Pain 85 (2000) 317–332

PAIN

www.elsevier.nl/locate/pain

Review article

Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art

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Received 3 November 1998; received in revised form 8 September 1999; accepted 9 September 1999

Abstract

In an attempt to explain how and why some individuals with musculoskeletal pain develop a chronic pain syndrome, Lethem et al. (Lethem J, Slade PD, Troup JDG, Bentley G. Outline of a fear-avoidance model of exaggerated pain perceptions. Behav Res Ther 1983;21:401–408) introduced a so-called 'fear-avoidance' model. The central concept of their model is fear of pain. 'Confrontation' and 'avoidance' are postulated as the two extreme responses to this fear, of which the former leads to the reduction of fear over time. The latter, however, leads to the maintenance or exacerbation of fear, possibly generating a phobic state. In the last decade, an increasing number of investigations have corroborated and refined the fear-avoidance model. The aim of this paper is to review the existing evidence for the mediating role of pain-related fear, and its immediate and long-term consequences in the initiation and maintenance of chronic pain disability. We first highlight possible precursors of pain-related fear including the role negative appraisal of internal and external stimuli, negative affectivity and anxiety sensitivity may play. Subsequently, a number of fear-related processes will be discussed including escape and avoidance behaviors resulting in poor behavioral performance, hypervigilance to internal and external illness information, muscular reactivity, and physical disuse in terms of deconditioning and guarded movement. We also review the available assessment methods for the quantification of pain-related fear and avoidance. Finally, we discuss the implications of the recent findings for the prevention and treatment of chronic musculoskeletal pain. Although there are still a number of unresolved issues which merit future research attention, pain-related fear and avoidance appear to be an essential feature of the development of a chronic problem for a substantial number of patients with musculoskeletal pain.

Keywords: Pain-related fear; Chronic pain; Musculoskeletal pain; Avoidance; Disability

1. Introduction

The development of chronic musculoskeletal pain from an apparently 'healed' acute injury has baffled researchers and clinicians alike. The fear-avoidance model has recently provided an enticing account of how chronic pain may develop. Pain problems have been viewed as complex, multidimensional developmental processes where various psychosocial factors are of the utmost importance (Skevington, 1995; Gatchel and Turk, 1996). However, it has been difficult to specifically spell-out the mechanisms by which acute problems become chronic. Thus, the introduction of the so-called 'fear-avoidance' model has been a welcomed explanation.

Fear-avoidance, which refers to the avoidance of movements or activities based on fear, has been put forth as a central mechanism in the development of long-term back pain problems. In particular, fear-avoidance is thought to play an instrumental role in the so-called deconditioning syndrome. Screening and assessment measures have begun to appear, and treatment as well as preventive interventions have been designed that are congruent with the fear-avoidance concept. Some authors have gone so far as to term the phenomenon an irrational fear or phobia, as the source of the danger is often not recognized by the clinician (Kori et al., 1990). However, research on fear-avoidance is very broad and ranges from theoretical analyses to laboratory and clinical studies. In the last decade, an increasing number of both experimental and clinical studies have shown that fear and anxiety influence the experience of pain, and chronic pain disability in particular. Moreover, the concept involves behavioral, physiological, and cognitive aspects of learning. Although a good deal of research has been conducted, it appears to have gaps, especially with

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0304-3959/00/$20.00
PII: S0304-3959(99)00242-0

regard to its application in the field of chronic pain. Consequently, there is a need for a critical review of this area in the hope of summarizing and integrating the current literature.

The purpose of this paper therefore is to present the 'state-of-the-art' regarding fear-avoidance in chronic musculoskeletal pain, and its relevant consequences. We will review the concept and theoretical underpinnings of the fear-avoidance model and the existing evidence for the main predictions that originate from this model. In addition, we shall critically appraise the currently available data relevant to assessment methods and interventions based on the fear-avoidance model. Finally we will provide some directions for future research.

2. Early views on the role of fear on pain

The idea of a relationship between fear and pain is not new. Historically, several authorities have expounded upon the association between pain and fear. One of the first philosophers who linked pain with fear was Aristotle who wrote, 'Let fear, then, be a kind of pain or disturbance resulting from the imagination of impending danger, either destructive or painful' (Eysenck, 1997). The major contribution of Walter B. Cannon, who in 1915 wrote his influential book 'Bodily changes in pain, hunger, fear and rage.', consisted of upgrading the status of pain from a simple sensation to a sensation accompanied by emotion. He was one of the first to demonstrate that pain is accompanied by increased adrenal secretions that were dependent on the sympathetic nervous system, as is the case in fear and anxiety, but he did not explicitly study the interrelation between pain and fear. The phylogenetic origin of fear was thought to be injury (Shepard, 1916), and later on, fear of injury or pain was considered a salient and distinct kind of fear (Dixon et al., 1957). In the 1960s, clinical researchers tried to gain more insight into the association between pain and emotions by examining the incidence of persistent pain in psychiatric patients. Spear (1967), for example, found pain to be associated relatively more often with anxiety disorders than with other diagnoses. Sternbach (1974), describing the clinical differences between acute and chronic pain, observed that pain of recent onset was associated with a pattern of physiological responses seen in anxiety attacks. In contrast, chronic pain was characterized by an habituation of autonomic responses and by a pattern of vegetative signs seen in depressive disorders.

However, it was not until modern times that a model was developed which relates fear and pain to behavior through avoidance learning. Avoidance is a psychological term with a relatively long history, but the term 'fear-avoidance' applied to the field of pain first appeared in an article by Lethem et al. in 1983. These authors described a model explaining how fear of pain and avoidance result in the perpetuation of pain behaviors and experiences, even in the absence of demonstrable organic pathology. Avoidance behavior, presumably fueled by fear, has been intensively studied since the 1960s (e.g. Rachlin, 1980). It refers to a type of learned behavior, which postpones or averts the presentation of an aversive event. Strictly taken, the term 'avoidance' is only used for behavior which postpones or averts the aversive event. If the aversive event is terminated by the behavior, the term 'escape' is at stake. However, both avoidance and escape are associated with negative reinforcement (Kanfer and Phillips, 1970; Kazdin, 1980). Avoidance learning occurs when the undesirable event has been successfully avoided by the performance of a certain (avoidance) behavior. Already in 1976, Fordyce devoted nearly ten pages to avoidance learning to explain various pain behaviors in chronic pain patients. Fordyce et al. (1982) also described how individuals learn that the avoidance of pain-provoking or pain-increasing situations reduces the likelihood of new pain episodes. The authors also proposed behavioral treatment approaches designed to modify these learned behaviors. In synchrony with the so-called 'cognitive revolution' in behavioral science, Turk et al. (1983) emphasized the role of attributions, efficacy expectations, and personal control within a cognitive-behavioral perspective on chronic pain. The basic new assumption of this approach is that individuals actively process information regarding internal stimuli and external events. In this context, Philips (1987) argued in favor of a cognitive approach to avoidance behavior, rather than an instrumental one. She took the view that avoidance is associated with the expectancy that further exposure to certain stimuli will promote pain and suffering.

Both the 'instrumental' and the 'cognitive' approach have lead to influential fear-avoidance models that purport to explain how pain behaviors can be maintained in chronic musculoskeletal pain. We describe these models in some detail below since they are the basis for understanding the fear-avoidance concept.

3. Model 1: the 'activity' avoidance model

Fig. 1 shows the basic fear-avoidance conditioning model specific for activities or movement and pain (Linton et al., 1984). Generally, two components are distinguished: a classical and an operant one. The classical component refers to the process in which a neutral stimulus receives a negative meaning or valence. The person learns to predict events in his/her environment. An injury elicits an automatic response such as muscle tension and sympathetic activation including fear and anxiety. An external stimulus may, through classical conditioning, elicit a similar response. Conditioning may take place through direct experience, or by information (vicarious learning) or even observation (modeling). For example, a person involved in a traffic accident may develop a fear of driving as a result of the traumatic experience. Likewise, a back pain patient may develop a fear of lifting

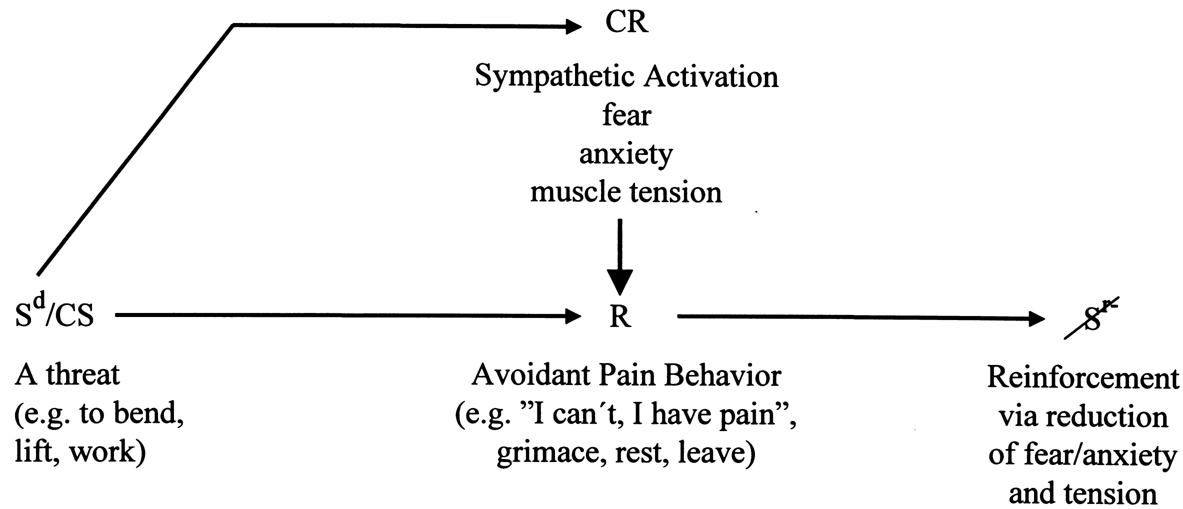

Fig. 1. The 'activity' avoidance model, combining classical and operant conditioning paradigms. A threatening and pain producing situation (S^d/CS) elicits a conditioned response (CR) of sympathetic activation including fear, which in turn leads to avoidance of the situation (R). The avoidance behavior is reinforced by a reduction of the unpleasant stimuli. CS refers to 'conditioned stimulus' and CR to 'conditioned response' in the classical paradigm. S^d refers to 'discriminative stimulus', R to 'response' and S^{R-} to reinforcement consequences in the operant paradigm.

after experiencing pain while lifting or after receiving information from a doctor that lifting can damage nerves in the spinal cord. The same type of fear can also develop if a person witnesses another person having an acute pain attack as the result of lifting.

