissue damage often elicits a sensation of pain and a reflex escape or withdrawal response as well as a gamut of physiologic changes, e.g., faster heart rate, higher blood pressure, greater secretion of epinephrine into the blood stream, increased blood sugar, dilated pupils and sweating. (Luciano, Vander, & Sherman, 1978, p. 283)

According to this definition, pain is a physical response to a physical stimulus. Yet, to the lay person pain is a negative, potentially destructive force whose only value is its effective warning when something biologically harmful is happening. To the sociologist, pain and the threat of pain are extremely powerful means for learning and for self or societal preservation. To the psychologist, pain is a perception, the translation of a physical stimulus into a perceived sensory experience and, like all perceptions, the perceived pain is highly subjective and modifiable according to the state of the person and the context in which the stimulus is encountered (Livingston, 1953).

Moreover, there are enormous individual variations in sensitivity to pain. At one end of the spectrum are children who are born insensitive to pain. These children may sustain severe burns, cuts, and bruises, and they learn only with difficulty to avoid inflicting severe wounds on themselves. At the other end of the spectrum are people with unduly persistent pains which continue to be suffered in the absence of any apparent physical cause, long after tissues are healed. The phantom limb syndrome is one example of pain which arises for no apparent reason and is perceived to originate from a limb which has long been missing.

It is also well-documented that pain is not always perceived after an injury, even if the person is fully conscious and alert. People are often injured in battle or automobile accidents without being aware of pain until some time later. Even the significance which pain has in a particular culture plays an essential role in how an individual perceives, feels, and responds to it. For instance, in Western cultures childbirth is considered to be an extremely painful ordeal. However, anthropologists have observed women in nonWestern cultures who display virtually no signs of distress during childbirth and almost immediately return to their work in the fields after delivery (Melzack, 1973). Thus, cultural learning is an important component of pain perception.

Traditionally, pain has been described as a sensory experience which

yields an emotional reaction, but current multidisciplinary research on pain now refutes this theory. Because it is such a completely interwoven human experience, pain is now defined by the International Association for the Study of Pain (1986) as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (p. s217). This definition recognizes that the subjective nature of nociception (the perception of noxious stimuli) need not be dependent on the properties of the physical characteristics of the stimulus.

A Model for Pain Perception and Modulation

While there are many current theories of pain perception, the most influential theory in the biomedical community is the original Gate Control Theory proposed by Ronald Melzack and Patrick Wall in 1965. In essence, this theory states that pain impulses transmitted from the nerve receptors through the spinal cord to the brain can be altered in the spinal cord, brainstem, and cerebral cortex. Regardless of intensity of the stimulus, little or no pain may be perceived due to the potential inhibiting ability of certain cells along the transmission route. Melzack and Wall propose that neural activity in the dorsal horns of the spinal cord act like a "gate" which can increase or decrease the amount of nerve impulses from the receptors to the central nervous system. Sensory input is, therefore, modulated by the gating mechanism in the dorsal horn before it can elicit pain perception.

According to Melzack and Wall's theory, the degree to which the gate increases or decreases sensory information is determined by the activity of large-diameter, myelinated sensory nerve fibers compared to activity on small diameter, myelinated and unmyelinated sensory nerve fibers. The small-diameter fibers conduct pain signals to the spinal cord. If nothing blocks them, the impulses travel up the spinal cord to the thalamus and cerebral cortex. Increased activity by the larger, relatively fast-conducting nerve fibers can inhibit the passage of pain-related information, thus, partially or totally decreasing the sensation of pain. In other words, large fiber stimulation closes the "gate" for the smaller and relatively slower-conducting fibers.

The resultant physiological balance between the nerve fiber types is only one aspect of the modulating pain system. Melzack and Wall (1965) suggest that pain experience also consists of three major psychological dimensions: (a) sensory-discriminative, (b) motivational-affective, (c) cognitive-evaluative. In other words, cognitive, or higher central nervous system processes, associated with thinking, influence the intensity and quality of pain experiences through "expectation, suggestion, level of anxiety, the meaning of the situation in which injury occurs, attention-distraction levels, competing sensory stimuli, and other psychological variables" (Melzack, Weisz, & Sprague, 1963, p. 240).

