CLAUSTROPHOBIC FEAR AND THE MAGNETIC RESONANCE IMAGING

PROCEDURE

by

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Abstract

The study was designed to assess the characteristics of fear induced by the Magnetic Resonance Imaging Procedure (MRI). The responses of two groups are compared: 1) patients who are completely encapsulated within the MRI machine, and 2) patients who are scanned only below the hip and are therefore not enclosed within the MRI machine. Fear is a multifaceted phenomenon composed of three components: 1) cognitive, 2) behavioral, and 3) physiological. Within this study three the components were assessed to provide a more detailed description of MRI-related claustrophobic fear. Knowing the specific factors which influence patient anxiety will help determine future treatment of MRI-related distress. Since many patients endure the scan while experiencing moderate to severe anxiety the extent to which anxiety influences the diagnostic value of the examination (i.e. clarity of scan image) was evaluated. There was a significant correlation between Beck Anxiety Inventory scores, a measure of subjective distress and physiological symptoms accompanying stress, and the level of motion artifact in the scan picture. Thus, anxiety contributes to motion artifact which degrades the MRI scan image. The poorer quality scan may reduce the diagnostic value of the scan making it necessary for several repetitions which increase hospital time, expense, and patient discomfort. Regression analyses were used to assess the contribution of several variables (e.g. anxiety sensitivity, fears of suffocation and restriction, fearful thoughts about the experience) to provide a predictive profile of those patients who may experience the most distress undergoing the procedure. Two variables were predictive of anxiety during the MRI scan - scores on the Claustrophobia Questionnaire and endorsement of fearful thoughts about the procedure. Patients who were more likely to experience distress in the scan scored higher on these measures indicating their primary concerns were about the claustrophobic aspects of MRI situation and the thoughts they have about undergoing the experience. The thoughts most highly correlated were those related to suffocation and restriction. Eleven out of eighty eighty patients experienced a panic attack during the scan, of which three resulted in scan

termination. The patients who experienced panic attacks scored on average 30 points higher on the Claustrophobia Questionnaire at pre-scan, thus, this measure has predictive validity as to which patients may experience the most amount of MRI-related fear. There was no difference between the two groups on position of entry into the MRI machine.

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Introduction

Undergoing Magnetic Resonance Imaging (MRI) procedures has led to severe claustrophobic fear responses in some individuals (Friday & Kubbel, 1990; Katz, Wilson, & Frazer, 1994). This technique is highly sophisticated allowing for superior diagnostic capabilities in assessing brain and body abnormalities unparalleled by any other modern technique. With any newly emerging technology the psychological impact of undergoing such procedures is often unknown. However, within the last 10 years evidence has accumulated suggesting that this particular procedure produces moderate to severe claustrophobic fear in 5-10% (some hospitals report up to 30%) (Kilborne & Labbe, 1990; General Electric MRI Production, personal communication) of the patients and leads to termination of the scan or non-attendance by at least 1% of the patients (Leonard Tong, personal communication) with some MRI manufacturers reporting up to 20% (Klonoff, Janata, & Kaufman, 1986). Case reports have provided insight into the problem, but single case studies are anecdotal and causal inferences cannot be drawn about the fear-inducing aspects of the procedure. Of the empirical studies to date most have been plagued by design problems (e.g. retrospective reports, lack of control groups, and statistical misapplication).

Since the fear generated by the MRI procedure is claustrophobic in nature this paper will review the current findings on Claustrophobia and discuss an assessment tool developed to measure this construct. A literature review of studies investigating the claustrophobic fear produced by the MRI examination will follow. Finally, an outline of the experimental design, hypotheses, measure selection, results, and discussion will conclude this thesis.

Claustrophobia

Claustrophobia has traditionally been defined as a fear of enclosed spaces. Recently, however, Rachman (1990) reconceptualized claustrophobia as a fear of what could happen to a person in an enclosed space rather than as a fear of the enclosed space per se. On this account, a claustrophobic person is not afraid of the elevator but what they imagine could

happen in the elevator, such as not being able to breate or feeling trapped and unable to escape. Certainly, one can envision negative events that could make it difficult to remain in an enclosed space for an extended period. For instance, if an elevator door were to jam the person would be trapped and, at least temporarily, unable to escape. Or, if there were a power outage, an elevator may come to an abrupt halt, the lights would probably go out, and air circulation could be limited; without adequate ventilation one could experience some difficulty breathing, and might eventually suffocate. The fear experienced by a claustrophobic person is in large part based on potential negative consequences that in an extreme case would reasonably frighten anyone; however, for the claustrophobic, the extent of these fears is disproportionate and unrealistic given the circumstances. A typical response to these fears, like many others, is avoidance. So not surprisingly, depending on the severity of their discomfort, claustrophobic individuals may often go to great lengths to avoid situations in which they feel restricted and/or unable to breath freely. For example, Rachman (1990) reported that some claustrophobic people will "walk up 10 or more flights of steps rather than use the elevator" or take highly circuitous routes to avoid driving through a tunnel.

Claustrophobia has been found to be the most common simple phobia (Costello, 1982) with estimates ranging from 5%-13% of women in the general population reporting it as an intense fear (Agras et al., 1969; Kirkpatrick, 1984). It is most frequently observed in young women between the age of 18 to 25 years. The most common claustrophobic situations are elevators, tunnels, and other enclosed spaces (Rachman, 1990). However, several recent reports in medical journals describe moderate to severe claustrophobia in some individuals apparently induced by the Magnetic Resonance Imaging Procedure (Kilborne & Labbe, 1990). This observation may have consequences for the investigation of claustrophobia which have been little studied for a number of reasons. For one, claustrophobia is a fear which does not often present itself in the clinic because patients find ways of coping (e.g. taking the stairs as opposed to the elevator) (Booth, 1990). In other words, claustrophobic individuals seem to have highly developed avoidance strategies. Furthermore, many people do not realize that claustrophobia can be treated and/or may believe their problem is not serious enough to

warrant treatment from psychological services (Ost, Jerremalm, & Johannson, 1982). Thus, in part due to the lack of pressure to provide treatment there has been relatively little research dedicated to investigating claustrophobia.

Etiology of Claustrophobia

The most common explanation for claustrophobia is conditioning (Rachman, Booth, & Whittal, 1988). That is, it is proposed that an event which is paired with an uncomfortable experience leads to fear of that event. For example, a claustrophobic individual may have been trapped in a closet playing 'hide and seek' as a child and subsequently developed a fear of enclosed spaces. Other proposed pathways to fear are through the provision of information or vicarious acquisition; however, conditioning may play a greater role in claustrophobia. It should be noted that it is difficult to accurately assess the etiology of claustrophobia since most accounts are retrospective and patient recall of historical events is often biased and incomplete; nevertheless, some data may provide insight. Ost, Jansson, & Jerremalm (1982) reported that approximately two-thirds of their claustrophobic sample recalled conditioning events which they believed led to their fear. Rachman (1990) refers to a study by Ploeger who assessed the fears developed by 10 miners after a 14 day entrapment underground. The event was acute and traumatic; 6 out of 21 miners suffocated during the incident. Nine of the ten miners who participated in the study developed marked fear of enclosed spaces indicating strong evidence for conditioning. Other ways of acquiring claustrophobia may be indirect, through vicarious learning or information. For example, Rachman also discusses a fire in an underground subway station which led to massive panic and hysteria, as well as the death of 31 people. After the broadcast of these events to the local community there was an increase in reports of claustrophobia in the media. The acquisition may have been vicarious, through seeing the distress of the travelers on television, or informational, reading about the details in the newspaper.

There also have been reports of the development of claustrophobia after undergoing the new medical procedure of Magnetic Resonance Imaging (MRI) (Katz, Wilson, & Frazer,

1994). More detail about the examination is presented in subsequent sections; however, briefly, the patient lies on a table encapsulated in a very narrow and restrictive bore. Interestingly, there have been case reports of patients developing claustrophobic fear after undergoing the MRI procedure when prior to the scan they indicated they were not uncomfortable in enclosed spaces. A discussion of the MRI-related claustrophobic occurrences will be found in the section titled "Claustrophobia and the Magnetic Resonance Imaging Procedure". The development of claustrophobia after MRI scanning may offer us a unique opportunity to investigate the emergence of a fear directly rather than relying on retrospective reports.

Treatment of Claustrophobia

Rachman and Levitt (1988) found that claustrophobic subjects frequently endorsed the thoughts "I will suffocate" and "I will be trapped" when entering a small experimental chamber. Even though subjects were given information about the safety of the chamber (e.g. reassurance that there is enough oxygen, the chamber is not airtight, and the provision of light) this did little to reduce their claustrophobic fear.

Booth and Rachman (1992) showed that claustrophobia can be reduced by direct exposure to enclosed spaces, cognitive modification methods, and some improvement was found using interoceptive techniques (exposing subjects to sensations of anxiety). The widest range of reduction was found using exposure therapy. Cognitive therapy showed specific declines in reported fear and panic. Shafran et al. (1993) reanalyzed the Booth-Rachman data and discovered that subjects experienced a large reduction in their claustrophobic fear when therapy reduced the thoughts "I will suffocate" and "I will be trapped".

Ost, Johansson, and Jerremalm (1982) used exposure therapy and applied relaxation methods. The two treatments yielded significant reductions in claustrophobia when compared to a waitlist control group. It is noteworthy that subjects who experienced more behavioral avoidance due to their fear benefited most from the exposure therapy and those with greater physiological disturbance received more benefit from the applied relaxation methods. The

authors discuss how treatment consonance (i.e. when the specifics of the patient's problem are matched to the treatment) may explain this pattern of results.