When the stimulus, which precedes the noxious or painful experience, begins to predict the pain, avoidance learning begins. The discriminative stimulus takes on negative valence that activates muscle reactivity, fear, anxiety etc. in itself. Avoiding the threatening situation, as illustrated in Fig. 1, is reinforced by reductions, e.g. in pain, fear, tension and anxiety. Once established, avoidance behavior is extremely resistant to extinction (Rachlin, 1980). This is because successful avoidance prevents the person from coming into contact with the actual (non-harmful) consequences of the threatening situation. Moreover, fear will return whenever the avoidance behavior cannot be carried out.

4. Model 2: the 'fear' avoidance model

A more cognitively oriented model of pain-related fear, which builds upon the previous model, is presented in Fig. 2 (Vlaeyen et al., 1995a,b). This model serves as an heuristic aid and ties several findings in the more recent literature together concerning the role of fear-avoidance in the development of musculoskeletal pain problems. It postulates two opposing behavioral responses: confrontation and avoidance, and presents possible pathways by which injured patients get caught in a downward spiral of increasing avoidance, disability and pain. The model, which is based on the work of Lethem et al. (1983); Philips (1987) and Waddell et al. (1993), predicts that there are several ways by which pain-related fear can lead to disability: (1) negative appraisals about pain and its consequences, such as catastrophic thinking, is considered a potential precursor of pain-related fear. (2) Fear is characterized by escape and avoidance behaviors, of which the immediate consequences are that daily activities (expected to produce pain) are not accomplished anymore. Avoidance of daily activities results in functional disability. (3) Because avoidance behaviors occur in anticipation of pain rather than as a response to pain, these behaviors may persist because there are fewer opportunities to correct the (wrongful) expectancies and beliefs about pain as a signal of threat of physical integrity. (4) Longstanding avoidance and physical inactivity has a detrimental impact on the musculoskeletal and cardiovascular systems, leading to the so-called 'disuse syndrome' (Bortz, 1984), which may further worsen the pain problem. In addition, avoidance also means the withdrawal from essential reinforcers increasing mood disturbances such as irritability, frustration and depression. Both depression and disuse are known to be associated with decreased pain tolerance (Romano and Turner, 1985; McQuade et al., 1988), and hence they might promote the painful experience.

From a cognitive-behavioral perspective, there are a number of additional predictions that can be derived from this model: (5) just like other forms of fear and anxiety, pain-related fear interferes with cognitive functioning. Fearful patients will attend more to possible signals of threat (hypervigilance) and will be less able to shift attention away from pain-related information. This will be at the expense of other tasks including actively coping with problems of daily life. (6) Pain-related fear will be associated with increased psychophysiological reactivity, when the individual is confronted with situations that are appraised as 'dangerous'.

In the next section, we will review the existing evidence in support of the above-mentioned predictions, point to lacunas and discuss future directions.

5. Negative appraisals as precursors of pain-related fear

'An ache beneath the sternum, in connoting the possibility of sudden death from heart failure, can be a wholly unsettling experience, whereas the same intensity and duration of ache in a finger is a trivial annoyance easily disregarded'. With this statement, Henry Beecher (1959, p. 159) emphasized the importance of cognitive processes in the pain experience since pain lacks an external standard of reference thus allowing considerable room for interpretation; more so than for example, normal vision or touch. A recent cognitive-behavioral theory of anxiety, the so-called 'four-factor theory' assumes that the emotional experience of anxiety is influenced by four different sources of information of which the cognitive appraisal of the situation is considered the most important. The other three, which are indirectly dependent on the first, are the level of physiological arousal, cognitions based on information stored in long-term memory, and action tendencies and behavior (Eysenck, 1997). In chronic pain, there is ample evidence that certain pain-specific beliefs have an impact on chronic pain adjustment. (For a review, see Jensen et al., 1991, 1994; Jensen and Karoly, 1992), but there are almost no studies on the specific beliefs that influence pain-related fear. In fact, with the statement cited above, Beecher gives an early example of what is now called a catastrophic (mis)interpretation of a bodily sensation.

There is some evidence that catastrophizing thoughts may be considered a precursor of pain-related fear. Pain catastrophizing is considered an exaggerated negative orientation toward noxious stimuli, and has been shown to mediate distress reactions to painful stimulation (Sullivan et al., 1995). McCracken and Gross (1993) found a significant correlation between the catastrophizing scale of the Coping Strategies Questionnaire (Rosenstiel and Keefe, 1983) and the scores on the Pain Anxiety Symptoms Scale (McCracken et al., 1992), a recently developed measure of fear of pain. Vlaeyen et al. (1995a,b) found that pain catastrophizing, measured with the Pain Cognition List (Vlaeyen et al., 1990) was superior in predicting pain-related fear than biomedical status and pain severity. In further support of this idea, Crombez et al. (1998a) found that pain-free volunteers with a high frequency of catastrophic thinking about pain became more fearful when threatened with the possibility of intense pain than students with a low frequency of catastrophic thinking.

A prospective study by Burton et al. (1995) concerning predictors of back pain chronicity 1 year after the acute onset is also worth mentioning in this context. These researchers found that catastrophizing, as measured by the Coping Strategies Questionnaire was the most powerful predictor: almost seven times more important than the best of the clinical and historical variables for the acute back pain patients. Additional evidence of the importance of catastrophizing is provided in a study comparing chronic pain patients seeking help (consumers) with people with chronic pain who were not having treatment, and who were recruited via advertisements in local newspapers (non-consumers). The results revealed that the consumers reported much higher levels of pain catastrophizing than the non-consumers did (Reitsma and Meijler, 1997).

Constructs that appear to overlap considerably with catastrophizing, are negative affectivity and anxiety sensitivity. Negative affectivity can be seen as a moderating variable in the emergence of pain-related fear. According to Watson and Pennebaker (1989), persons with high negative affectivity are hypervigilant for all forms of (external and internal) threat, and therefore are considered more vulnerable to develop specific fears (Eysenck, 1992). For individuals with high negative affectivity who also experience pain, pain may be the most salient threat, and as a consequence, pain-related fear may emerge. Reiss and McNally (1985) introduced a fear-expectancy model of avoidance behavior that is based on the idea that anxiety disorders occur more frequently in patients with a specific personality characteristic which they called 'anxiety sensitivity'. This should be seen as a specific tendency to react anxiously to one's own anxiety and anxiety-related sensations (fear of fear). Asmundson and Norton (1995) found that chronic back pain patients with high anxiety sensitivity reported more fear of pain and tended to have greater avoidance of activities than those with lower anxiety sensitivity, despite equal levels of pain. In a subsequent study using structural equation modeling, Asmundson and Taylor (1996) corroborated the finding that anxiety sensitivity directly exacerbates fear of pain, even after controlling for the effects of pain severity on fear of pain. However, anxiety sensitivity affected escape and avoidance behaviors indirectly, via fear of pain. These findings would support Reiss's (1991) view that more basic fears (such as fear of somatic sensations, fear of cognitive dyscontrol, or fear of being outwardly anxious) underlie many specific fears, and that these should be considered a more general vulnerability factor for the development of these specific fears (see Asmundson et al., 1999).

Fears can also originate from traumatic experience. Within 1–4 months after a motor vehicle accident, 39% of the victims develop a post-traumatic stress disorder (Blanchard et al., 1996). Turk and Holzman (1986) suggested that fear-avoidance beliefs in chronic pain patients may be especially salient when the original acute pain problem resulted from sudden traumatic injury. Further evidence for this assumption was found by Vlaeyen et al. (1995b) and Crombez et al. (1999). Chronic low back pain patients who retrospectively reported a sudden traumatic pain onset, scored higher on the Tampa Scale for Kinesiophobia than patients who reported that the pain complaints started gradually. Additionally, there is evidence that a large percentage of people with chronic musculoskeletal pain meet DSM-IV criteria for post-traumatic stress disorder (Asmundson et al., 1998).

6. Pain-related fear and the overprediction of pain

Almost half a century ago, Hill et al. (1952) observed in their study on the effects of anxiety and morphine on discrimination of intensities of painful stimuli that under conditions promoting anxiety or fear of pain, subjects tended to overestimate the intensities of painful stimuli. More recently, in a series of studies with laboratory-induced pain, Arntz et al. (1990) concluded that anxious subjects produced more overpredictions of pain and that these overpredictions were less easily disconfirmed than those of the non-anxious subjects were. In a clinical setting, McCracken et al. (1993) investigated associations among predictions about pain, pain-related fear using the pain anxiety symptoms scale and range of motion in 43 chronic back pain patients who were exposed to pain during a physical examination. During the examination, patients were requested to repeatedly raise the extended leg to the point of pain tolerance. They found that anxious patients showed a tendency to overpredict pain early in the sequence of pain, while the low anxious patients underpredicted pain. Moreover, a significant relation between prediction of pain and range of motion during the straight leg raise was found, suggesting that those who expect more pain avoid pain increase by terminating the leg raise earlier. Of interest, however, is that patients tend to correct their pain expectancies when they are given the opportunity to repeat the same pain-eliciting activity. When chronic back pain patients were requested to perform four exercise trials consisting of flexing and extending the knee three times at maximal force (with a Cybex 350 system), Crombez et al. (1996) found that after overpredicting the pain experienced during the first exercise bout, the reported pain expectancy was corrected during the next exercise bout. In other words, after some exposures, overpredictions of pain intensity tended to match actual experience. The important clinical implication is that fearful patients may benefit from graded exposure to movements and activities that they previously avoided.