Melzack (1973) argues in his landmark book, *The Puzzle of Pain,* that:

> It is also firmly established that stimulation of the brain activates descending efferent fibers which can influence afferent conduction at the earliest synaptic levels of the somaesthetic system. Thus it is possible for brain activities subserving attention, emotion, and memories of prior experience to exert control over the sensory input... In this way somatic inputs from all parts of the body, as well as visual and auditory inputs, are able to exert a modulating influence on transmission through the dorsal horns. (p. 60)

Since the proposal of Melzack and Wall's theory over twenty years ago, a tremendous amount of research has been undertaken in the biomedical field to test the physiological validity, as well as clinical relevance, of the Gate Control Theory. To date, studies have demonstrated conflicting results, in that not all studies confirm physiological predictions made by the Gate Control Theory; clinical investigations have also provided mixed results (Nathan, 1976; Hoffert, 1986). Nevertheless, the Gate Control Theory remains one of the most important and influential theories in the study of pain.

Contemporary theorists now recognize the inadequacy of the concept of pain as a physical quantum proportional to the amount of tissue damage, stimulus intensity, or the body's response to injury. Researchers and clinicians acknowledge that physiological and psychological factors interact to yield pain perceptions and pain behaviors. The psychic and physical factors that determine the sensation of pain are inseparable components of a single phenomenon, and manipulation of any or all of these factors will affect the quality and intensity of pain perception.

Pain Management

The fact that pain is a subjective and very personal experience, which sometimes cannot be seen, touched, or measured by persons other than the experiencing individual, has presented enormous problems for those who study this phenomenon in patients (Bonica, 1979), especially for those whose ultimate research goal is the development of effective pain treatment measures.

There are many different types of pain management techniques designed to alleviate pain, ranging from surgical to pharmacological and psychological. The technique used can depend on several factors, such as the nature of the illness, its degree of severity, the amount of pain behavior from the individual, and the individual's history of previous physical and mental ailments. Because people respond to pain and treatment of pain in such different ways, "a total psychologic and social evaluation [of the patient] is mandatory to develop the most appropriate

therapeutic strategy. These are essential to define the role that psychologic, social, cultural, motivational, and related factors play in the patient's total pain experience" (Bonica, 1979, p. 126).

Interventions for pain management include such techniques as drug therapy, surgical intervention, and electrical stimulation. Clinicians and clinical researchers have also manipulated psychological variables in order to modify the perception of pain.

Turner and Chapman (1982a) suggest that pain may be termed chronic "when it persists beyond the usual course of a disease or normal healing time for an injury, or when it is associated with a progressive disease such as arthritis" (p. 1). They categorize psychological intervention for chronic pain under three headings: (a) physiological, (b) operant conditioning, and (c) cognitive-behavioral.

Physiological Approaches

In Turner and Chapman's first approach to pain management, the psychological treatment goal is to modify or control the physiological factors involved in the pain experience. For example, biofeedback is employed to give a person information about changes in his/her physiologic state, thus, giving the person the advantage of using these signals to control "involuntary" function (Siegele, 1974). Muscle relaxation training is another example: The primary purpose is to relax tense muscles believed to exacerbate the pain (Wells, 1982; Stewart, 1976; Corah, Gale, Pace & Seyrek, 1981). The Lamaze childbirth method is an example of successful utilization of this procedure.[1]

Operant Conditioning

Fordyce, Fowler, Lehmann, and DeLateur (1968) developed a model which applies learning theory principles, especially principles of operant conditioning, to the treatment of chronic pain. The goal of the operant conditioning model is to decrease operant, or learned pain, behaviors, (e.g., verbalized complaints, moans, special posturing to minimize the pain, etc.) and to replace them with positive, healthy behaviors (e.g., increased mobility, completion of a task, etc.). To do this, there must be a change in the environmental contingencies (rewards and punishments following the behaviors). The theoretical basis of the operant conditioning model is that pain problems, as defined by the