Treatment of MRI-induced Claustrophobic Fear

Although systematic desensitization for MRI-induced claustrophobia was reported for a single case (Klonoff & Kaufman, 1986), I can find only one group treatment study. Quirk, Letendre, Ciottone, and Lingley (1989) randomly assigned 50 patients scheduled to undergo an MRI scan to one of three treatment conditions: 1) information, 2) information and counseling, and 3) information and relaxation exercises. In the information condition patients were shown a film produced by the MRI manufacturer on the structure and function of the machine, and also were provided with additional but unspecified information. In the counseling+information condition the patients were shown the same film (without additional information) and were also involved in "a discussion of relaxation strategies (e.g. imaginative visualization, and breathing relaxation techniques)", and had an opportunity to ask questions. In the third intervention condition, relaxation+information, the patient was shown the informational videotape and listened to a "relaxation audiotape". During the tape the subject was encouraged to "conceive of each exhalation as cathartic process" to relieve tension and asked to create a "visual image of a stroll through a flower garden". Carefully reading the description of these groups, there is no clean control group for comparison: each group got information, but there was no group which received only information. The information group was the most likely to have served as a control but was contaminated because they were provided with additional unspecified information which the other groups did not get. Thus, it is difficult to tease out the effects of what this additional information provided. The counseling and relaxation interventions were not pure: both groups were given relaxation techniques in some form, one verbally from the experimenter with less time and no practice, the other auditorily via tape and with some practice. The study was also plagued with statistical misapplication. The authors conducted 63 paired t-tests on the items of the STAI which may have given an inflated rate of statistical significance. Furthermore, there was no mention of

whether the data met the assumptions required for repeated measures analysis of variance. Given there were unequal subjects in the groups it is very likely there were several violations (e.g. multilevel sphericity, homogeneity of covariance, and homogeneity of variance for the between and within factors). The results indicated that overall anxiety, assessed by the state-portion of the STAI, increased for the information group pre- to post-MRI (pre- and post-examination means for groups 1 = 37.5, 46.1; 2 = 36.9,40.7; 3 = 43.1,39.3 - only group 1 means were significantly different). This finding does not fit with pre-existing data: a decline in anxiety would be expected since only 10-15% in other studies show increases of anxiety while the majority habituate exhibiting a reduction in anxiety after they have been exposed to the machine (the subjects were not preselected claustrophobics so they should fit this pattern). There were no significant changes in anxiety for the counseling and relaxation groups although there was a trend towards reduction for the information and relaxation group. The authors assert that "psychologic preparation that includes relaxation strategies is more effective than provision of information alone"; however, this bold statement is not supported by their data. Thus, the treatment of claustrophobic fear related to the MRI procedure has not been adequately investigated. Until we know the specific characteristics of the fear produced by the MRI examination it will be difficult to provide adequate and appropriate treatment.

<u>Validation of the two-factor model of Claustrophobia</u>

A number of studies support the view that the two primary elements in claustrophobia are a *fear of suffocation* and a *fear of restriction* (Booth & Rachman, 1992, Rachman, Levitt, Lopatka, 1987, Rachman, Levitt, Lopatka, 1988, Shafran, Booth, & Rachman, 1993; Rachman & Taylor, 1993). Rachman, Levitt, and Lopatka (1987) exposed subjects with panic disorder (PD) and subjects with claustrophobia to their respective fear-evoking stimuli. Panic attacks were precipitated in both groups. Compared to panics reported by PD patients where fear of losing control seems to play a very prominent role, those reported by claustrophobics were more likely to be characterized by fear of suffocation and bodily sensations such as

shortness of breath. Thus, fear of suffocation was not simply a symptom of panic attacks in general but rather was linked specifically to fear of enclosed spaces (claustrophobia).

Booth and Rachman (1992) also found that many of the claustrophobics frequently endorsed the thoughts "I will suffocate" when they entered a small chamber as part of a behavioral approach test. Another thought which was frequently cited was "I will be trapped". Shafran, Booth, and Rachman (1993) noted that thoughts of suffocation and restriction were prominent in claustrophobics, who often experienced panic attacks when these thoughts arose. Furthermore, Booth and Rachman observed an immediate and dramatic reduction in claustrophobic fear when therapy reduced the thoughts "I will suffocate" and "I will be trapped".

Rachman and Taylor (1993) used a multi-assessment approach including a self-report questionnaire, behavioral exposure tasks, and a structured interview to further investigate fears of suffocation and restriction in claustrophobia. The self-report questionnaire (for claustrophobia) included items that assessed fear of enclosed spaces and other situations that impose restriction or impede one's breathing. Behavioral exposure tasks were designed to induce fears of suffocation and/or restriction (e.g. entering a small closet, breathing through a narrow straw, wearing a gas mask, lying in a bunkbed, and wearing a canvas bag over one's torso). The closet is a typical claustrophobic stimulus expected to evoke fears of suffocation and restriction. The straw, and to a lesser extent, the mask were presumed to measure suffocation fear. The bag, and to lesser extent, the bunkbed were considered to be measures of restriction fear. Subjects were asked to rate their fear and their feeling of safety on 0-100 point scales (where 0 = no fear, not safe and 100 = terrifying fear, totally safe, respectively). The brief interview assessed subjects' level of anxiety in claustrophobic situations, when their air supply was threatened and their movements were restricted. Subjects also were asked to recall instances where they had experienced claustrophobic fears. Results of all three methods of assessment supported the hypothesis that fear of suffocation and fear of restriction are the two primary factors contributing to claustrophobia. Factor analyses indicated that these factors accounted for 36% (questionnaire) to 58% (behavioral exposure tests) of the

variance. These factors were not independent showing a correlation of 0.52 on the questionnaire, and 0.56 on the behavioral exposure tests. Results from the interview indicated that those subjects who regarded themselves as claustrophobic scored higher on both the suffocation and restriction scales than those who were not self-identified claustrophobics. Furthermore, for the claustrophobics the fears of suffocation and restriction tended to co-occur, whereas for the nonclaustrophobics the occurrence of restriction and suffocation was independent. Administration by McIsaac & Rachman (in preparation) of the self-report claustrophobia questionnaire to an additional group of university students (n=210) replicated all aspects of the original study. The two-factor solution accounted for 43.7% of the variance, achieving perfect simple structure (i.e. no complex or hyperplane items). In other words, each item correlated with only one factor and there were no items which did not load on any factor. The factors were correlated 0.57 (McIsaac & Rachman, in preparation).

Thus, substantial evidence supports the existence of two underlying fears in claustrophobia, namely, suffocation and restriction, and a measurement instrument has been developed to assess those fears.

Claustrophobia and the Magnetic Resonance Imaging Procedure

The most common situations which evoke claustrophobic fear are elevators, tunnels, and other enclosed spaces (Rachman, 1990). However, there are several recent reports on the claustrophobic effects of the MRI procedure. MRI is a body and brain imaging technique with superior resolution qualities over other existing methods such as computer tomography (CT) or positron emission tomography (PET). Because the MRI yields greater soft tissue contrasts it is often the diagnostic test of choice (over CT which is a shorter test but does not produce as fine-grained resolution or PET which uses radiation and is used for dynamic brain functioning rather than its spatial resolution capabilities which are poor) (Brand, 1994).

The MR imaging procedure often takes up to one hour and requires the patient to be completely immobilized in a small cylinder. Immobilization is achieved by having the patient lie in a narrow bed with a water tube strapped to the head and the head strapped to the

scanning bed. The patient is then put inside the long narrow tube of the MRI machine which is referred to as the magnetic bore. The magnetic bore is extremely narrow; the body coil is approximately 100cm and the head coil 30cm, with a length of 33cm. Thus, the head is completely encapsulated leaving about one inch from the inner surface of the head coil to the head for most individuals (Klonoff, Janata, & Kaufman, 1986). For head and neck scans the entire body is entered into the bore. The noise from the rotation of the magnetic coils is almost deafening (e.g. similar to a jack-hammer) (Quirk, Letendre, Ciottone, Lingley, 1989; McIsaac, 1994, personal experience). The restrictive aspects are obvious given the procedure but why people might be afraid of suffocating is less clear. The cylinder is open on both ends and sufficient air is available. Many individuals have claimed they were afraid the machine would close down on them, blocking their air supply (Personal observation, UBC and VH MRI sites, 1994). Thus, while the restrictive aspects stem from a physical reality (i.e. strapped in bed and narrow chamber), the suffocation appears to be a somewhat catastrophic misinterpretation of how the machine functions.

Case-Reports

Klonoff et al. (1986) reported on a patient who was unable to complete the MR scan due to claustrophobia. Fishbain and colleagues (1988) also described two patients who had no initial symptoms of claustrophobia, or other anxiety-related problems, but developed claustrophobia after the MR procedure. Both individuals were chronic pain patients who said they were no longer able to tolerate enclosed spaces, such as elevators and automobiles after the MRI procedure. To my knowledge, this is the first reported instance of the development of claustrophobia by a medical procedure. Brand (1994) likewise discussed a patient who exhibited an acute claustrophobic reaction where none had previously existed prior to MR scanning. These reports are noteworthy in that the individuals had no previous history of claustrophobia. The iatrogenic effects of the MR procedure may make this a rare opportunity to investigate the development of a phobia.