7. Pain-related fear and physical performance

Does pain-related fear also affect physical performance? One of the main features of fear and anxiety is the tendency to escape from and avoid the perceived threat. Although chronic pain in itself cannot always be avoided, the activities assumed to increase pain or (re)injury may be. One of the consequences, however, is that daily activity levels decrease, possibly resulting in functional incapacity. A number of studies have investigated the association between pain-related fear and physical performance, which are summarized in Table 1. In the above-mentioned study by McCracken et al. (1992), a significant correlation was found between pain-related fear and range of motion as measured with a flexometer. Vlaeyen et al. (1995a) used a simple lifting task during which patients were asked to lift a 5.5 kg weight with the dominant arm and hold it until pain or physical discomfort made it impossible for the patient to continue. A significant correlation was found between lifting time and the Tampa Scale for Kinesiophobia (TSK). In

Table 1
Correlations of pain-related fear and behavioral performance measures

Authors	*N*	Behavioral performance measure	Pain–related fear	Correlation	*P*
McCracken et al. 1992[a]	43	Straight leg raising test	PASS	−0.36	<0.05
Vlaeyen et al. 1995a	33	Lifting a 5.5 kg weight	TSK	−0.44	<0.01
Crombez et al. 1998	49	Knee-extension-flexion Unit of the Cybex 350 System	LBPQ		
		Peak torque	Fear of pain	−0.16	NS
		Performance variability		0.31	<0.025
		Work ratio		0.38	<0.005
		Peak torque	Fear of (re)injury	−0.27	<0.05
		Performance variability		0.33	<0.025
		Work ratio		0.39	<0.005
Crombez et al. 1999	38	Trunk-extention-flexion unit of the Cybex 350 system			
		Peak torque	TSK	−0.40	<0.01
			FABQ–physical	−0.45	<0.01
			FABQ–work	−0.10	NS
		Lifting a 5.5 kg weight			
			TSK	−0.49	<0.01
			PASS	−0.33	<0.01

[a] Findings are based on a re-analysis of the data (McCracken, pers. commun.). PASS, Pain Anxiety Symptoms Scale (McCracken et al., 1992); TSK, Tampa Scale for Kinesiophobia (Kori et al., 1990); LBPQ, Leuven Back Pain Questionnaire (Crombez et al., 1998); FABQ, Fear Avoidance Beliefs Questionnaire (Waddell et al., 1993).

addition, the TSK correlated significantly (0.52) with a single visual analog scale measuring the fear of (re)injury just after completion of the lifting task. However, in this study, pain intensity was not measured. As a consequence, it might be possible that the poor performance was due to increased pain rather than escape or avoidance. To rule out this possibility, Crombez et al. (1998) conducted a similar study using the knee-extension-flexion unit (KEF; Cybex 350 system) as the behavioral task. They purposely chose a performance test that patients believed put minimal strain on their back. The researchers again found a significant association between performance level and pain-related fear, but no relationship between performance and pain intensity. In a replication study using linear regression, Crombez et al. (1999) showed that pain-related fear was the best predictor of behavioral performance in a trunk-extension-flexion and weight lifting task, even after partialling out the effects of pain intensity. In sum, there is now sufficient evidence that pain-related fear is associated with escape/avoidance of physical activities resulting in poor behavioral performance.

A central question is whether the results of these studies also generalize to everyday situations. A quite robust measure of activity levels in daily life consists of the quantification of energy expenditure, for example with the use of the doubly-labeled water technique (Westerterp et al., 1995). Energy expenditure may be calculated by analyzing the excretion of isotopes in urine samples during a number of consecutive days. The method has not been utilized in pain patients, and has the disadvantage of being expensive. In patients who underwent coronary bypass surgery, energy expenditure on postoperative leisure activities has been reported to be associated to fear of injury (O'Connor, 1983). Alternatively, quantification of physical activity can be done with activity diaries (Fordyce, 1976) or with the more advanced automated activity monitors (Bussman et al., 1998). Using long-term ambulatory monitoring in eight failed back surgery patients in and around their own homes, Bussman et al. (1998) found associations between different postures and fear avoidance as measured with the TSK. Based on their published data, we calculated the associations (Kendall'Tau) between TSK and different postures. The data indicate that patients with pain-related fear are less active: they sit more (Tau = 0.30) and tend to avoid standing positions (Tau = −0.33)). However, replications with larger samples are needed.

8. Pain-related fear and self-reported disability

A key issue is how pain-related fear actually affects daily activities and the development of disability. Studies investigating generalization of pain-related escape/avoidance to disability levels in daily life are summarized in Table 2. Philips and Jahanshahi (1986) found that in a group of headache sufferers, avoidance of activities, and withdrawal from

Table 2
The relationship between pain-related fear and self-reported disability measures[a]

Authors	*N*	Disability	Pain-related fear	Correlation	*P*
Riley et al., 1988	56	SIP	PAIRS	0.51	<0.001
				(SIP-physical)	
				0.47	<0.001
				(SIP-total)	<0.001
Waddell et al., 1993	184	RDQ	FABQ–physical	0.51	<0.001
			Present work loss	0.13	NS
			Work loss in past year	0.23	<0.01
		RDQ	FABQ–work	0.55	<0.001
			Present work loss	0.39	<0.001
			Work loss in past year	0.55	<0.001
Vlaeyen et al., 1995b	33	RDQ	TSK	0.49	<0.01
McCracken et al., 1996		PDI	PASS		
			Cognitive	0.51	<0.001
			Escape/avoidance	0.66	<0.001
			Fear	0.38	<0.01
			Physiological	0.51	<0.001
			Total	0.61	<0.001
Tait and Chibnall, 1997	395	PDI	SOPA–harm	0.21	<0.001
Crombez et al., 1999	3331	RDQ	FABQ–physical	0.51	<0.001
			FABQ–work	0.63	<0.001
			TSK	0.56	<0.001
	31	RDQ	TSK	0.43	<0.01
			PASS–total	0.13	NS

[a] TSK, Tampa Scale for Kinesiophobia (Kori et al., 1990; Vlaeyen et al., 1995); FABQ, Fear Avoidance Beliefs Questionnaire (Waddell et al., 1993); PASS, Pain Anxiety Symptoms Scale (McCracken et al., 1992); PAIRS, Pain And Impairment Relationship Scale (Riley et al., 1988); PDI, Pain Disability Index (Pollard, 1984); SIP, Sickness Impact Profile (Bergner et al., 1981); SOPA, Survey Of Pain Attitudes (Jensen et al., 1987); RDQ, Roland Disability Questionnaire (Roland and Morris, 1983).

social situations was the most prominent behavior reported by these individuals. One salient stimulus may be work or the workplace as patients often associate their pain with work (Linton and Buer, 1995). Waddell et al. (1993) reported that fear-avoidance beliefs about physical activities and work are strongly related to disability and work loss in the previous year, more so than biomedical variables and characteristics of pain and concluded that 'fear of pain and what we do about it is more disabling than the pain itself' (Waddell et al., 1993, p. 164). In a study that compared people matched for pain intensity and duration, fear-avoidance beliefs (pain and impairment relationship scale) were found to be an important factor discriminating between people with no sick leave and those with considerable sick leave (Linton and Buer, 1995). Not surprisingly, fear-avoidance has been included in a screening questionnaire designed to detect patients at risk of developing persistent problems. Not only were 'fear-avoidance beliefs' related to future pain and function, but also it was the most salient variable related to future sick absenteeism (Linton and Halldén, 1997, 1998).

However, when 252 patients presenting with low back pain at a primary health-care facility were studied in an effort to isolate risk factors, the results did not support the fear-avoidance concept (Burton et al., 1995). Although the FABQ was employed, the final discriminate analysis on disability showed that psychosocial factors e.g. coping and distress were related, but not fear-avoidance. This may indicate differences between studies in outcome variables e.g. disability versus work, but it may also indicate that the fear-avoidance concept is closely related to other psychosocial terms.

With their Survey Of Pain Attitudes (SOPA), Jensen et al. (1994) examined the relationship of pain-specific beliefs to chronic pain adjustment. They found that the SOPA harm scale (the specific belief that pain is a signal for damage) made a unique contribution to the prediction of physical dysfunction, as measured by the sickness impact profile (SIP; Bergner et al., 1981). However, this relationship was substantial only for patients reporting pain duration of less than about 2.4 years. Using linear regression, Vlaeyen et al. (1995b) found that fear of movement/(re)injury is a better predictor of self-reported disability levels as measured with the Roland disability questionnaire (RDQ; Roland and Morris, 1983; Beurskens et al., 1996) than biomedical findings and pain intensity levels. These findings were successfully replicated by Crombez et al. (1999). Asmundson et al. (1997) described a cohort of chronic pain patients with the Multidimensional Pain Inventory (MPI; Kerns et al., 1985) and found that patients who were classified as 'dysfunctional', and hence considered most disabled, scored the highest on the Pain Anxiety Symptoms Scale. In their study comparing pain-specific fear measures with more general anxiety questionnaires, McCracken et al. (1996) showed that disability was most strongly correlated with the more specific pain-related fear measures, as compared to a more general measure of anxiety. These researchers also showed that pain-related fear not only predicts disability levels, but also non-specific physical complaints other than the primary pain complaints in patients with chronic pain, thereby complicating the pain problem (McCracken et al., 1998). All of these studies are cross-sectional in nature and positive correlations or regression weights should not be confused with causal effects. Pain-related fear is likely to cause increased avoidance of activity and disability, but theoretically, the opposite might be true as well, or both may be related to a third variable (e.g. traumatic experience).

The prospective study by Klenerman et al. (1995), however, supports the idea that pain-related fear is a precursor of disability, rather than a consequence of it. In this study, which employed acute back pain patients in a primary care setting, a set of psychological variables (including fear-avoidance indicators) turned out to be one of the most powerful predictors of chronic disability 1 year later. One problem with this study, however, is that the authors did not actually use a standardized measure of pain-related fear and avoidance. Linton et al. (1999) included a large sample from the general population in their prospective cohort study with the aim to examine whether pain catastrophizing and fear-avoidance in pain-free individuals predict subsequent episodes of musculoskeletal pain. They found that individuals who scored above the median score of a modified version of the Fear Avoidance Beliefs Questionnaire (FABQ; Waddell et al., 1993) had twice the risk of having an episode of pain during the following year.