[1]The Lamaze technique, originated by the French obstetrician Fernand Lamaze, is a prepared childbirth method which focuses on "(a) education of the mother about the childbirth experience, (b) physical training and preparation for childbirth, and (c) psychological preparation through mastery of pain-management techniques (e.g., focal-point visualization, disciplined breathing, muscular relaxation)" (Clark, McCorkle, and Williams, 1981, p. 89).

overt behaviors, will greatly diminish if appropriate behaviors are positively reinforced, and negative behaviors are no longer reinforced.

Cognitive-Behavioral Therapy

The cognitive-behavioral approach to pain management emphasizes the role of cognitive factors and their relationship to pain behaviors.

> A basic assumption is that the cognitions (attitudes, beliefs, and expectations) people maintain in certain situations can determine their emotional and behavioral reactions to those situations. As cognitive (e.g., distraction, significance of the pain for the individual) and emotional variables (e.g., anxiety) influence the experience of pain, it seems logical that the modification of cognitions could be used to alter the pain experience. (Turner & Chapman, 1982b, p. 30)

When applied to pain, cognitive-behavioral interventions consist of teaching individuals specific cognitive skills. Strategies used in experimental designs that have been found effective include: (a) imagining that the stimulated area is insensitive (Chaves & Barber, 1974); (b) dissociation from painful stimuli (Blitz & Dinnerstein, 1971); (c) thinking about pleasant events (Worthington, 1982; Clum, Luscomb, & Scott, 1982); and (d) concentrating on simple mathematical or visuomotor tasks (Wolff, Cohen, & Greene, 1976). Self-hypnosis is also included in cognitive-behavioral approaches to pain (Orne, 1976). Although the mechanisms involved are unclear, the latter studies suggest that attention to visual, auditory, or tactile stimuli, together with strong suggestion, may diminish or even totally abolish pain perception.

In evaluating the effectiveness of these three psychological techniques—physiological approaches, operant conditioning, and cognitive-behavioral therapy—Turner and Chapman (1982b) state that because the cognitive-behavioral therapies emphasize the subjective state of pain, they have the potential of addressing a wider range of chronic problems in a more comprehensive manner. Upon examination, the cognitive-behavioral method would also seem to be a closer ally to the Gate Control Theory of pain than the other two interventions. After reviewing the medical treatment of pain, Melzack and Casey (1968) conclude:

> The surgical and pharmacological attacks on pain might well profit by redirecting thinking toward the neglected and almost forgotten contribution of motivational and cognitive processes. Pain can be treated not only by trying to cut down sensory input by anaesthetic blocks, surgical interventions and the like, but by influencing the motivational-affective and cognitive factors as well. (p. 435)

A possible conclusion to be drawn from this literature review is that a complex multidimensional phenomenon such as pain will require a multidimensional approach in treatment methodology as well. Since no two individuals perceive and respond to pain in the same manner, no single intervention has yet been identified to be effective for all sufferers. More research needs to be employed in determining the efficacy of the psychological therapies in pain management to delineate which methods are best suited for various pain problems.

The Use of Music in Controlling Pain

Recognition of the inherent qualities of music in association with medicine has its roots in antiquity. The Persians and Hebrews used music as therapy for a variety of illnesses; the early Greeks—Plato, Asclepiades, Pythagoras—used music to alter psychological and physical states; the tribal medicine men of Africa used music as a primary tool to enhance their healing powers. From the Renaissance and continuing through the eighteenth century, there are references to the influence of music on blood pressure, muscular activity, breathing, and digestion.

During the late eighteenth and nineteenth centuries, the traditional associations between music and medicine began to wane. However, during the late nineteenth and twentieth centuries, the great technological, pharmaceutical, and scientific advances made in medicine brought a resurgence of interest. Particularly within the last ten years, attention has been focused on clinical and experimental research evaluating the physiologic and psychologic effects of music on the workings of the body, both in health and in disease. [For comprehensive reviews on the history of and research in music and medicine, see Taylor (1981) and Standley (1986).] Despite this revival of interest, the effect of music on pain perception has, nevertheless, received scant attention in the scientific literature.