Empirical Studies

Increased awareness of the problems evoked by MRI prompted empirical studies assessing the factors producing MRI-anxiety. An estimated 5 to 10% of patients undergoing magnetic resonance imaging scans experience claustrophobic reactions during the procedure (Kilborn & Labbe, 1990; Friday & Kubel, 1990). Kilborne and Labbe (1990) investigated the occurrence of MRI claustrophobic-related distress, using 108 subjects, who had never undergone an MRI scan. They found that 7 of the 108 subjects (6.48%) stopped the scan due to claustrophobic fear. Scores on the Fear Survey Schedule from 62 subjects indicated that 6 subjects (9.68%) reported an increase in fear when in enclosed spaces at one-month follow-up. While pain also played an important role in scan termination it did not contribute to the development of claustrophobic fear after the scan. For those who stopped the scan, postscan anxiety, as measured by the State-portion of the State Trait Anxiety Scale (STAI) (Spielberger, 1983), was a better predictor of claustrophobic fear at one-month follow-up than was prescan anxiety. In those who experienced anxiety but did not stop the scan, pre- and postscan fear were positively correlated with claustrophobic fear at one-month follow-up. However, most of the patients were able to complete the scan, and as exposure-based models of anxiety would predict, their anxiety declined after the scanning was completed.

Additional evidence of the anxiety-producing properties of MR imaging was gathered by Katz, Wilson, & Frazer (1994). These investigators assessed anxiety pre- and postscan, using the STAI, and found that 5% of the patients *terminated* the scan because of claustrophobic fear. Although most of the patients tolerated the scan well, showing reductions in anxiety from pre- to postscan, 37% of the subjects experienced moderate to severe anxiety during the scan.

Quirk, Letendre, and Ciottone (1989) studied 46 patients undergoing MRI. Sixty-five percent of the 26 subjects who completed the exit interview reported experiencing moderate to severe claustrophobic anxiety during the scan. The patients' main complaint was of restriction. Of those who stopped the scan because of distress, many complained of increased awareness of physiological sensations such as heart rate, sweating, and in particular, an inability to breathe. Previously our laboratory found that fears of restriction and suffocation

were moderately correlated. Thus, it may be that once a fear of restriction is elicited, those individuals who are afraid of suffocating develop panic responses which further trigger their suffocation fears. Interestingly, in the Quirk et al. study, patients' primary complaints concerned the restrictive aspects of the magnetic bore and only when distress became more acute did patients begin to experience fears of suffocation (This has also been observed at the VH MRI site, personal observation, 1995).

To date there are several studies documenting the claustrophobic effects of the MRI examination. Now that the existence of the problem has been identified further research is needed to characterize the nature of the MRI-related fear. Most studies documenting the anxiety-inducing effects have not adequately assessed the physiological component of the patients' fear responses or the fear sensations related to the MRI experience. Likewise, most have reported the patients thoughts about the procedure only incidentally and behavioral changes before and after the scan have been assessed incompletely. For example, the reports are based on the level of anxiety before and after scan as assessed by the STAI and self-rating of level of anxiety on Likert scales. Claustrophobia is usually assessed via one item on the Fear Survey Schedule asking whether the patient fears enclosed spaces. We do not have adequate information on the thoughts, behaviors, and sensations experienced by the patients. Only by knowing this type of information can we test which therapy would be most efficacious and directly target those components which seem to play the most central role in MRI-induced claustrophobic fear. Additionally, within Canada, data from 939 hospitals indicated that 20,722,075 radiology examinations (including MRI, CT scans, and x-rays) were performed in 1992 (Statistics Canada). The number of MRI machines has risen dramatically in many countries; in Canada there has been an increase of 18.6% from 1989 to 1993, in the United States an increase of 20.4% from 1987 to 1992, and in Germany an increase of 25.5% from 1987 to 1993 (Rublee, 1994). Obviously, the demand for such procedures is high and given that each scan costs approximately $1000 it is important to establish the factors that may interfere with providing reliable scan results.

Current Study

The purpose of the present study was to characterize the claustrophobic fear patients experience when undergoing the magnetic resonance imaging procedure. The aims of the study were the following: 1) attempt to provide a predictive profile of those patients who may experience claustrophobic distress, 2) characterize the fear induced by the MRI procedure more comprehensively than previously, 3) determine which aspects of the MRI procedure (e.g. body fully enclosed within the MRI machine) were most distressing, and 4) assess the contribution of anxiety to the reduction of scan quality.

Predictions

Prediction 1. It was predicted that scores on the claustrophobia questionnaire (assessing fears of suffocation and restriction) and patients' cognitions prior to the MRI scan would significantly predict the level of subjective anxiety experienced during the scan. Anxiety sensitivity, BAI scores, and pain would not play a role in predicting anxiety during the procedure.

Prediction 2. It was predicted that patients within the salient claustrophobic situation (full enclosure in the MRI machine) would produce higher overall means on the measures than those not directly placed in the claustrophobic situation (not fully enclosed within the MRI machine). A comparison was made between the group encapsulated within the MRI machine (i.e. the head-first group) and the comparison group who were not completely enclosed (i.e. the feet-first group) using anxiety sensitivity, fears of suffocation and restriction, anxiety symptoms, cognitions, avoidance behavior, and patients' thoughts as mean composite dependent variables.

Prediction 3. It was predicted that anxious patients would move more and therefore show more motion artifacts on the MRI images. Since many patients endure the scan despite experiencing moderate to severe anxiety the extent to which anxiety influenced the diagnostic value of the examination (i.e. clarity of the scan image) was evaluated.

Methods

Subjects

Subjects were obtained from Vancouver Hospital Oak & 12th Street Site. Data were obtained from 107 outpatients; 80 outpatients undergoing the MRI procedure for the first time, 22 outpatients who had already received an MRI, and 5 patients who provided unusable data. Excluded from the study were subjects who were inpatients, non-English speakers, quadriplegic, or blind patients. Data from an additional five subjects were not used because two subjects were non-English speakers, two subjects because of limited time due to the scheduling of other medical procedures, and one subject who failed to complete the post-scan questionnaire packet before leaving. For the present study only the 80 patients experiencing the MRI for the first time were included in the analyses. Subjects ranged in age from 18-82 (43 males, 37 females).

Procedures

Prior to data collection, a meeting was held with hospital staff to discuss the rationale and methods of the study. The staff was given an opportunity to comment on the feasibility of the study and made suggestions for improvement.

The procedures for subject selection were obtained from Poole & Wang (in preparation). Subjects were given a written invitation by the hospital staff to participate in the study. The invitation introduced the study, specified the time requirements involved, and indicated that participation was voluntary and refusal to participate would not jeopardize treatment or further medical care. Those patients interested in either taking part or learning more about it were asked to hold onto the invitation and were approached by the investigator. Subjects who consented to participate were given a set of questionnaires which took approximately 10 minutes to complete. The questionnaires gathered information regarding consent to participate, symptoms of fear and anxiety, patient satisfaction, previous and present pain, and thoughts they had about the MRI experience. More detail on the questionnaires will be provided below in the "Measures" section.

Upon completion of the questionnaires, the technologists were handed a rating form to record the time taken to complete the scan, problems in obtaining a clear scan, as well as how anxious and cooperative they perceived the patient to be.

After the MRI examination, patients were asked to complete the same set of questionnaires with only minor modifications (e.g. changing statements to past-tense). Incorporation of a one-month follow-up was built into the data collection but will not be a part of this thesis. The follow-up contains additional measures as well as a debriefing form.

Measures

Claustrophobia Questionnaire

Claustrophobia was measured using the Claustrophobia Questionnaire (CLQ) developed previously in our laboratory. The instrument consists of 29 statements for each of which the subject is required to indicate the level of anxiety on a 5-point scale (0=not at all anxious, 1=slightly anxious, 2=moderately anxious, 3=very anxious, 4=extremely anxious) s/he would experience in a particular situation. The situations were selected from those commonly experienced as anxiety-provoking by claustrophobics, in particular those involving aspects of restriction (e.g. "Handcuffed for 15 minutes") and/or suffocation (e.g. "Swimming while wearing a nose plug"). The restriction subscale consists of 14 items whereas the suffocation subscale consists of 15 items. The questionnaires are presented in the Appendix.

Anxiety Sensitivity Index

Anxiety sensitivity was measured using the Anxiety Sensitivity Index (ASI) (Peterson & Reiss, 1987; for an excellent review see Taylor, in press). In using the ASI, subjects rate the extent they agree with items such as "Unusual body sensations scare me" and "It scares me when I feel faint" on a 5-point Likert scale (0=very little, 1=a little, 2=some, 3=much, 4=very much). The scores were summed to create a scale total score for each subject. The Anxiety Sensitivity Index is an instrument which consists of 16 self-report items assessing two aspects of the construct: 1) fears of anxiety-related sensations, and 2) beliefs that these sensations are harmful.

Pain Questionnaire

The Pain Questionnaire (Pain) measured pain intensity for current and chronic pain, as well as whether pain medication was taken on the day of the scan. The post-scan pain measure assessed level of pain experienced while undergoing the MRI scan. The items were selected from the McGill Pain Assessment Questionnaire which is a supplement for the McGill Pain Questionnaire (Melzack, 1975)

The Beck Anxiety Inventory

The Beck Anxiety Inventory (BAI) is a 21-item self-report questionnaire assessing severity of anxiety using a 4-point scale (0=not at all, 1=mildly, 2=moderately, 3=severely). For each subject the scores across all items were summed to yield a total score, ranging from 0 to 63. The Beck Anxiety Inventory (BAI) was selected over the state portion of the State-Trait Anxiety Inventory because this instrument assesses the bodily sensations of anxiety, as well as subjective/cognitive experience (Beck & Steer, 1988; Bordon, Peterson, Jackson, 1991; Hewitt & Norton, 1993; Osman, Barrios, Aukes, Osman, & Markway, 1993). Since claustrophobia is closely linked with physiological sensations, this instrument is hypothesized to capture aspects of anxiety more central to claustrophobic fear.