In sum, there is considerable evidence that pain-related fear not only leads to poor physical performance as measured in the laboratory, but that these effects also generalize to activities of daily life including activities at the workplace. In addition, fear-avoidance beliefs may be an important predictor of pain episodes, early on in pain-free people.

9. The 'disuse' syndrome

Although escape and avoidance may be an effective and appropriate coping response in the short term (Wall, 1979), exclusive reliance on it may result in a variety of negative repercussions. The physically negative aspects of avoidance were first demonstrated by Brady et al. (1958), who found that monkeys pressing a lever at a high rate to avoid shock developed duodenal ulcers from which they died within a few weeks. No ulcers were seen in yoked controls, who received the same shocks but had no avoidance contingency available. There is surprisingly little research focused on the negative effects of avoidance behavior in humans. As pointed out above, a strong correlation has been found between fear-avoidance beliefs, behavioral performance and self-reported disability. However, no study directly assessing the physiological consequences of fear-avoidance in the pain situation could be located. Prolonged avoidance of movements and activities is assumed to cause detrimental changes in the musculoskeletal system, often referred to as 'disuse syndrome' (Kottke, 1996; Bortz, 1984). Although we have not been able to find a more specific definition than 'the detrimental consequences of long-term inactivity', the term disuse is being used in the pain literature in at least two different ways: (a) physical deconditioning as a consequence of reduced use of the musculoskeletal system (e.g. Wagenmakers et al., 1988); and (b) impairments in muscle coordination, leading to guarded movements (e.g. Main and Watson, 1996).

9.1. Deconditioning

There are a plentitude of studies demonstrating that exercise and fitness are beneficial in a biomedical sense to maturation, strength, and healing of bones, tendons and muscles. Exercise is found to be associated with psychological benefits, possibly mediated by neuroendocrine responses (Bouchard et al., 1994; Morgan, 1997). Likewise, bedrest and other forms of immobilization are pernicious for disks, muscles, joints, bones, ligaments, and tendons. Deconditioning refers to a progressive process of worsening physical fitness as a result of reduced muscular activity.

A classic method for the assessment of muscle strength is based on dynamometry. Patients are requested to perform maximally on a bicycle ergometer or Cybex machine. For example, Wagenmakers et al. (1988) found that during incremental cycle ergometry, as compared to healthy but untrained controls, patients with non-specific muscle pains who were unable to exercise at high intensities showed decreased endurance and an increased dependence on glycolysis at low intensities. Biopsies revealed that these patients also had a lower content of mitochondria in their muscles, and the authors suggested that these biochemical changes were a consequence of their reduced habitual activities. However, the assumption that lumbar dynamometry provides objective and unbiased measures that can quantify functional capacity is now being challenged. Menard et al. (1994), for example, found a difference in the pattern of dynamometry in two groups of LBP patients who differed only in the propensity of abnormal illness behavior (as indicated by the Waddell score). Lee et al. (1995) found a generalized strength reduction (of both trunk and knee muscles) in chronic low back patients as compared to healthy controls, with significant correlations between trunk and knee strength in both groups. Both Menard et al. (1994) and Lee et al. (1995) proposed that fear of pain or (re)injury might be one of the possible explanations. Unfortunately, they did not include a measure of pain-related fear.

A major problem with dynamometry is that pain-related fear or pain intensity may inhibit muscle activation (Verbunt et al., 1999). A relatively easy technique to detect the discrepancy between muscle force during voluntary contraction and the maximum available muscle force is the percutaneous twitch superimposition technique (Rutherford et al., 1986; Mannion et al., 1997). During voluntary contraction, the motor nerves are stimulated percutaneously (twitch). During a truly maximum contraction no extra force is generated by the twitch. This method provides a way to predict maximum force from submaximal efforts, and can be considered a promising tool in assessing muscle weakness in cases where muscle activation is inhibited for example by pain-related fear. However, it still needs to be demonstrated that pain-related fear is a significant predictor of the extra force generated by the twitch.

9.2. Guarded movement

The second meaning of disuse involves disordered coordination and electromyography (EMG) patterns during movement such as walking. For example, Arendt-Nielsen et al. (1995) have shown that chronic low back pain patients have EMG patterns of the musculus erector trunci that show less modulation and more continuous activity during gait than do healthy controls. Koelman et al. (1996) reported that a number of chronic low back pain patients do not allow a counter-rotation between transversal pelvic and thoracic rotation when increasing walking speed. Patients who experienced less pain showed more counter-rotation at higher walking speeds. The inability to make a counter-rotation was often accompanied by hyperstability of the pelvic and thoracic rotation, leading to 'guarded movements'. Keefe and Hill (1985) have provided early evidence that asymmetries in gait are correlated with pain behavior, and Fordyce (1976) advocated the use of 'speed walking' in reducing chronic low back pain patients' pain behaviors. Main and Watson (1996) suggested that guarded movements are likely to be moderated by pain-related fear, and elaborated on the flexion relaxation phenomenon (FRP). The FRP refers to the sudden cessation of muscle activity during the activity of forward flexion from the standing position. In subjects with back pain the FRP is frequently absent. The FRP has been observed to return to normal as symptoms resolve after an acute injury (Haig et al., 1993) and as a result of treatment (Triano and Schultz, 1987). Watson et al. (1997) demonstrated that the loss of the FRP can be reliably measured over time by the use of the flexion relaxation ratio (FRR) which compares the amount of EMG activity in the paraspinal muscles at maximal activity during forward flexion and the activity at the fully flexed position. In a subsequent study, Watson et al. (1997) examined the role of pain-related fear and self-efficacy beliefs on guarded movement, as measured by the FRR. They found the FRR to be significantly correlated with fear-avoidance beliefs, and not with current pain intensity or disability level. Moreover, following a pain management program, significant correlations were discovered between reductions in fear-avoidance beliefs, increases in pain self-efficacy beliefs and increased FRR's on movement. No such associations were identified between EMG measures and changes in range of movement, pain report or disability. This study suggests that pain-related fear plays an important role in the development of guarded movement, and more so than pain severity or disability levels.

In sum, pain-related fear may also be responsible for the worsened physical condition and the occurrence of guarded movement patterns displayed by a number of chronic musculoskeletal pain patients. These effects are probably mediated by avoidance behaviors and poor physical performance, which are considered as the more immediate consequences of pain-related fear.

10. Attention to bodily sensations

The cognitive theory of anxiety put forward by Eysenck (1997) makes the assumption that the most important function of anxiety is to facilitate the early detection of potentially threatening situations. In other words, highly anxious individuals demonstrate hypervigilance, both generally and specifically. General hypervigilance (or distractibility) refers to the propensity to attend to any irrelevant stimuli being presented. Specific hypervigilance involves the inclination to attend selectively to threat-related rather than to neutral stimuli.

In laboratory studies with healthy subjects and experimentally induced pain stimuli, there is evidence that the role of anxiety on pain perception is mediated by attentional processes (Arntz et al., 1994). There is very little research that directly examines hypervigilance in pain patients who report pain-related fear. Based on their study investigating the construct validity of the McGill pain questionnaire, Pearce and Morley (1989) suggested that patients with chronic pain are characterized by selective attention towards cues that are thematically related to pain and its consequences. A more recent replication with the dot-probe paradigm, Asmundson et al. (1997) found that individuals with chronic pain with low anxiety sensitivity were able to shift their attention away from stimuli related to pain, in contrast to the subjects with high pain sensitivity. In other words, they found evidence for a specific form of hypervigilance. These findings are in line with the observation by Crombez et al. (1998b) that chronic back pain patients who avoid back straining activities not only report high fear of pain and fear of (re)injury, but also high attention to back sensations. Similarly, McCracken (1997) reported that attention to pain as reported with the pain vigilance and awareness questionnaire (PVAQ) was most strongly associated with pain-related fear, and to a somewhat lesser degree but still significantly with depression, physical and psychosocial disability and health care utilization.

Eccleston et al. (1997) used a primary task paradigm, in which subjects are requested to direct their attentional focus towards a mental task while receiving painful stimuli. Degradation in task performance on the mental task is taken as an index of attentional interference due to body hypervigilance. The researchers found that disruption of attentional performance was most pronounced in chronic pain patients who reported high negative affect, somatic awareness and high pain intensity (Eccleston and Crombez, 1999). These attentional processes not only apply to clinical pain or painful stimulation but also appear to hold for more ambiguous bodily sensations. Using a body scanning reaction time paradigm, Peters et al. (1999) found that in a group of fibromyalgia patients detection latency for innoxious electrical stimuli in the arm was predicted by scores on the Pain Anxiety Symptoms Scale, and most consistently by the cognitive anxiety subscale.

A conclusion that may be drawn is that although the majority of studies have used experimental pain with healthy volunteers there is good evidence that pain-related fear leads to increased attention toward the source of the threat, in casu bodily sensations (hypervigilance). This is at the expence of other tasks, such as usual everyday activities or the voluntary use of pain coping strategies. An interesting question to be answered is whether, through attentional demands, pain-related fear hampers adjustment to chronic pain, at worst resulting in persisting disability.

In individuals with pain-related fear, hypervigilance may also be influenced by external information about illness, such as feedback about diagnostic tests. In the field of health anxiety (e.g. Warwick and Salkovskis, 1990), a number of studies have examined cognitive responses to different kinds of information about diagnostic tests. In general, individuals who are anxious about their health tend to use avoidance strategies when receiving negative test results, but are hypervigilant when perceiving positive and ambiguous test results. In non-anxious individuals, almost the opposite seems to occur: positive test results elicit minimization of the seriousness of the condition, and increased doubts about the validity of the information (Ditto et al., 1988). In a well designed study in individuals with subclinical health anxiety, Hadjistavropoulos et al. (1998) examined responses to a cold pressor task after the subjects received feedback on an ostensible diagnostic measure, indicating positive, negative or ambiguous risk for health complications. Overall, health anxious individuals interpreted the diagnostic information more negatively, reported more catastrophizing, seeked more reassurance, and were less able to engage in protective strategies during the cold pressor task. Surprisingly, the moderating effect of the positive or ambiguous diagnostic information was not found. It still needs to be seen whether the findings can be replicated in a clinical sample of health anxious individuals, and more particularly in chronic pain patients who report substantial pain-related fear.