One of the most widely known applications of music in the medical field has been audioanalgesia: the use of auditory stimulation (music and/or noise) as an analgesic agent. For dental pain, music as a supplement to anaesthesia was popularized after studies by Gardner and Licklider (1959, 1960) praised the use of music in dental procedures. Patients were given a remote volume control box and told to increase the auditory stimulation to mask the sound of the drill and/or if they felt any sensations of pain. Gardner and Licklider (1960) reported that out of 1000 patients, 65% had complete suppression of pain, 25% had suppression enough that no analgesia was required, and 10% had less than adequate relief.

Although the physiological and psychological mechanisms involved remain unclear and controversial, and dentists report varied success with this procedure, music with suggestion, under patient control, has proven to have salutary effects for dental patients in reducing pain

perception (Morosko & Simmons, 1966).

Studies emanating from laboratory research have suggested that sound stimulation does not raise pain threshold but does affect tolerance levels (Robson & Davenport, 1962; Melzack et al., 1963; Moore, Browne, & Hill, 1964). Clinicians have also reported successful results in using music as a means of reducing pain perception. MacClelland (1979) found music to provide a diversion and distraction from the strange sights and treatments in the operating room and when carried over into the recovery period, patients experienced "shortened, more pleasant post-anaesthetic recovery. Feelings of pain, discomfort, apathy, and sadness resulting from cerebral inoccupation will decrease" (MacClelland, 1979, p. 258). Herth (1978) found a 30% drop in the use of pain medications by those hospitalized patients who listened to music when experiencing pain. A study in which music was used during the first 48 hours after abdominal surgery showed a positive reduction in patients' musculoskeletal reactions, pain-relieving medications, and verbal pain reports (Locsin, 1981).

Bonny (1983) describes the use of music tapes with specific hospitalized patient populations. Coronary and intensive care units, operating and recovery rooms were equipped with cassette recorders, earphones, and classical or popular tapes for patient use. Pilot studies were conducted on the effect of music on physiological and psychological responses, particularly stress. Preliminary reports suggested that there was lessened anxiety and depression in patients who listened to music and a gross measure for pain also showed greater tolerance of pain and suffering.

Although very encouraging, most of the clinical reports on the effect of music on pain do not provide clear, objectively controlled studies for determining the specific effects of music on people experiencing pain and medical problems. Understandably, the hospital experience is a difficult arena in which to conduct controlled studies that will yield "hard data." Clearly, research in this area is needed to validate the reportedly positive effects of music on pain perception.

Music as a Cognitive Strategy

Of special interest to the authors is the possibility that the use of music as a cognitive strategy may have the potential of exerting an influence on pain perception by acting along all three psychological dimensions involved in the pain experience, as described by Melzack and Wall (1965): sensory-discriminative, motivational-affective, and cognitive-evaluative.

For example, an individual can exert control over the sensory-discriminative component of pain by such means as physical and mental relaxation, including slow, deep breathing (Melzack, 1973). Music facilitates this physical and mental relaxation process by providing

reinforcing cues, such as slow tempos and constant rhythmic patterns. That music may induce relaxation has received both experimental and clinical support (Chetta, 1981; Zimny & Weidenfeller, 1963; Ellis & Brighouse, 1952). Evidence of this is the use of music as an integral component of the Lamaze technique as a conditioning stimulus for relaxation during labor (Clark et al , 1981).

Hanser, Larson, and O'Connell (1983) incorporated a music therapy training program with the Lamaze technique for expectant mothers to use during labor and childbirth. The purpose of the music during labor and delivery was "(a) to cue rhythmic breathing; (b) to assist the woman in relaxing by prompting positive associations with the music; and (c) to focus attention on the music, diverting attention from discomfort and extraneous hospital sounds which might signal anxiety" (p.52). The results of the study showed that patients displayed fewer pain responses (e.g., verbalizations and physical movement) when music was played during labor as compared to patients who had no background music within the same environment. Comments from the mothers as well as the hospital staff were all very favorable toward the use of music in the birth process.