The Cognitions Questionnaire

The Cognitions questionnaire (COGS) is a compilation of thoughts a subject might experience when in the MRI machine. These items were produced by taking statements from previous claustrophobia studies (the Rachman series), anecdotal statements made by MRI patients reported in the literature, and a medical injury survey (Kleinkneckt, 1993). Additional items were included to assess thoughts about the medical care provided.

Avoidance Questionnaire

The Avoidance Questionnaire was adopted from the Mobility Inventory for Agoraphobia (MI) (Chambless, Caputo, Jasin, Gracely, & Williams, 1985). Modifications were made to add situations a claustrophobic person might avoid.

Technician Rating Form

The Technician Rating Form was developed to assess scan quality, the nature of the problems experienced while scanning, and their perceptions of patient anxiety and cooperation. Motion artifacts are the best overt indicator of anxiety problems within the MR machine. The technician indicated the series with the most motion artifact. The MRI machine has a built-in function to calculate the amount of motion artifact there is within a given window. More information was obtained by asking the technologist whether s/he had difficulty getting clear scans because the patient was nervous and had the technologist record the number of repeated scans needed to get a clear scan. Although a direct measure of anxiety influencing scan clarity cannot be obtained, the movement data provide a rough quantitative index.

Missing data

Mean values of each scale total was used to replace missing data. That is, each scale total was calculated and if an item was missing the value was replaced by the mean of that particular scale. This option was chosen because only twelve of eighty subjects had items missing. In addition, the average number of missing values was one item over all scales. Scales missing more than one item were dropped from the analyses; this can be noted in varying degrees of freedom for separate analyses.

Results

Scale Statistics

All scores were calculated using the sum of the scale items. Estimates of internal consistency (Cronbach's alpha) were satisfactory for all pre-scan scales. Presented in Table 1 are the number of subjects, estimates of internal validity, and range of scores for the pre-scan measures. Presented in Table 2 are means and standard deviations for pre- and post-scan measures. Only those subjects undergoing the MRI for the first time were used in the following analyses. There were 22 patients who had previously experienced an MRI scan; comparison of mean scores on the anxiety measures yielded no differences between the groups. However, the repeating patients will not be included in the following analyses.

Comparisons of the MRI sample to previous samples showed that pre-scan scores on the ASI and CLQ were similar to non-clinical samples. Specifically, the mean score on the ASI for the MRI sample (M=17.7, SD=9.3) is similar to normal sample scores (M=15.4, SD=8.1) and much lower than those reported for a group of patients with anxiety disorders (M=25.8, SD=10.9) (Reiss et al., 1986). The mean score on the Claustrophobia Questionnaire for the MRI group (M=28.7, SD=20.25) did not differ compared to the mean obtained from a sample of 210 undergraduates (M=36.4, SD=19.1) (McIsaac & Rachman, in preparation). However, pre-scan scores on the BAI for the MRI sample were high compared to normal samples, resembling scores of patients with anxiety disorders. This finding is not surprising, given that the MRI patients were about to experience a novel medical procedure for moderate to serious health problems. The mean of the BAI for the MRI sample (M=20.5, SD=15.6) was higher compared to non-clinical samples. For example, Borden, Peterson, and Jackson (1991) obtained a mean of 10.75 (SD=9.12) from undergraduate subjects and Osman, Barrios, Aukes, Osman, and Markway (1993) obtained a mean of 11.54 (SD=10.26) from a community sample. The MRI sample more closely resembled the BAI scores found for a clinical sample obtained by Beck and Steer (1990) with a mean of 22.98 (SD=12.84).

Twenty out of eighty patients (i.e. 25%) scored 'moderately' to 'extremely' anxious on subjective ratings of anxiety (i.e. Likert scale, 1 = not at all anxious to 4 = extremely anxious),

which is higher than percentages obtained from previous studies using STAI scores showing

5-10% of the MRI samples within this range (Kilborne & Labbe, 1990). However, some

hospitals report that up to 30% of patients score 'moderate' to 'extremely'

Table 1

Number of Subjects, Range, and Estimates of Internal Consistency for Pre-scan Scales

Scale	N	Range	Alpha*
Anxiety Sensitivity Index	80	5-43	.85
Beck Anxiety Inventory	77	0-60	.96
Claustrophobia Questionnaire	73	0-88	.95
Cognitions Questionnaire	74	17-65	.84

* Cronbach's Alpha

Table 2

Scale Means and Standard Deviations at Pre- and Post-Scan

Scale	Mean (S.D.)	
	Pre-Scan	Post-Scan
Anxiety Sensitivity Index	17.7(9.3)	13.1(8.1)***
Beck Anxiety Inventory	20.5(15.6)	10.8(13.3)***
Claustrophobia Questionnaire	28.5(20.2)	26.5(22.1)
Cognitions Questionnaire	25.9(8.9)	25.2(8.2)
Pain Subjective Rating	1.3(1.1)	1.4(1.3)

*p <.05

**p < .01   all probability estimates are 2-tailed

***p <.001

anxious on the STAI (General Electric MRI production, personal communication) a figure which more closely compares to that obtained for the current sample.

In summary, comparisons of the MRI sample to previous samples showed that pre-scan scores on the ASI and CLQ were similar to non-clinical samples but pre-scan scores on the BAI for the MRI sample were high compared to normal samples, resembling scores of patients with anxiety disorders. The percentage of patients experiencing high anxiety was similar to previous studies.

Subjective Anxiety at Post-Scan and its Predictors

Test

A standard multiple regression analysis was performed between subjective rating of anxiety experienced during the MRI scan (as assessed at post-scan) as the dependent variable and ASI, BAI, CLQ, COGS, and pain as predictors. The standard multiple regression technique was chosen over hierarchical regression and stepwise regression since there were moderate correlations between some of the independent variables. The standard multiple regression technique allows for simultaneous entry of all the independent variables; each variable is assessed as if it had entered the regression after all the other independent variables had entered. Thus, each independent variable is evaluated for what it adds to the prediction of the dependent variable that is different from the predictability provided by the other independent variables (Tabachnik & Fidell, 1989). Alternative techniques would not allow the independent contribution of each variable to be assessed. The intercorrelations between the variables are presented in Table 3.

Assumptions

Although the variables were slightly positively skewed, a square root transformation of the variables led to trivial effect in the results of the regression analysis. Examination of the residuals and standard error of the regression coefficient indicated that the assumptions of normality, linearity, equality-of-variance, and multicollinearity were met.

Table 3

Intercorrelations among Subjective Anxiety, ASI, BAI, CLQ, COGS, and Pain Pre-scan Scales

	ASI	BAI	CLQ	COGS	Pain
Subj. Anx.	.14	.21*	.48***	.42***	-.05
ASI		.33***	.36***	.39***	.30***
BAI			.31***	.48***	.03
CLQ				.49***	.15
COGS					.05

 *p < .05

 **p < .01   all probability estimates are 2-tailed

***p < .001

Inspection of the data yielded only one univariate outlier (Mahal test mean = 4.93) but Cook's test indicated that this value did not influence the regression results (Cook D = 0.19). The preceding results therefore offer no grounds for questioning the statistical assumptions for regression, supporting the use of untransformed data for analysis.

<u>Results</u>

Two of the independent variables were found to contribute significantly to the prediction of subjective anxiety during the MRI scan (as assessed rating at post-scan), these were the Claustrophobia Questionnaire and the Cognitions Questionnaire. The two variables accounted for 29.2% (24.5% adjusted) of the variability in subjective anxiety at post-scan. The R value for regression analysis was significanly different from zero (F(5,74) = 6.13, p<.001). The results indicate that the level of subjective anxiety experienced during the scan (assessed at post-scan) may be at least partially predicted by an individual's degree of anxiety for claustrophobic situations and the fearful cognitions they had before entering the machine. Table 4 displays correlation coefficients, the standardized regression coefficients (β), R, R squared, adjusted R squared, t, and t significance level. It is important to note that only those cognitions associated with the underlying fears of claustrophobia (i.e. fears of suffocation and restriction) and pain correlated with subjective anxiety at post-scan, while those thoughts concerning patient care and the length of the scan did not correlate with subjective anxiety. For example, moderate correlations were found for "I will find it disturbing because I can't move" (r=.44, p<.001), "I will be trapped" (r=.38, p<.001), and "I will suffocate" (r=.37, p<.001).

Analyzing the Claustrophobia Questionnaire further indicated that a cutoff score of 46 would detect 80% (8 out of 10, one panicker did not adaquately complete the CLQ) of those patients who panicked (true positives) while only detecting 7.35% (5 out of 68) who did not panic (false positives).

Table 4

Multiple Regression Analysis of Subjective Anxiety at Post-Scan

Predictor	r(xy)	βj	t	t sig
ASI	.14	-.08	-.67	.50
BAI	.21	-.02	-.14	.89
CLQ	.48	.39	3.35	.001
COGS	.42	.28	2.20	.03
Pain	-.05	-.10	-.99	.33

Multiple R	= .54	
R square	= .29	$F(5, 74) = 6.13$, $p < .0001$
R square (adjusted)	= .25	

* n=80 subjects included in this analysis.