Based on the available literature, it is likely that pain-related fear has implications for how individuals respond to diagnostic information and attend to pain. Therefore, fearful patients may benefit from clear and unambiguous information, not only about the diagnostic tests but also about possible strategies that can be used to cope with daily life situations. This is an area in which more research effort needs to be devoted (e.g. Turner et al., 1998).

11. Symptom-specific muscular reactivity

In addition to the attentional processes, pain-related fear can also lead to increased pain by way of concomitant muscular reactivity. When individuals are confronted with anxiety-eliciting stimuli, a number of changes occur in the autonomic nervous system including skin conductance levels, muscular reactivity and heart rate. Extensive research by Flor and Turk (1989) and Flor et al. (1992) suggests that psycho-physiological responses in chronic pain are symptom specific and stress-related. For example, compared to healthy controls, chronic low back pain patients showed elevated reactivity in the paralumbar musculature when confronted with a personally relevant stressor, and not with stressors in general. Similar elevations were found at symptom-specific body musculature for tension headache patients (musculus frontalis) and patients with temporomandibular pain dysfunction (musculus masseter). This response stereotypically appears to be limited to the muscular system and was not observed in measures of the autonomic system. Similarly, for the subgroup of chronic low back pain patients with substantial pain-related fear, one can predict elevated paraspinal EMG-levels to occur in fearful chronic low back pain patients when confronted with movements which they believe are harmful. This muscular reactivity to stress may further maintain the pain problem.

Psychophysiologic reactivity in fearful chronic low back pain patients was studied in an experiment where the subjects were presented a video recording including a neutral situation (a nature documentary) followed by a physical activity being performed rigorously by a dummy patient (Vlaeyen et al., 1999a). The patients remained seated during the 6 min video-exposure, and were instructed to watch carefully as they would be asked to perform the same activity at the end of the video presentation. EMG activity of four muscles were recorded continuously: lower paraspinal muscles and tibialis anterior muscles (both bilaterally). The results were partly as predicted, partly surprising. Although self-reported subjective tension during the activity exposure increased relative to the nature documentary in the fearful chronic low back pain patients, there was a decrease in muscular reactivity across both stimuli. This decrement, however, was significantly less in fearful patients who remained at about the same reactivity. Supposedly, contextual fear caused by the experimental set-up produced increased muscular reactivity during baseline. The non-fearful patients readily habituated, while the fearful patients did not. As predicted, the reactivity was symptom-specific: only the reactivity of the left erector spinae was predicted by fear of movement/(re)injury. Extending the diathesis-stress model described by Flor et al., the reactivity of other than paraspinal muscles (in casu the tibialis anterior muscles) were also influenced by pain-related fear, but only in the subgroup of patients reporting high on a measure of negative affectivity. In addition, change in lower paraspinal EMG predicted subsequent pain report during a lifting task in the expected direction: fewer decreases in EMG readings predicted higher pain ratings. Although these results are in line with the series of carefully designed studies by Flor and colleagues, further studies are needed to fully understand what the consequences of this muscular reactivity can be.

The review thus far as demonstrated the possible importance of fear-avoidance in chronic pain. This evidence is so compelling that it has become relevant to work routinely with it in research as well as in the clinic. The subsequent section surveys techniques for measuring fear-avoidance while treatment is dealt with in the final section.

12. Assessment of pain-related fear

Measuring fear-avoidance is an important, but sometimes a difficult task in clinical and research settings. Fortunately, there is considerable relevant experience in measuring avoidance available in the psychological literature. It is generally agreed that assessment should strive to cover objective and subjective aspects falling within the cognitive, behavioral, and physiological realm. Thus, while self-report is an important part of assessment, behavioral observation and psychophysiological recordings may also be valuable in determining the qualities of pain-related fear.

12.1. Self-report

A basic question that may be asked is what the patient is afraid of, or in other words what is the nature of the perceived threat? The most common answer would be pain. Nevertheless, the relationship between avoidance behavior and specific fears appears to be more complex than the model may insinuate. Patients for example, may not view their problem as involving fear at all and may simply see difficulty in performing certain movements or activities. Other patients may fear not so much current pain, but pain that will be experienced at a later time, for example the day after a physical exercise. Finally, patients may not fear pain itself, but the impending (re)injury that it is supposed to indicate. The literature reflects this lack of clarity by discussing measures for the assessment of fear of pain, fear of work and physical activity, and fear of (re)injury as a result of movement. Overall, these pain-specific measures of pain-related fear are better predictors of pain, disability and pain behavior compared with more general anxiety measures or measures of negative affect (McCracken et al., 1996; Crombez et al., 1999).

12.2. Fear of pain

An early attempt is the Pain And Impairment Relationship Scale (PAIRS) developed to study chronic pain patient's attitudes concerning activity and pain (Riley et al., 1988). The scale has 15 items which are rated on seven-point Likert scales and it has been found to have good psychometric characteristics (DeGood and Shutty, 1992). The original study demonstrated that beliefs that activity would increase pain were related to physical impairment.

In 1992, the Pain Anxiety Symptoms Scale (PASS, McCracken et al., 1992) was developed to measure cognitive anxiety symptoms, escape and avoidance responses, fearful appraisals of pain and physiologic anxiety symptoms related to pain. It is a 40-item questionnaire with internally consistent subscales (McCracken et al., 1993). The validity of the PASS has been supported by positive correlations with measures of anxiety, cognitive errors, depression, and disability (McCracken et al., 1996). A more recent exploratory factor analysis (Larsen et al., 1997) revealed five factors which could be labeled as catastrophic thoughts, physiological anxiety symptoms, escape/avoidance behaviors, cognitive interference and coping strategies.

12.3. Fear of work-related activities

The Fear-Avoidance Beliefs Questionnaire (FABQ), developed by Waddell et al. (1993), focuses on the patient's beliefs about how work and physical activity affect his/her low back pain. The FABQ consists of two scales, fear-avoidance beliefs of physical activity and fear-avoidance beliefs of work, of which the latter was consistently the stronger. The authors found that fear-avoidance beliefs about work are strongly related with disability of daily living and work lost in the past year, and more so than biomedical variables such as anatomical pattern of pain, time pattern, and severity of pain. On the other hand, the FABQ-physical subscale is much stronger in predicting behavioral performance tests (Crombez et al., 1999).

12.4. Fear of movement/(re)injury

The Survey Of Pain Attitudes (SOPA: Jensen et al., 1987) was developed to assess patients attitudes towards five dimensions of the chronic pain experience: pain control, pain-related disability, medical cures for pain, solicitude of others, and medication for pain. Because of the authors' clinical observation of an association between chronic patients' hesitancy to exercise and the expressed fear of possible injury, a new scale (harm) was added to the original instrument (Jensen et al., 1994). As well as the disability and control scales, the harm scale appeared to independently predict levels of dysfunction.

The Tampa Scale for Kinesiophobia (TSK; Kori et al., 1990) is a 17-item questionnaire that is aimed at the assessment of fear of (re)injury due to movement. Each item is provided with a Likert scale with scoring alternatives ranging from 'strongly agree' to 'strongly disagree'. Most psychometric research has been carried out with the Dutch version of the TSK (Vlaeyen et al., 1995a). The TSK appears to be sufficiently reliable ($\alpha = 0.77$) and valid. Modest but significant correlations were found with measures of pain intensity, catastrophizing, impact of pain on daily life activities and generalized fear. Regression analyses revealed that levels of disability were best predicted by TSK, and that the latter was best predicted by catastrophizing. Pain intensity levels and biomedical findings were significantly less predictive of both pain-related fear and disability levels (Vlaeyen et al., 1995b). Moreover, the TSK discriminated well between avoiders and confronters during a behavioral performance task (Vlaeyen et al., 1995a). A factor analysis revealed four non-orthogonal factors, to which following labels were assigned: harm, fear of (re)injury, importance of exercise, avoidance of activity (Vlaeyen et al., 1995b). Because of the relatively high intercorrelations among the subscales, the more favorable internal consistency of the TSK total score, and the good construct validity of the total score, the total score is preferable to the subscales. The TSK-total score has been shown to be associated with behavioral performance tests and self-reported disability (Crombez et al., 1999).

In sum, questionnaires for the assessment of pain-related fear are now available, although the validity of some of them needs to be explored further. For clinical purposes, these questionnaires seem to be appropriate as a first screening to identify patients who suffer excessive pain-related fear. Unfortunately, norm data are not yet available and thus there are no cut-off points indicating clinically relevant levels of fear avoidance. Moreover, the questionnaires do not tell us what the individual is exactly fearful of. To identify the idiosyncratic aspects of the fear, and the essential fear-provoking stimuli in a particular patient, new assessment methods will need to be developed.

12.5. Observational methods

The observational measure most frequently used in fear is the behavioral approach (or avoidance) test (BAT). A BAT is a behavioral measure in which a fear-eliciting stimulus is placed in a standardized environment. The patient is instructed to approach the stimulus and engage in progressively more bold interactions with it (Bellack and Hersen, 1988). The test is particularly useful in that it elicits specific thoughts, bodily sensations and other experiences that may complete the assessment procedure. Although BATs have been extensively used in fear and anxiety assessment, their application in the area of chronic pain has been scarce. A variant of the test has been described by Fordyce (1976), who called it an activity (in)tolerance test. To assess activity or exercise intolerance, patients are asked to perform the target exercise 'Until pain, weakness, or fatigue causes him or her to stop' (p. 170). Consequently, a BAT assessment might include movements for which the patient is fearful could be chosen as the target exercises. Since we could find no report of an observational method for evaluating pain-related fear, there appears to be a dire need for further work in this area.