The motivational-affective component of the pain experience includes the emotional feelings the subject has while experiencing pain. Such feelings as anxiety, helplessness, and a lack of control may exacerbate the painful experience (Bonny, 1983). If, on the other hand, music listening is used as a coping strategy, benefits to the patient will accrue by virtue of distraction or the elicitation of pleasurable emotional states induced by the rhythms and melodies being presented. A learned association may be developed which conditions the amelioration of the painful experience to the presentation of suitable musical selections.

One way to deal with the cognitive-evaluative component of the pain is for patients to reconceptualize the painful experience (Meichenbaum & Turk, 1976). For example, confronting and handling a potentially painful situation by altering one's expectations redefines the painful situation. Often, in medical situations, individuals feel ignorant of their physical condition and unable to exert much influence over their ailment without professional assistance. By "taking charge" of at least some elements of the painful situation by actively listening to music for the purpose of gaining control over their pain, the patients may learn a cognitive strategy that allows a previously painful experience to be reconceptualized to one that they can, in fact, control. Such a treatment approach is designed to counteract the sense of learned helplessness that often accompanies chronic pain.

There is an additional benefit to this approach: If patients can learn these positive associations to the therapeutic qualities inherent in music, then the focus on the positive aspects of music and the potential of music to make them feel good may foster music as a coping strategy for any time, any place, even when they do not have equipment available. They

may be able to relive a song, a melody line, or a complex musical score in their heads and recapture the relaxation and peace that music is able to provide.

The Attributes of Music for Pain Control

Among its many attributes, music contains two distinct qualities that may be useful for developing effective pain coping skills: an attention-distraction dimension and an affect dimension.

Attention-Distraction Dimension

Music is time-ordered: It involves a sequence of sounds and silences accruing over time with rhythmicity. Music clearly has the potential of holding one's attention, challenging one's intellect, and modifying one's emotional state regardless of one's musical preference or knowledge.

> The unique structure of music—it exists only through time—requires the individual to commit himself to the experience moment by moment. Except for relatively minute deviations, music (whether an entire piece or merely a measure or phrase in repeated practice) cannot be interrupted without losing its intent. . . . Once begun, music must be continued without interruption in order that a completed idea or expression may result; regardless of its length or complexity or type and degree of skill it requires, the music must be carried through in its time order. (Gaston, 1968, p. 35)

The musical process also has the potential of altering one's perception of time. Cognitively engaging oneself in the music may allow for distraction away from the reality of the moment, away from self-preoccupation. The clinical advantage of this is obvious for the individual who is able to "lose him/herself" in the music: The sensation of pain may or may not totally diminish, but the suffering involved would be greatly reduced.

Affect Dimension

Music is mood-evoking: It arouses emotional experiences that may provide heightened meaning to a situation, evoke religious beliefs, stir past memories, and allow for self-catharsis.

> A thorough examination of music . . . shows what an enormous and potentially unlimited range of active self-integrative experience is available for therapeutic use: the vast range of emotional experience possible—in addition to the 'conventional' range of emotions, all kinds of moods and nuances of feelings can be realized, all subtleties and progressions of change, all degrees of intensity. (Nordoff & Robbins, 1977, p.2)

Clearly, a patient's physical pain is not the only problem that should be addressed by clinicians. For a suffering individual, words may be ineffective for communicating the feelings and emotions involved in the experience of pain. If not dealt with, these feelings and emotions may only exacerbate the situation and hinder therapy and relief.

And, like pain, music is both personal and internal. For the individual who cannot speak of his/her pain, catharsis may be achieved by personal involvement with the music. Ultimately this would be beneficial not only for the patient but for the medical staff as well. As one nurse stated: "Music provided an opportunity to show [the patient] that we wanted to communicate with this person on the level he wanted. . . . It was a means of communicating our concern and care" (Herth, 1978, p. 23).