Comparison of Head-First and Feet-First Groups

Manipulation Check

An analysis of covariance test between the head-first and feet-first groups on the rating of subjective anxiety at post-scan, using pre-scan subjective anxiety rating as a covariate, produced significant results ($F(1,74)=6.73$, $p<.01$). Thus, the groups differed in the amount of subjective distress experienced during the scan. That is, as predicted, individuals in the head-first group were more anxious in the scan than patients in the feet-first condition ($M=2.22$, $SD=1.0$ vs. $M=1.64$, $SD=.95$), whereas the two groups did not differ in anxiety at pre-scan ($M=2.0$, $SD=.9$ vs. $M=2.0$, $SD=.9$). This result served as a manipulation check for the multivariate analysis of covariance, presented below, comparing the head-first and feet-first group on questionnaire scores at post-scan, using pre-scan scores as covariates.

Test

The multivariate analysis of covariance determines whether mean differences between the groups at post-scan, using a combination of the dependent measures, is greater than chance (Tabachnick & Fidell, 1989). The dependent variables are linearly combined so as to achieve the greatest separation between the two groups. Pre-scan scores were used as covariates to partial out the initial differences between the groups.

Assumptions

Assumptions of normality, linearity, and multicollinearity were sufficiently met. Although the variables were slightly positively skewed, as mentioned above, square root transformation of the data did not alter the results. Homogeneity of variance tests were satisfactory for all variables except the CLQ at post-test ($F(1,9022=7.2$, $p<.007$). The homogeneity of variance test compares variance-covariance matrices for both groups; the results indicated a significant difference between the two matrices on the CLQ post-test. However, since the head-first group had more subjects and larger variance than the feet-first group the bias of the significance test is conservative.

Results

A multivariate analysis of covariance was performed on five dependent variables: ASI, BAI, CLQ, COGS, and pain, with position in the MRI machine as the independent variable. The results indicated no significant difference between the head-first and feet-first group $(F(5,63)=.29, p>.92)$. The effect size of only .025 indicates there is a neglible difference when using the questionnaire measures to detect differences in anxiety for direction of entry into the machine. Means and standard deviations for the groups are presented in Table 5.

Analysis of three individual items (i.e. "I will be trapped", "I will suffocate", and "I will feel like I can't breathe") on the Cognitions Questionniare did not yield significant differences between the head-first and feet-first groups at pre- or post-scan.

Table 5

Scale Means and Standard Deviations for Head-First and Feet-First groups

Scale	Mean(S.D.)		
	Pre-Scan	Post-Scan	N
Head-First Group:			
Anxiety Sensitivity Index	18.6(9.8)	13.7(8.4)***	54
Beck Anxiety Inventory	20.5(15.6)	12.2(13.2)***	52
Claustrophobia Questionnaire	31.2(21.9)	30.1(24.7)	52
Cognitions Questionnaire	26.5(9.7)	26.2(8.5)	52
Pain	1.3(1.1)	1.3(1.3)	54
Subjective Anxiety Rating	2.0(.9)	2.2(1.0)	54
Feet-First Group:			
Anxiety Sensitivity Index	15.7(8.1)	12.0(7.4)***	26
Beck Anxiety Inventory	20.4(16.0)	7.8(13.3)***	25
Claustrophobia Questionnaire	22.9(15.3)	19.1(13.0)	24
Cognitions Questionnaire	24.2(6.7)	23.1(7.3)	22
Pain	1.6(1.3)	1.4(1.1)	26
Subjective Anxiety Rating	2.0(.9)	1.64(1.0)*	

*p < .05

**p < .01   all probability estimates are 2-tailed

***p < .001

MRI-related Anxiety and Motion Artifact

A correlation was used to assess the direction and strength of the relationship between a measure of anxiety during the MRI scan (assessed at post-scan) and the level of motion artifact in the MRI scan picture. The correlation was not significant between motion artifact and subjective anxiety rating during the scan ($r=.02$, $p<.91$). However, there was a significant correlation between motion artifact and post-test BAI scores ($r=.27$, $p<.045$), which is a more comprehensive measure including the physiological symptoms associated with anxiety and post-test CLQ scores ($r=.42$, $p<.002$). Correlations for the anxiety measures and motion artifact are presented in Table 6.

Panic Attacks

Eleven of the patients reported experiencing a panic attack during the MRI scanning procedure. Three of these subjects who panicked terminated the scan prematurely. The means and standard deviations of the panickers vs. the non-panickers are presented in Table 7 to show differences in pre-scan to post-scan scale scores for each group. The means and standard deviations for panickers versus non-panickers are presented in a alternative format in Table 8, Figure 1, and Figure 2 to illustrate significant differences between the two groups at pre- and post-scan. Patients who experienced panic attacks during the scan reported significantly higher subjective anxiety before (pre-scan $M=2.55$, $SD=1.13$ vs. $M=1.96$, $SD=.84$) ($t(77)=2.06$, $p<.04$), as well as during the scan than those patients who did not panic ($M=3.73$, $SD=.47$ vs. $M=1.76$, $SD=.81$)($t(68)=7.78$, $p<.001$). The panic versus non-panic groups were significantly different on pre-scan scores on the CLQ ($M=56.0$, $SD=21.5$ vs. $M=24.1$, $SD=16.34$) and COGS ($M=32.7$, $SD=12.3$ vs. $M=24.7$, $SD=7.8$) questionnaire ($t(71)=5.49$, $p<.001$ and $t(72)=2.9$, $p<.005$). The groups did not significantly differ on pre-scan scores of ASI, BAI, and pain. In particular, the CLQ scores were approximately 30 points higher at pre-scan for patients who experienced a panic attack than for patients who did not ($M=56.0$, $SD=21.6$ vs. $M=24.1$, $SD=16.3$). Thus, the CLQ may show an ability to discriminate those who had panic attacks during the scan.

Table 6

Correlations between Post-scan Anxiety Measures and Motion Artifact

	ASI	BAI	CLQ	COGS	Pain	Subj. Anx.
Motion Artifact	.20	.27*	.42**	.06	-.14	.02

*p < .05

**p < .01   all probability estimates are 2-tailed

Table 7

Means and Standard Deviations of Panickers and Non-Panickers

Scale	Mean(S.D.)		
	Pre-Scan	Post-Scan	N
Panickers:			
ASI	21.8(9.0)	20.4(6.7)	11
BAI	24.6(20.7)	31.7(14.6)	10
CLQ	56.0(21.6)	55.3(19.7)	10
COGS	32.7(12.3)	38.9(8.4)	11
Pain	1.45(1.4)	1.64(1.0)**	11
Non-Panickers:			
ASI	17.0(9.3)	12.1(7.9)***	69
BAI	19.8(14.7)	7.7(10.0)***	68
CLQ	24.1(16.3)	22.0(19.0)	64
COGS	24.7(7.8)	23.1(5.8)	64
Pain	1.38(1.3)	1.22(1.0)	69

Table 8

Scale Means and Standard Deviations for Panic vs. Non-panic at Pre- and Post-Scan

Scale	Mean(S.D.)	
	Panickers (n=11)	Non-Panickers (n=69)
Pre-scan:		
Anxiety Sensitivity Index	21.8(9.0)	17.0(9.3)
Beck Anxiety Inventory	24.6(20.7)	19.8(14.7)
Claustrophobia Questionnaire	56.0(21.6)	24.1(16.3)***
Cognitions Questionnaire	32.7(12.3)	24.7(7.8)**
Pain	1.45(1.4)	1.38(1.3)
Subjective Anxiety Rating	2.5(1.1)	2.0(.84)
Post-scan:		
Anxiety Sensitivity Index	20.4(6.7)	12.1(7.9)**
Beck Anxiety Inventory	31.7(14.6)	7.7(10.0)***
Claustrophobia Questionnaire	55.3(19.7)	22.0(19.0)***
Cognitions Questionnaire	38.9(8.4)	23.1(5.8)***
Pain	1.64(1.0)	1.22(1.0)
Subjective Anxiety Rating	3.73(.47)	1.76(.81)