12.6. Psychophysiological methods

Besides symptom-specific muscular reactivity, fear conditioning can also be demonstrated using the so-called startle probe. The startle response is a primitive defensive reflex that serves a protective function, avoiding organ injury and acting as a behavioral interruption that prepares the individual in dealing with possible threat. According to a number of animal and human experiments, the magnitude of the startle reflex is found to be related to the emotional valence of the foreground stimulus (Vrana et al., 1988; Lang, 1995). There is also evidence that the startle is potentiated when anxious subjects are anticipating a threatening stimulus (Grillon et al., 1991). In a recent experiment, Crombez et al. (1997) exposed healthy volunteers to different heat stimuli. The researchers observed an intensification of the startle reflex to a noise burst during the more threatening high intensity stimuli as compared to the low intensity stimuli. Likewise, it is hypothesed that startle responses may provide an psychophysiological index of the threat value of pain, movements or activities that are reported to be threatening in pain patients. Some evidence was found in a study in which high and low fearful chronic low back pain patients were given video-exposure with vigorous movements performed by a dummy patient. After the video-exposure, patients were also requested to actually perform the movements. While they were anticipating the performance, a number of noise bursts were delivered. The results showed a trend in which the high-fearful patients had larger amplitudes than the low fearful patients did (Beisiegel, 1997).

13. Clinical management of pain-related fear

What are the implications of the current findings for the treatment of musculoskeletal pain? Keeping in mind that a relatively small percentage of chronic back pain patients are responsible for 75–90% of the societal costs (Van Tulder et al., 1995), the early identification of patients at risk to become disabled might lead to more effective interventions, that in turn reduce disability, and associated costs (Linton, 1998). Pain-related fear, and fear of movement/(re)injury in particular, must be considered such a risk factor. Pain-related fear may be an essential aspect of a broader early assessment of psychosocial 'yellow flags' (Kendall et al., 1997). The FABQ, PASS and the TSK have the potential to identify a subgroup of back pain patients whose level of disability may be mainly determined by pain-related fear, and not by pain intensity or biomedical status. For this subgroup, an early cognitive-behavioral intervention might be warranted. According to the suggestions made by Turner (1996) and Von Korff (1996) for behavioral interventions in primary care, such an intervention could be designed in three steps: screening, education, and exposure. In fact, clinical routines that minimize fear avoidance may well be an effective method of prevention. However, since little work has been done to specifically examine the role of fear avoidance in prevention, this may be a top priority for future research. Successful early attempts at prevention after all appear to include aspects that may prevent the development of fear avoidance e.g. education, clear communication, reassurance and advice to maintain usual activities. A hope for the future is that unraveling the role of pain-related fear and avoidance in the development of chronic problems will provide clinical routines that enhance prevention.

In terms of screening, both the TSK and FABQ are relatively short questionnaires that are appropriate for use in a primary as well as secondary care setting. In case of elevated scores, it is worth inquiring about the essential stimuli: what is the patient actually afraid of? So far, there is a lack of standardized tools for identifying these stimuli. In addition to checklists of daily activities, the presentation of visual materials such as pictures of back-stressing activities and movements might be worthwhile. They might be helpful in the development of graded hierarchies, reflecting the full range of situations avoided by the patient, beginning with those that provoke only mild discomfort, and ending with activities or situations that are well beyond the patient's present abilities. Each item is then rated by the patient on a 0–100 scale according to the amount of fear it would cause (Vlaeyen and Crombez, 1999). In our experience abrupt changes in movements (e.g. suddenly being hit) or activities consisting of repetitive spinal compressions (riding a bicycle on a bumpy road) are frequently mentioned stimuli in chronic back pain patients who score high on the pain-related fear measures. These situations are feared because of beliefs about the causes of pain, such as ruptured or severely damaged nerves. ('if I lift heavy weights, the nerves in my back might be damaged'). Such a screening routine may also be supplemented by information about the precipitants (situational or internal) of the pain-related fear, and about the direct and indirect consequences. This screening might also include other areas of life stresses, as they might increase arousal levels and indirectly also fuel pain-related fear.

The second step consists of unambiguously educating the patient in a way that the patient views his pain as a common condition that can be self-managed, rather than as a serious disease or a condition that needs careful protection. Although cognitive-perceptual factors, such as catastrophizing in particular, are associated with pain-related fear, didactic lectures and rational argument may facilitate behavior change, but are not as effective as first-hand evidence. For a fearful patient, it is far more convincing to actually experience him/herself behaving differently than it is to be told that he/she is capable of behaving differently (Bandura, 1977). Graded exposure to the feared stimulus has proven to be the most effective treatment ingredient for individuals suffering from excessive fears and phobias (Davey, 1997). The reason is that it provides a unique way of challenging the credibility of the patients (maladaptive) appraisal and belief system.

Therefore, the third, and probably most essential step, consists of graded exposure to the situations the patients has identified as 'dangerous' or 'threatening'. Such a cognitive-behavioral approach always is introduced with a careful explanation of the fear-avoidance model (Fig. 2), using the patient's individual symptoms, beliefs and behaviors to illustrate how vicious circles maintain the pain problem. Subsequently, the most common approach would be to devise individually tailored practice tasks based on a graded hierarchy of fear-eliciting situations. Such a graded exposure is quite similar to the graded activity programs in that it gradually increases activity levels despite pain (Fordyce et al., 1982, 1986; Lindström et al., 1992), but is quite dissimilar in that it pays special attention to the idiosyncratic aspects of the pain-related fear stimuli. For example, if the patient fears the repetitive spinal compression produced by riding a bicycle on a bumpy road, then the graded exposure should include an activity that mimics that specific activity, and not just a stationary bicycle. Such an approach gives the individual an opportunity to correct the inaccurate predictions about the relationship between activities and harm. A preliminary study using a replicated single case cross-over experimental design in four patients with chronic low back pain who were offered a treatment outlined above showed promising results (Vlaeyen et al., 1999b). After a no-treatment baseline measurement period, the fearful patients were randomly assigned to one of two interventions. In intervention A, patients received the graded exposure in vivo first, followed by graded activity. In intervention B, the sequence of treatment modules was reversed. As predicted, improvements only occurred during the graded exposure in vivo, and not during the graded activity, irrespective of the treatment order. Analysis of the pre-post treatment differences also revealed that decreases in pain-related fear also concurred with decreases in pain catastrophizing and pain disability.

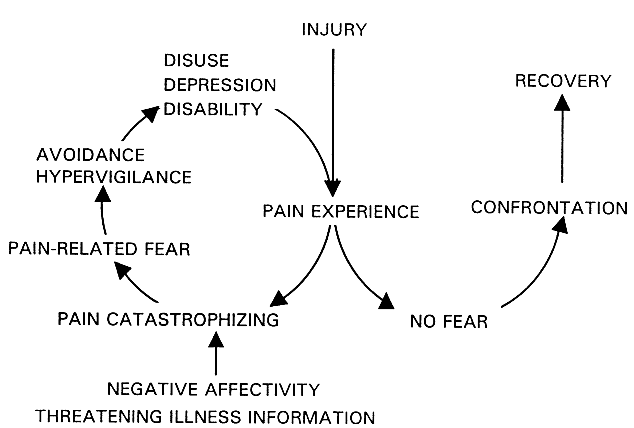

Fig. 2. The 'fear'-avoidance model. If pain, possibly caused by an injury, is interpreted as threatening (pain catastrophizing), pain-related fear evolves. This leads to avoidance behaviors, and hypervigilance to bodily sensations followed by disability, disuse and depression. The latter will maintain the pain experiences thereby fueling the vicious circle of increasing fear and avoidance. In non-catastrophizing patients, no pain-related fear and rapid confrontation with daily activities is likely to occur, leading to fast recovery. Pain catastrophizing is assumed to be also influenced by negative affectivity and threatening illness information.

Although such a cognitive-behavioral approach would appear highly applicable in most treatment settings, it has not been implemented and studied systematically. Randomized prospective studies including extended follow-up assessments and cost-effectiveness analyses demonstrating the impact of such a customized approach are likely to promising, and badly needed.

14. Conclusions

The idea that fear of pain and (re)injury may be more disabling than pain itself (Waddell, 1996, 1998; Crombez et al., 1999) refutes the early notion that the lowered ability to accomplish tasks of daily living in chronic pain patients is merely the consequence of pain severity. The accumulating research evidence seems to corroborate this. A large number of mainly cross-sectional studies have shown that pain-related fear is indeed one of the most potent predictors of observable physical performance and self-reported disability levels. There is also preliminary evidence that pain-related fear predicts new back pain episodes in pain-free people and that in chronic pain patients, it is associated with collateral non-specific physical complaints than the primary pain compliant. Possible mechanisms reviewed here are misinterpretations of bodily sensations, inaccurate predictions about pain, hypervigilance, physical deconditioning processes, and muscular reactivity. The evidence gathered in the last decennium also favors a cognitive-behavioral model first forwarded by Lethem et al. (1983) and later, in a refined version, put forward by Vlaeyen et al. (1995a).

There still are a number of unresolved issues, which merit future research attention. They concern the origins of pain-related fear, the role of illness information and feedback about diagnostic tests provided by medical specialists and therapists, the early identification of individuals with pain-related fear, the identification of the essential fear-stimuli, the relationship between pain-related fear and aspects of muscular disuse and reactivity, and finally, the development and evaluation of systematic treatments of patients with chronic pain who suffer from pain-related fear.

Pain-related fear and avoidance appears to be an essential feature of the development of a chronic problem for at least some patients. Indeed, this line of research may unlock the mysterious transition from acute to chronic pain. This in turn promises to provide a new foundation for the early identification of risk patients, prevention, assessment and treatment. The cognitive-behavioral conceptualization also not only contributes to the differential diagnosis of the heterogeneous group of patients with chronic musculoskeletal pain, but also constitutes possible explanations for the patients symptoms, and hence successful treatment suggestions. Yet, we just scratched the surface of this area so that the implications and conclusions we may draw are limited. Given the compelling evidence reached to date, however, fear-avoidance needs to be considered in clinical practice and given priority in research.