Conclusions

In sum, the Gate Control Theory proposed by Melzack and Wall (1965) suggests an interrelationship between ascending (afferent) and descending (efferent) nerve fibers involved in pain perception. Pain is a function of the physiological balance of noxious information travelling through the large and small diameter nerve fibers of the afferent system conveying pain information to the emotional, cognitive, and motor centers of the brain. Efferent nerve fibers carrying information from the brain exert descending control of pain experience by transmitting information about cortical functions such as attention, emotion, and motivation. Manipulation of any one or all of these afferent or efferent processes affects the quality and intensity of pain perception.

Within this theoretical framework, the cognitive dimensions of the pain experience become particularly important. Turk (1982) states:

> The important issue . . . is how patients facing impending aversive stimulation (events; e.g., noxious medical and surgical procedures), currently exposed to intense stimulation (e.g., chronic pain), or overresponsive to threatening stimuli (e.g., migraine headaches, peptic ulcers) can be helped to alter their conceptualizations such that the situations become less threatening. In short, what strategies or approaches can the health care provider employ to effect more adaptive responding. (p. 53)

Intuitively, it seems reasonable to propose that actively listening to music in a structured fashion may yield a cognitive strategy, via cognitive mechanisms involving attention-distraction, emotion, imagery, catharsis, and/or relaxation, for altering the perception of pain.

Music therapists are, in fact, employing a variety of techniques and approaches both in laboratory (e.g., Brown, 1987) and clinical (e.g., Wolfe, 1978) settings. There is a need, however, for music therapists to pursue more clearly designed, well-controlled research on the use of

music as a cognitive-behavioral strategy for pain management in order to ascertain its effectiveness in health care.

Important questions for investigation include: (a) What are the active components in music that allow for cognitive strategy intervention? (i.e., what are people cueing in on when they are actively focusing on the music?); (b) To what degree does music affect physiological and/or psychological responses to painful stimuli?; (c) How well, depending upon type of pain problem, are observed positive effects sustained over time?; (d) What type of music delivery system (e.g., free field vs. headphones, choice of music preferences, length of music delivery) are best suited for pain patients?; and, (e) What personality trait variables correlate with the successful use of music for controlling pain?

In short, much is still needed to be explored within this fascinating and complex area of health care. Among health care practioners today, there is a great deal of interest in alternative, nonpharmaceutical means of pain management. Providing patients with successful and meaningful cognitive-behavioral strategies within a well-defined, comprehensive music program is a challenge for music therapists concerned with the treatment and modification of pain.

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Carlene J. Brown, MA, CMT-BC, is a doctoral candidate in Systematic Musicology, School of Music, at the University of Washington, Seattle, Washington. She is currently pursuing clinical research at the Virginia Mason Hospital in Seattle on the use of music as a cognitive-behavioral therapy for postoperative pain. Ms. Brown has been awarded the 1989-90 Dorothy Danforth-Compton Fellowship and is a board member of the Washington Music Therapy Association.

Andrew C.N. Chen, Ph.D., is a Research Associate Professor in the Department of Psychiatry and Behavioral Sciences, Department of Psychology, and the University of Washington Multidisciplinary Pain Center, Seattle, Washington. As a brain psychophysiologist he focuses on the analyses of brain-evoked potentials and cortical power spectrum in relation to human pain and cognitive control. He is a member of several scientific societies, including the International Association for the Study of Pain, American Pain Society, Society for Neuorsciences, and the International Organization of Psychophysiologists. He is author of numerous scientific publications.

Samuel F. Dworkin holds a dental degree and a Ph.D. in clinical psychology from New York University. He is Professor of Oral Medicine, Professor of Psychiatry and Behavioral Sciences and is affiliated with the Mutidisciplinary Pain Center, School of Medicine, University of Washington, Seattle, Washington. Dr. Dworkin's research interests focus on psychophysiologic and psychosocial aspects of acute and chronic pain and how the psychotherapeutic process may be directed to most effectively modify pain and pain behavior. He holds several National Institute of Health research awards.