*p < .05

**p < .01   all probability estimates are 2-tailed

***p< .001

Panic vs. Non-panic
Pre-scan
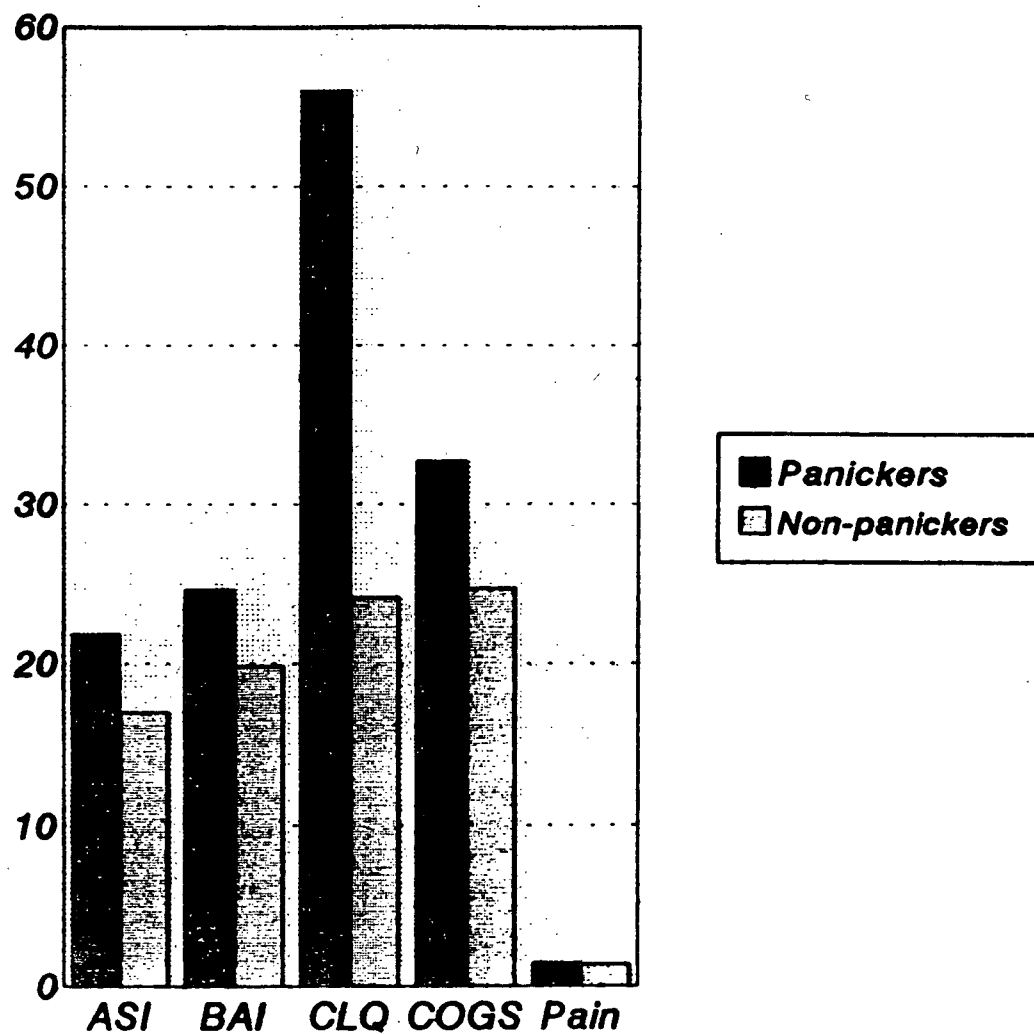
Figure 1: Mean scores for panickers and non-panickers on pre-scan measures.

Panic vs. Non-panic
Post-scan
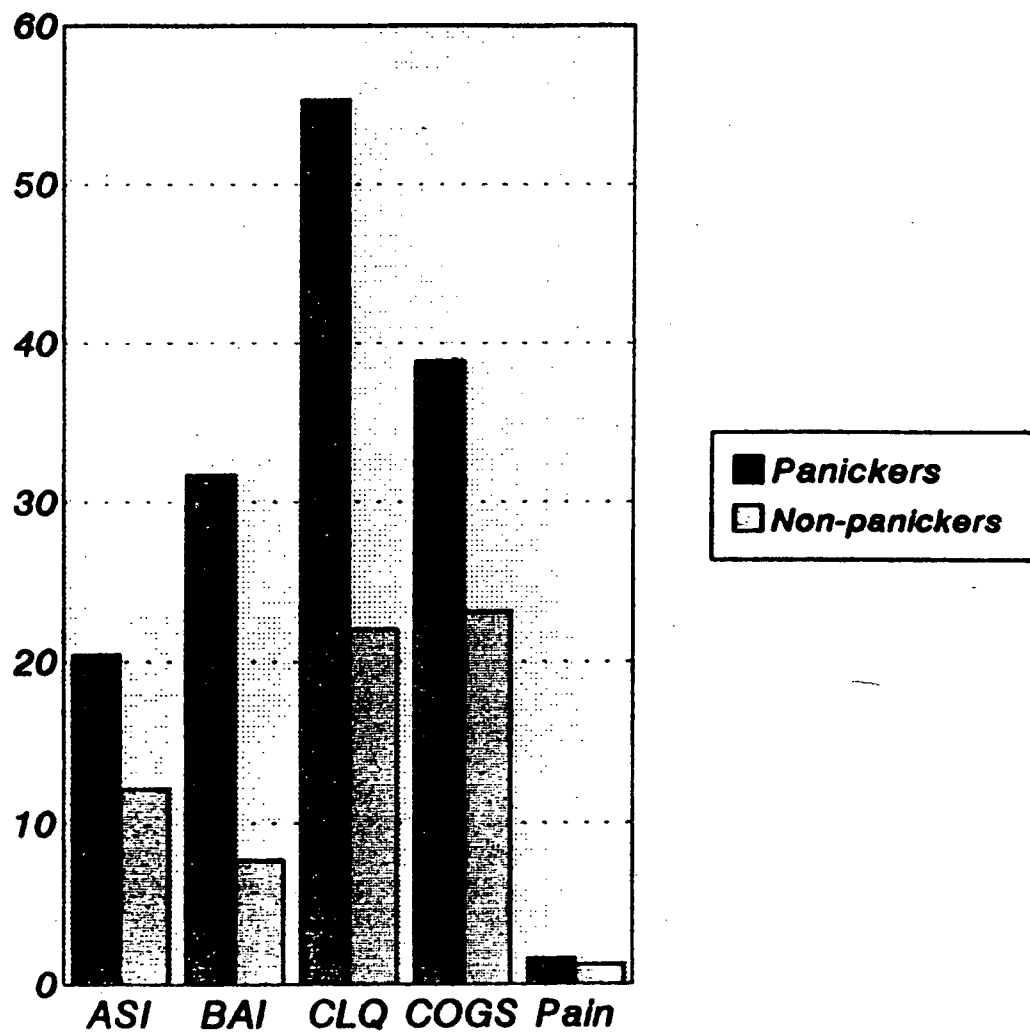
Figure 2: Mean scores for panickers and non-panickers on post-scan measures.

Discussion

Experiencing an MRI scan is anxiety provoking for many individuals. The technique is new and often patients are provided with little information about the procedure. In the present MRI sample, 25% reported 'moderate' to 'extreme' anxiety on subjective ratings during the scan (assessed at post-scan). Previous studies have employed the use of the State-portion of the State-Trait Anxiety Inventory which has produced reports of 5-10% patients within the 'moderate' to 'extreme' anxiety range (Kilborne & Labbe, 1990). However, some hospitals report up to 30% of their patients experience such levels of anxiety which is a figure closer to that obtained for our MRI sample (General Electric MRI production, personal communication). Given the high rates of distress associated with the MRI examination, and the financial loss due to poor scan images and scan termination, a detailed analysis of the contributing factors to MRI-related anxiety was timely and important.

The aims of the study were the following: 1) attempt to provide a predictive profile of those patients who may experience claustrophobic distress, 2) characterize the fear induced by the MRI procedure more comprehensively than previously, 3) determine which aspects of the MRI procedure (e.g. body fully enclosed within the MRI machine) were most distressing, and 4) assess the contribution of anxiety to the reduction of scan quality.

In addressing the first aim, the prediction that scores on the Claustrophobia Questionnaire and level of endorsement of fearful cognitions before entering the scan would in part determine the level of subjective anxiety during the procedure was supported. The thoughts most highly correlated with subjective anxiety during the scan were those related to suffocation and restriction. The results of the study has important practical implications. The Claustrophobia and Cognitions measures could be given in advance of the scan to identify the subjects most likely to experience severe distress. The Claustrophobia and Cognitions Questionnaires are better predictors of subjective anxiety during the MRI scan than ASI, BAI, and level of pain at pre-scan. This indicates that the subjective anxiety experienced can be

attributed specifically to claustrophobic aspects of the MRI situation and beliefs associated with claustrophobia rather than a generalized increase in anxiety or pain.

The second aim of the study was to characterize the fear induced by the MRI procedure more comprehensively than previously. The studies conducted to date have assessed changes in level of anxiety before and after the MRI scan using the State-Trait Anxiety Inventory. The present study went a step further assessing differences in levels of claustrophobic fear, anxiety sensitivity, subjective and physiological symptoms of anxiety as measured by the Beck Anxiety Inventory, and fearful thoughts a patient may experience before and during the scan. It was found that patients' primary concerns were fears of restriction and suffocation. Neither anxiety sensitivity nor pain played significant roles in subjective anxiety experienced during the procedure.

Addressing the third aim of the study, to assess the aspects of the procedure most distressing to patients, it was predicted that those in the head-first condition would provide higher scores on the measures than those in the feet-first condition. The manipulation check showed that there was an actual difference in subjective anxiety between the two groups during the scan (but not at pre-scan). However, this difference was not detected by the ASI, BAI, CLQ, COGS, and pain questionnaires. This result is surprising given the head-first group was completely enclosed in a claustrophobic situation, whereas the feet-first group was not enclosed. One possible explanation is that these measures were not sensitive to the sorts of changes that occur during the 50-minute scan. The one-month follow-up may indicate changes in the measures which are more substantial given that components of fear may change with the passage of time.

The final aim of the study was to assess the contribution of anxiety to the reduction of scan quality. It was predicted that anxious patients would move more and therefore show more motion artifacts on the MRI images. There was a significant correlation between the post-scan CLQ and motion artifact. Fears of claustrophobic situations are expected to be associated with motion when enclosed in a highly restrictive environment such as the MRI machine, as subjects may be assessing the range of possible movement or may simply be

agitated. There was a significant correlation between the scores on the post-scan BAI and the amount of motion artifact. Anxiety, in particular somatic symptoms as assessed by the BAI, would also give rise to agitation and motion.