Acknowledgements

We are grateful to Geert Crombez, Gordon Waddell, Paul Watson, Chris Main, Madelon Peters, Arnoud Arntz, Anja van den Hout, Peter Heuts, Jeanine Verbunt, Piet Portegijs, Robert Wagenaar, Mario Geilen, Jeroen de Jong and the staff of the Department of Pain Rehabilitation of the Hoensbroeck Rehabilitation Center and for continuous inspiring discussions. Work related to this paper was, in part, supported by grant no. 904-65-090 of the Council for Medical and Health Research of the Netherlands (NWO-MW) to Johan W.S. Vlaeyen and by a grant of the Swedisch Fund for Working Life Research to Steven J. Linton.

References

Arendt-Nielsen L, Graven-Nielsen T, Svarrer H, Svensson P. The influence of low back pain on muscle activity and coordination during gait. Pain 1995;64:231–240.

Arntz A, Van Eck M, Heijmans M. Predictions of dental pain: the fear of any expected evil, is worse than the evil itself. Behav Res Ther 1990;28:29–34.

Arntz A, Dreesen L, De Jong P. The influence of anxiety on pain: attentional and attributional mediators. Pain 1994;56:307–314.

Asmundson GJG, Norton GR. Anxiety sensitivity in patients with physically unexplained chronic back pain: a preliminary report. Behav Res Ther 1995;33:771–777.

Asmundson GJG, Taylor S. Role of anxiety sensitivity in pain-related fear and avoidance. J Behav Med 1996;19:577–586.

Asmundson GJG, Norton GR, Allerdings MD. Fear and avoidance in dysfunctional chronic back pain patients. Pain 1997a;69:231–236.

Asmundson GJG, Kuperos JL, Norton GR. Do patients with chronic pain selectively attend to pain-related information? Preliminary evidence of the mediating role of fear. Pain 1997b;72:27–32.

Asmundson GJG, Norton GR, Allerdings MD, Norton PJ, Larsen DK. Posttraumatic stress disorder and work-related injury. J Anxiety Disord 1998;12:57–69.

Asmundson GJG, Norton PJ, Norton GR. Beyond pain: the role of fear and avoidance in chronicity. Clin Psychol Rev 1999;19:97–119.

Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psych Rev 1977;84:191–215.

Beecher HK. Measurement of subjective responses, New York: Oxford University Press, 1959.

Beisiegel E. De startle respons als maat voor kinesiofobie (The startle response as a measure of kinesiophobia), University of Maastricht, 1997, Unpublished thesis.

Bellack AS, Hersen M. Behavioral assessment, a practical handbook, New York: Pergamon Press, 1988.

Bergner M, Bobbit RA, Carter WB, Gibson BS. The sickness impact profile: Development and final revision of a health status measure. Med Care 1981;19:787–805.

Beurskens A, de Vet H, Köke A. Responsiveness of functional status in low back pain: a comparison of different instruments. Pain 1996;65:71–76.

Blanchard EB, Hickling EJ, Taylor AE, Loos WR, Forneris CA, Jaccard J. Who develops PTSD from motor vehicle accidents? Behav Res Ther 1996;34:1–10.

Bortz WM. The disuse syndrome. West J Med 1984;141:691–694.

Bouchard C, Shephard RJ, Stephens T, editors. Physical activity, fitness and health. Champaign, IL: Human kinetics Publishers, 1994.

Brady JP, Porter RW, Conrad DG, Mason JW. Avoidance behavior and the development of gastroduodenal ulcers. J Exp Anal Behav 1958;1:69–72.

Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and subchronic low back trouble. Spine 1995;20:722–728.

Bussman JBJ, van de Laar YM, Neleman MP, Stam HJ. Ambulatory accelerometry to quantify motor behaviour in patients after failed back surgery: a validation study. Pain 1998;74:153–161.

Cannon WB. Bodily changes in pain, hunger, fear and rage, New York and London: D. Appleton Company, 1915.

Crombez G, Vervaet L, Lysens R, Eelen P, Baeyens F. Do pain expectancies cause pain in chronic low back patients? A clinical investigation. Behav Res Ther 1996;34:9.

Crombez G, Baeyens F, Vansteenwegen D, Eelen P. Startle intensification by painful heat stimuli. Eur J Pain 1997;1:87–94.

Crombez G, Eccleston C, Baeyens F, Eelen P. When somatic information threatens, catastrophic thinking enhances attentional interference. Pain 1998a;75:187–198.

Crombez G, Vervaet L, Lysens R, Baeyens F, Eelen P. Avoidance and confrontation of painful, back straining movements in chronic back pain patients. Behav Modification 1998b;22:62–77.

Crombez G, Vlaeyen JWS, Heuts PHTG, Lysens R. Fear of pain is more disabling than pain itself. Evidence on the role of pain-related fear in chronic back pain disability. Pain 1999;80:329–340.

Davey GCL. Phobias. A handbook of theory, research and treatment, Chichester: Wiley, 1997.

DeGood DE, Shutty MS. Assessment of pain beliefs, coping and self-efficacy. In: Turk DC, Melzack R, editors. Handbook of pain assesment, New York: Guilford, 1992.

Ditto PH, Jemmott JB, Darley JM. Appraising the threat of illness: a mental representation approach. Health Psychol 1988;7:183–200.

Dixon JJ, De Monchaux C, Sandler J. Patterns of anxiety: the phobias. Br J Med Psychol 1957;30:34–40.

Eccleston C, Crombez G. Pain demands attention: a cognitive-affective model of the interruptive function of pain. Psychol Bull 1999;125:356–366.

Eccleston C, Crombez G, Aldrich S, Stannard C. Attention and somatic awareness in chronic pain. Pain 1997;72:209–215.

Eysenck MW. Anxiety: the cognitive perspective, Hillsdale: Lawrence Erlbaum Associates, 1992.

Eysenck MW. Anxiety and cognition. A unified theory, Hove: Psychology Press, 1997.

Flor H, Turk DC. Psychophysiology of chronic pain: Do chronic pain patients exhibit symptom-specific psychophysiological responses. Psychol Bull 1989;105:215–259.

Flor H, Birbaumer N, Schugens MM, Lutzenberger W. Symptom-specific psychophysiological responses in chronic pain patients. Psychophysiology 1992;29:452–460.

Fordyce WE. Behavioral methods for chronic pain and illness, St. Louis: Mosby, 1976.

Fordyce WE, Shelton JL, Dundore DE. The modification of avoidance learning in pain behaviors. J Behav Med 1982;5:405–414.

Fordyce WE, Brockway J, Bergman J, Spengler D. A control group comparison of behavioral versus traditional management methods in acute low back pain. J Behav Med 1986;2:127–140.

Gatchel RJ, Turk DC. Psychological approaches to pain management. A practitioner's handbook, New York, London: Guildford Press, 1996.

Grillon C, Ameli R, Woods SW, Merikangas K, Davis M. Fear-potentiated startle in humans: effects of anticipatory anxiety on the acoustic blink reflex. Psychophysiology 1991;28:588–595.

Hadjistavropoulos HD, Craig KD, Hadjistavropoulos T. Cognitive and behavioral responses to illness information: the role of health anxiety. Behav Res Ther 1998;36:149–164.

Haig AJ, Weisman G, Haugh LD, Pope M, Grobler LJ. Prospective evidence for change in paraspinal muscle activity after herniated nucleus pulposus. Spine 1993;18:926–930.

Hill HE, Flanary HG, Kornetsky CH, Wikler A. Effects of anxiety and morphine on discrimination of intensities of painful stimuli. J Clin Invest 1952;31:473–480.

Jensen MP, Karoly P. Pain-specific beliefs, perceived symptom severity, and adjustment to chronic pain. Clin J. Pain 1992a;8:123–130.

Jensen MP, Karoly P. Selfreport scales and procedures for assessing pain in adults. In: Turk DC, Melzack R, editors. Handbook of pain assessment, New York: The Guilford Press, 1992b. pp. 135–151.

Jensen MP, Karoly P, Huger R. The development and preliminary validation of an instrument to assess patients'attitudes toward pain. J Psychosom Res 1987;31:393–400.

Jensen MP, Turner JA, Romano JM. Self-efficacy and outcome-expectancies: relationship to chronic pain coping strategies and adjustment. Pain 1991;44:263–269.

Jensen MP, Turner JA, Romano JM, Lawler BK. Relationship of pain-specific beliefs to chronic pain adjustment. Pain 1994;57:301–309.

Kanfer FH, Phillips JS. Learning foundations of behaviour therapy, New York: Wiley, 1970.

Kazdin AE. Behavior modification in applied settings, revised ed. Homewood Il: Dorsey Press, 1980.

Keefe FJ, Hill RW. An objective approach to quantifying pain behavior and gait patterns in LBP patients. Pain 1985;21:153–161.

Kendall NAS, Linton SJ, Main CJ. Guide to assessing psychosocial Yellow Flags in acute low back pain: Risk factors for long-term disability and work loss. Accident rehabilitation and Compensation Insurance Corporation of New Zealand and the National Health Committee, New Zealand.

Kerns RD, Turk DC, Rudy TE. The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). Pain 1985;23:345–356.

Klenerman L, Slade PD, Stanley IM, Pennie B, Reilly JP, Atkinson LE, Troup JDG, Rose MJ. The prediction of chronicity in patients with an acute attack of low back pain in a general practice setting. Spine 1995;4:478–484.

Koelman TW, Kwakkel G, Wagenaar RC. Het fysiotherapeutisch pijnmanagement: lage rugklachten als voorbeeld. (Physiotherapeutic management: low back pain as an example). In: Mattie, editor. Pijninformatorium, Houten: Bohn Stafleu Van Loghum, 1996.

Kori SH, Miller RP, Todd DD. Kinisophobia: A new view of chronic pain behavior. Pain Management 1990;Jan/F;:35–43.

Kottke FJ. The effects of limitation of activity upon the human body. J Am Med Assoc 1996;196:117–122.

Lang PJ. The emotion probe. Studies of motivation and attention. Am Psychologist 1995;50:372–385.