Previous research has shown that claustrophobic fear is comprised of two underlying fears - suffocation and restriction (Rachman, 1990). The measure designed to assess these fears, the Claustrophobia Questionnaire, was successful in predicting the level of distress experienced by the patient, the scores were associated with amount of motion artifact appearing on the scan, and this measure may distinguish those patients who experience panic attacks during the scan from those who do not. The MRI experience is extremely claustrophobic; patients are strapped to a bed and entered into a cavity the width of ones shoulders.

The subjects who panicked during the scan experienced serious distress, possibly compromised the integrity of the scan results, and may have prolonged the scan requiring an increase in technologist time. The scores of these subjects on the anxiety measures, especially the Claustrophobia and Cognitions measures were high in comparison to the subjects who did not panic. With the estimated cost of $1000 per scan, scan quality is important and technologist time valuable and it is likely that the scan results of people experiencing panic would be compromised. Furthermore, the distress of three panickers was so great that the scan was terminated before completion, resulting in a $3000 dollar loss. If three out of every 80 patients terminate the scan at Vancouver Hospital MRI Oak & 12th street site (which scans approximately 600 individuals per year), the hospital would lose $22,500 each year. If the Claustrophobia and the Cognitions Questionnaires were routinely incorporated into MRI assessment procedures, this loss would be substantially reduced.

In terms of the limitations of this study, the findings are not generalizable to inpatient populations. Inpatients often have multiple health problems of greater severity than outpatients. Additionally, inpatients are often on medication which may interact with the patient's experience of the MRI procedure in different ways from non-medicated outpatients. Also, given the small sample size of the patients who experienced panic attacks during the

procedure (n=11) the means tested for this group may be unstable, thus, caution should be used when extending the findings for this group to the population.

Future studies should examine whether reducing patients fears of restriction and suffocation before the scan would decrease the level anxiety experienced during the procedure. Since scores on the Claustrophobia and Cognitions measures indicate those patients who may experience the most distress, high scoring individuals could be identified in advance and administered an intervention to reduce these fears. Not only would the reduction in claustrophobic fear benefit patients enduring such an anxiety provoking procedure but may decrease the amount motion artifact degrades scan images and the numbers of scans terminated.

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Appendix A

Demographics (pre-scan)

Name: _____   Subject Number: _____

Address:

_____

_____

Phone: _____

1. Age: _____   2. Height: _____   3. Weight: _____

4. Inpatient? _____ Outpatient? _____

5. Are you accompanied today? _____ Yes _____ No   If yes, with whom? _____

6. Reason for MRI scan: _____

7. Is this your first MR scan? _____ Yes _____No

      a. If no, how many MR scans have you experienced?_____

8. Did you take __anti-anxiety or __anti-pain medication before coming in today? _____Yes _____No

      a. Name and dosage? _____

9. Estimate how many cups of caffeinated coffee do you drink each day? _____

10. Estimate how many cups of tea do you drink each day? _____

11. Estimate how many glasses of any other caffeinated beverage do you drink each day? (e.g. colas)

      a. Please specify type and amount: _____

A panic attack is the sudden onset of intense apprehension, fear, or terror, often associated with feelings of impending doom. Some of the most common symptoms experienced during an attack are dizziness, shortness of breath, chest pain or discomfort, and trembling or shaking.

12.Based on this definition, have you ever experienced a panic attack? _____Yes _____No

      a. If yes, how many? _____

      b. When do they occur? _____

13. Do you ever feel claustrophobic? _____Not at all _____Mildly _____ Moderately _____ Severely

      a. If yes, in what situations? _____

Appendix B

ASI (pre-scan)

Circle the number that best represents the extent to which you agree with the item. If any of the items concern something that is not part of your experience (e.g., "It scares me when I feel shaky" for someone who has never trembled or had the "shakes"), answer on the basis of how you think you might feel *if you had* such an experience. Otherwise, answer all items on the basis of your own experience.

	Very Little	A little	Some	Much	Very Much
1. It is important for me not to appear nervous	0	1	2	3	4
2. When I cannot keep my mind on a task, I worry that I might be going crazy	0	1	2	3	4
3. It scares me when I feel "shaky" (trembling)	0	1	2	3	4
4. It scares me when I feel faint	0	1	2	3	4
5. It is important for me to stay in control of my emotions	0	1	2	3	4
6. It scares me when my heart beats rapidly	0	1	2	3	4
7. It embarrasses me when my stomach growls	0	1	2	3	4
8. It scares me when I am nauseous	0	1	2	3	4
9. When I notice that my heart is beating rapidly, I worry that I might have a heart attack	0	1	2	3	4
10. It scares me when I become short of breath	0	1	2	3	4
11. When my stomach is upset, I worry that I might be seriously ill	0	1	2	3	4
12. It scares me when I am unable to keep my mind on a task	0	1	2	3	4
13. Other people notice when I feel shaky	0	1	2	3	4
14. Unusual body sensations scare me	0	1	2	3	4
15. When I am nervous, I worry that I might be mentally ill	0	1	2	3	4
16. It scares me when I am nervous	0	1	2	3	4

<u>Appendix C</u>

CLQ-S (pre-scan)

Instructions: Please indicate the degree to which you would feel **anxious** in each of the following situations by circling the most appropriate number.

0 = Not at all anxious
1 = Slightly
2 = Moderately
3 = Very
4 = Extremely

	Not at all	Slightly	Moder- ately	Very	Extre- mely
1. Swimming while wearing a nose plug.	0	1	2	3	4
2. Working under a sink for 15 minutes.	0	1	2	3	4
3. Standing in an elevator on the ground floor with the doors closed.	0	1	2	3	4
4. Trying to catch your breath during vigorous exercise.	0	1	2	3	4
5. Having a bad cold and finding it difficult to breathe through your nose.	0	1	2	3	4
6. Snorkeling in a safe practice tank for 15 minutes.	0	1	2	3	4
7. Using an oxygen mask.	0	1	2	3	4
8. Lying on a bottom bunk.	0	1	2	3	4
9. Standing in the middle of the 3rd row at a packed concert realizing that you will be unable to leave until the end.	0	1	2	3	4
10. In the center of a full row at a cinema.	0	1	2	3	4
11. Working under a car for 15 minutes.	0	1	2	3	4
12. At the furthest point from an exit on a tour of an underground mine shaft.	0	1	2	3	4
13. In the back of a small 2-door car with a person on either side of you, and all the windows fogged up.	0	1	2	3	4
14. Lying in a sauna for 15 minutes.	0	1	2	3	4
15. Waiting for 15 minutes in a plane on the ground with the door closed.	0	1	2	3	4

CLQ-R (pre-scan)

Instructions: Please indicate the degree to which you would feel **anxious** in each of the following situations by circling the most appropriate number.

0 = Not at all anxious
1 = Slightly
2 = Moderately
3 = Very
4 = Extremely

	Not at all	Slightly	Moder- ately	Very	Extre- mely
1. Locked in a small DARK room without windows for 15 minutes.	0	1	2	3	4
2. Locked in a small WELL LIT room without windows for 15 minutes.	0	1	2	3	4
3. Handcuffed for 15 minutes.	0	1	2	3	4
4. Tied up with hands behind back for 15 minutes.	0	1	2	3	4
5. Caught in tight clothing and unable to remove it.	0	1	2	3	4
6. Standing for 15 minutes in a straitjacket.	0	1	2	3	4
7. Lying in a tight sleeping bag enclosing legs and arms, tied at the neck, unable to get out for 15 minutes.	0	1	2	3	4
8. Head first into a zipped up sleeping bag, able to leave when you wish.	0	1	2	3	4
9. Lying in the trunk of a car with air flowing through freely for 15 minutes.	0	1	2	3	4
10. Having your legs tied to an immovable chair.	0	1	2	3	4
11. In a public washroom and the lock jams.	0	1	2	3	4
12. In a crowded train which stops between stations.	0	1	2	3	4
13. Having a nylon stocking over your face for 15 minutes.	0	1	2	3	4

Appendix D

BAI (pre-scan)

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by each symptom AS YOU FEEL NOW by circling the most appropriate number. Use the following scale:

0 = Not at all
1 = Mildly; It did not bother me much.
2 = Moderately; It was very unpleasant but I could stand it.
3 = Severely; I could barely stand it.

1. Numbness or tingling.	0	1	2	3
2. Feeling hot.	0	1	2	3
3. Wobbliness in legs.	0	1	2	3
4. Unable to relax.	0	1	2	3
5. Fear of the worst thing happening.	0	1	2	3
6. Dizzy or lightheaded.	0	1	2	3
7. Heart pounding or racing.	0	1	2	3
8. Unsteady.	0	1	2	3
9. Terrified.	0	1	2	3
10. Nervous.	0	1	2	3
11. Feelings of choking.	0	1	2	3
12. Hands trembling.	0	1	2	3
13. Shaky.	0	1	2	3
14. Fear of losing control.	0	1	2	3
15. Difficulty breathing.	0	1	2	3
16. Fear of dying.	0	1	2	3
17. Scared.	0	1	2	3
18. Indigestion or discomfort in abdomen.	0	1	2	3
19. Faint.	0	1	2	3
20. Face flushed.	0	1	2	3
21. Sweating (not due to heat).	0	1	2	3

Appendix E

Cognitions Questionnaire (pre-scan)

These are some thoughts or ideas that people may have about MRI testing. Please indicate how intense each thought is for you by circling the appropriate number.