Larsen DK, Taylor S, Asmundson GJG. Exploratory factor analysis of the Pain Anxiety Symptoms Scale in patients with chronic pain complaints. Pain 1997;69:27–34.

Lee JH, Ooi Y, Nakamura K. Measurement of muscle strenght of the trunk and the lower extremities in subjects with history of low back pain. Spine 1995;20:1994–1996.

Lethem J, Slade PD, Troup JDG, Bentley G. Outline of a fear-avoidance model of exaggerated pain perceptions. Behav Res Ther 1983;21:401–408.

Lindström I, Öhlund C, Eek C, Wallin L, Peterson L, Fordyce WE, Nachemson AL. The effect of graded activity on patients with subacute low back pain: a randomized prospective clinical study with an operant conditioning behavioral approach. Phys Ther 1992;72:279–290.

Linton SJ. The socioeconomic impact of chronic back pain: is anyone benefiting? Pain 1998;75:163–168.

Linton SJ, Buer N. Working despite pain: factors associated with work attendance versus dysfunction. Int J Behav Med 1995;2(3):252–262.

Linton SJ, Halldén K. In: Jensen TS, Turner JA, Wiesenfeld-Hallin Z, editors. Proceedings of the 8th World Congress on Pain: progress in pain research and management. vol. 8, Seattle: IASP Press, 1997. pp. 527–536.

Linton SJ, Halldén K. Can we screen for problematic back pain? A screening questionnaire for predicting outcome in acute and subacute back pain. Clin J Pain 1998;14(3):209–215.

Linton SJ, Melin L, Gotestam KG. Behavioral analysis of chronic pain and its management. Progress in behavior modification. vol. 18, New York: Academic Press, 1984.

Linton SJ, Buer N, Vlaeyen JWS, Hellsing A-L. Are fear-avoidance beliefs related to a the inception of an episode of back pain? A prospective study. Psychol Health 1999 (in press).

Main CJ, Watson PJ. Guarded movements: development of chronicity. J Musculoskel Pain 1996;4:163–170.

Mannion AF, Dolan P, Adam GG, Adams MA, Cooper RG. Can maximal back muscle strenght be predicted from submaximal efforts? J Back Musculoskel Rehabil 1997;9:49–51.

McCracken LM. Attention to pain in persons with chronic pain: a behavioral approach. Behav Ther 1997;28:271–284.

McCracken LM, Gross RT. Does anxiety affect coping with pain? Clin J Pain 1993;9:253–259.

McCracken LM, Zayfert C, Gross RT. The pain anxiety symptoms scale: development and validation of a scale to measure fear of pain. Pain 1992;50:63–67.

McCracken LM, Gross RT, Sorg PJ, Edmands TA. Prediction of pain in patients with chronic low back pain: effects of inaccurate prediction and pain-related anxiety. Behav Res Ther 1993;31:647–652.

McCracken LM, Gross RT, Aikens J, Carnkike Jr CLM. The assessment of anxiety and fear in persons with chronic pain: a comparison of instruments. Behav Res Ther 1996;34:927–933.

McCracken LM, Faber SD, Janeck AS. Pain-related anxiety predicts non-specific physical complaints in persons with chronic pain. Behav Res Ther 1998;36:621–630.

McQuade KJ, Turner JA, Buchner DM. Physical fitness and chronic low back pain. Clin Orthop Rel Res 1988;233:198–204.

Menard MR, Cooke C, Locke SR, Beach GN, Butler TB. Pattern of performance in workers with low back pain during a comprehensive motor performance evaluation. Spine 1994;2:1359–1366.

Morgan W. Physical activity and mental health, London: Taylor and Francis, 1997.

O'Connor AM. Factors related to the early phase of rehabilitation following aortocoronary bypass surgery. Res Nursing Health 1983;6:107–116.

Pearce J, Morley S. An experimental investigation of the construct validity of the McGill Pain Questionnaire. Pain 1989;39:115–121.

Peters ML, Vlaeyen JWS, van Drunen C. Hypervigilance for innoxious somatosensory stimuli in fibromyalgia patients. 1999 (unpublished manuscript).

Philips HC. Avoidance behaviour and its role in sustaining chronic pain. Behav Res Ther 1987;25:273–279.

Philips HC, Jahanshahi M. The components of pain behavior report. Behav Res Ther 1986;24:117–125.

Pollard CA. Preliminary validity study of Pain Disability Index. Percept Motor Skills 1984;59:974.

Rachlin H. Behaviorism in everyday life, Englewood Cliffs, HJ: Prentice-Hall, 1980.

Riley JF, Ahern DK, Follick MJ. Chronic pain and functional impairment: assessing beliefs about their relationship. Arch Phys Med Rehabil 1988;69:579–582.

Reiss S. Expectancy theory of fear, anxiety, and panic. Clin Psych Rev 1991;11:141–153.

Reiss S, McNally RJ. The expectancy model of fear. In: Reiss S, Bootzin RR, editors. Theoretical issues in behavior therapy, New York: Academic Press, 1985. pp. 107–121.

Reitsma B, Meijler WJ. Pain and patienthood. Clin J Pain 1997;13:9–21.

Roland M, Morris R. A study of the natural history of back pain. Part I. Development of a reliable and sensitive measure of disability in low back pain. Spine 1983;8:141–144.

Romano JM, Turner JA. Chronic pain and depression. Does the evidence support a relationship? Psychol Bull 1985;97:311–318.

Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. Pain 1983;17:33–44.

Rutherford OM, Jones DA, Newham DJ. Clinical and experimental application of the percutaneaous twich superimposition technique for the study of human muscle activation. J Neurol Neurosurg Psychiatry 1986;49:1288–1291.

Shepard JF. Affective phenomena. Psychol Bull 1916;13:202–205.

Skevington SM. Psychology of pain, Chichester: Wiley, 1995.

Spear FG. Pain in psychiatric patients. J Psychosomatic Res 1967;11:187–193.

Sternbach RA. Pain patients: traits and treatment, New York: Academic Press, 1974.

Sullivan MJL, Bishop SR, Pivik J. The pain catastrophizing scale: development and validation. Psychol Assess 1995;7:524–532.

Tait RC, Chibnall JT. Development of a brief version of the survey of pain attitudes. Pain 1997;70:229–236.

Triano JJ, Schultz AB. Correlation of objective measures of trunk motion and muscle function with low back disability ratings. Spine 1987;12:561–565.

Turk DC, Holzman AD. Chronic pain: interfaces among physical, psychological and social parameters. In: Holzman AD, Turk DC, editors. Pain Management. A handbook of psychological treatment approaches, New York: Pergamon, 1986.

Turk DC, Meichenbaum D, Genest M. Pain and behavioral medicine. A cognitive-behavioral perspective, New York: Guilford Press, 1983.

Turner JA. Educational and behavioral interventions for back pain in primary care. Spine 1996;21:2851–2858.

Turner JA, LeResche L, Von Korff M, Ehrlich K. Back pain in primary care. Patient characteristics, content of initial visit, and short-term outcomes. Spine 1998;23:463–469.

Van Tulder MW, Koes BW, Bouter LM. A cost-of-illness study of back pain in the Netherlands. Pain 1995;62:233–240.

Verbunt J. Van der Heijden G, Vlaeyen JWS, Heuts PHGT, Pons C, Knottnerus A. The disuse syndrome: facts and fiction in chronic musculoskeletal pain. 1999 (unpublished manuscript).

Vlaeyen JWS, Crombez G. Fear of movement/(re)injury, avoidance and pain disability in chronic low back pain patients. Manual Ther 1999 (in press).

Vlaeyen JWS, Geurts SM, Kole-Snijders AMJ, Schuerman JA, Groenman NH, van Eek H. What do chronic pain patients think of their pain? Towards a pain cognition questionnaire. Br J Clin Psych 1990;29:383–394.

Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995a;62:363–372.

Vlaeyen JWS, Kole-Snijders AMJ, Rotteveel A, Ruesink R, Heuts PHTG. The role of fear of movement/(re)injury in pain disability. J Occup Rehabil 1995b;5:235–252.

Vlaeyen JWS, Seelen HAM, Peters M, De Jong P, Aretz E, Beisiegel E, Weber W. Fear of movement/(re)injury and muscular reactivity in chronic low back pain patients: an experimental investigation. Pain 1999a;82:297–304.

Vlaeyen JWS, de Jong J, Geilen M, Heuts PHTG, Van Breukelen G. Graded exposure in vivo in the treatment of pain-related fear: a replicated single-case experimental design in four patients with chronic low back pain. Behav Res Ther 1999b (accepted).

Von Korff M. In: Campbell J, editor. A research program for primary care pain management: back pain, Seattle: IASP Press, 1996. pp. 457–465 Pain 1996 – an updated review.

Vrana SR, Spence EL, Lang PJ. The startle probe response: A new measure of emotion? J Abn Psychol 1988;97:487–491.

Waddell G. Keynote address for primary care forum. Low back pain: a twentieth century health care enigma. Spine 1996;21:2820–2825.

Waddell G. The back pain revolution, Edinbugh: Churchill Livingstone, 1998.

Waddell G, Newton M, Henderson I, Somerville D, Main C. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993;52:157–168.

Wagenmakers AJM, Coakley JH, Edwards RHT. The metabolic consequences of reduced habitual activities in patients with muscle pain and disease. Ergonomics 1988;31:1519–1527.

Wall PD. On the relation of injury to pain. Pain 1979;6:253–264.

Warwick HM, Salkovskis PM. Hypochondriasis. Behav Res Ther 1990;28:105–117.

Watson D, Pennebaker JW. Health complaints, stress, and distress: Exploring the central role of negative affect. Psychol Rev 1989;96:234–254.

Watson P, Booker CK, Main CJ, Chen ACN. Surface electromyography in the identification of chronic low back pain patients: the development of the flexion relaxation ratio. Clin Biomech 1997;12:165–171.

Westerterp KR, Wouters L, van Marken Lichtenbelt, WD. The Maastricht protocol for the measurement of body composition and energy expenditure with labeled water. Obes Res 1995;3(Suppl 1):49–57.