1 = Not at all
2 = Mildly
3 = Moderately
4 = Extremely

1. The procedure will go smoothly.	1	2	3	4
2. I will feel relaxed and calm.	1	2	3	4
3. I will find out I have a serious illness or medical problem.	1	2	3	4
4. I will need to use the bathroom during testing.	1	2	3	4
5. I will be trapped.	1	2	3	4
6. I will suffocate.	1	2	3	4
7. I will find it disturbing because I can't move.	1	2	3	4
8. I find the technologist reassuring.	1	2	3	4
9. I will not be able to control what is happening to me.	1	2	3	4
10. My friend or relative is with me so I feel safe.	1	2	3	4
11. I will feel helpless.	1	2	3	4
12. The sound of the machine will frighten me.	1	2	3	4
13. I will not tolerate the pain well.	1	2	3	4
15. The technologist is caring.	1	2	3	4
16. I will panic.	1	2	3	4
17. I will feel peaceful.	1	2	3	4
18. The technologists and doctors are kind and informative.	1	2	3	4
19. I might faint.	1	2	3	4
20. I will feel like I can't breathe.	1	2	3	4
21. I will experience pain and discomfort.	1	2	3	4
22. I fear that I will act foolishly.	1	2	3	4
23. I might have a heart attack.	1	2	3	4
24. The temperature in the machine will be unpleasant.	1	2	3	4
25. The examination will take a long time.	1	2	3	4
26. I am looking forward to getting the results of my MRI test.	1	2	3	4

Appendix F

O/U Questionnaire (pre-scan)

Using the rating scale below please answer the following questions.

1	2	3	4
Not at all	Slightly	Moderately	Extremely

1. Rate how *interesting* you think the MRI test will be. 1 2 3 4

2. Rate the level of *anxiety* you think you will experience in the MRI machine. 1 2 3 4

3. Estimate how *long* you think the MRI test will be. .... _____(min.)

4. Rate how *anxious* you are now. 1 2 3 4

Appendix G

SP Criteria Questionnaire (pre-scan)

1. Are you especially afraid of enclosed spaces? _____ Yes _____No (if no skip this page)

2. What are you afraid could happen when in an enclosed space?

_____

_____

_____

3. How much does your fear of enclosed spaces interfere with your life?

___Not at all ___Slightly ___Moderately ____Very ____Extremely

4. Is there anything you've avoided because of being afraid of enclosed spaces? _____ Yes _____No

5. Do you think that you are more afraid of enclosed
spaces than you should be or that makes sense? _____ Yes _____No

Appendix H

Avoidance Questionnaire (pre-scan)

Please indicate the degree to which you <u>avoid</u> the following places or situations <u>because of discomfort or anxiety</u>. Rate your amount of avoidance using the following scale:

1	2	3	4	5
Never avoid	Rarely avoid	Avoid about half the time	Avoid most of the time	Always avoid

Places

1. Theatres. 1 2 3 4 5

2. High places. 1 2 3 4 5

3. Enclosed places (e.g. tunnels). 1 2 3 4 5

4. Hospitals. 1 2 3 4 5

5. Elevators. 1 2 3 4 5

Riding in

6. Buses. 1 2 3 4 5

7. Subways. 1 2 3 4 5

8. Small automobiles. 1 2 3 4 5

9. Large automobiles. 1 2 3 4 5

10. Airplanes. 1 2 3 4 5

11. Trains. 1 2 3 4 5

Situations

12. Wearing a seatbelt. 1 2 3 4 5

13. The sight of blood. 1 2 3 4 5

14. Enclosed in snug bed sheets. 1 2 3 4 5

15. Injections or minor surgery. 1 2 3 4 5

16. Wearing tight clothing. 1 2 3 4 5

17. Parties or social gatherings. 1 2 3 4 5

18. Going to the dentist. 1 2 3 4 5

Appendix I

Pain Assessment Questionnaire(pre-scan)

If you are in current pain and/or have had a chronic pain problem please fill out this section. If you are not in pain, please omit this section.

Are you taking pain medication? Yes: _____   No: _____

Have you taken any pain medication today? Yes:_____   No: _____

Medical History:

    A) How long have you had pain: _____

    B) Circumstances for pain onset: _____

Pain Description:

The following words represent pain of increasing intensity:

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

    A) Choose the number of the word which best describes your <u>current</u> pain:

	Your pain right now

If you have a <u>chronic pain problem</u> please complete the following. Otherwise, skip this section.

The following words represent pain of increasing intensity:

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

    B) Choose the number of the word which best describes your <u>chronic</u> pain:

	Your pain at its worst
	Your pain at its least
	The worst toothache you ever had
	The worst headache you ever had
	The worst stomach-ache you ever had

Appendix J

Technologist Rating Form (pre-scan)

Subj No.: _____

Scan

Record time from entering MR room to exiting MR room (not just time in bore).

1. Start time:_____

2. Finish time: _____

3. Type of scan: _____

4. Head first in bore? _____ Feet first in bore? _____ Face up? _____ Face down? _____

5. Contrast IV? ____Y ____N

6. Number of repeats due to motion artifact: _____

7. Indicate series with the MOST ghosting motion artifact (Except: Sagittal Spin echo T1, Thoracic, Lumbar, or Localizers): _____

8. Did the patient require removal from the bore in between scans due to emotional distress?__Y__N

9. Was a friend or nurse required to be in the room with patient due to emotional distress? __Y__N

10. Was medication administered to reduce anxiety? __Y __N   If so, what? _____Dose?_____

11. Problems obtaining a scan? _____ Yes _____ No

   If yes, list reasons:

   _____

   _____

   _____

Patient

12. Was the patient cooperative? ___Not at all ___Mildly ___Moderately ___Completely

13. Was the patient anxious? ____Not at all ____Mildly ____Moderately ____Severely

14. Did the patient complain of claustrophobia? ____Y ____N

15. Was it satisfying to work with this patient? ___Not at all ___Mildly___Moderately __Completely

Thank you!

Appendix K

ASI (post-scan)

Circle the number that best represents the extent to which you agree with the item. If any of the items concern something that is not part of your experience (e.g., "It scares me when I feel shaky" for someone who has never trembled or had the "shakes"), answer on the basis of how you think you might feel if you had such an experience. Otherwise, answer all items on the basis of your own experience.

		Very Little	A little	Some	Much	Very Much
1.	It is important for me not to appear nervous	0	1	2	3	4
2.	When I cannot keep my mind on a task, I worry that I might be going crazy	0	1	2	3	4
3.	It scares me when I feel "shaky" (trembling)	0	1	2	3	4
4.	It scares me when I feel faint	0	1	2	3	4
5.	It is important for me to stay in control of my emotions	0	1	2	3	4
6.	It scares me when my heart beats rapidly	0	1	2	3	4
7.	It embarrasses me when my stomach growls	0	1	2	3	4
8.	It scares me when I am nauseous	0	1	2	3	4
9.	When I notice that my heart is beating rapidly, I worry that I might have a heart attack	0	1	2	3	4
10.	It scares me when I become short of breath	0	1	2	3	4
11.	When my stomach is upset, I worry that I might be seriously ill	0	1	2	3	4
12.	It scares me when I am unable to keep my mind on a task	0	1	2	3	4
13.	Other people notice when I feel shaky	0	1	2	3	4
14.	Unusual body sensations scare me	0	1	2	3	4
15.	When I am nervous, I worry that I might be mentally ill	0	1	2	3	4
16.	It scares me when I am nervous	0	1	2	3	4

Appendix L

CLQ-S (post-scan)

Instructions: Please indicate the degree to which you would feel **anxious** in each of the following situations by circling the most appropriate number.

        0 = Not at all anxious
        1 = Slightly
        2 = Moderately
        3 = Very
        4 = Extremely

	Not at all	Slightly	Moder- ately	Very	Extre- mely
1. Swimming while wearing a nose plug.	0	1	2	3	4
2. Working under a sink for 15 minutes.	0	1	2	3	4
3. Standing in an elevator on the ground floor with the doors closed.	0	1	2	3	4
4. Trying to catch your breath during vigorous exercise.	0	1	2	3	4
5. Having a bad cold and finding it difficult to breathe through your nose.	0	1	2	3	4
6. Snorkeling in a safe practice tank for 15 minutes.	0	1	2	3	4
7. Using an oxygen mask.	0	1	2	3	4
8. Lying on a bottom bunk.	0	1	2	3	4
9. Standing in the middle of the 3rd row at a packed concert realizing that you will be unable to leave until the end.	0	1	2	3	4
10. In the center of a full row at a cinema.	0	1	2	3	4
11. Working under a car for 15 minutes.	0	1	2	3	4
12. At the furthest point from an exit on a tour of an underground mine shaft.	0	1	2	3	4
13. In the back of a small 2-door car with a person on either side of you, and all the windows fogged up.	0	1	2	3	4
14. Lying in a sauna for 15 minutes.	0	1	2	3	4
15. Waiting for 15 minutes in a plane on the ground with the door closed.	0	1	2	3	4

CLQ-R (post-scan)

Instructions: Please indicate the degree to which you would feel **anxious** in each of the following situations by circling the most appropriate number.

> 0 = Not at all anxious
> 1 = Slightly
> 2 = Moderately
> 3 = Very
> 4 = Extremely

	Not at all	Slightly	Moder-ately	Very	Extre-mely
1. Locked in a small DARK room without windows for 15 minutes.	0	1	2	3	4
2. Locked in a small WELL LIT room without windows for 15 minutes.	0	1	2	3	4
3. Handcuffed for 15 minutes.	0	1	2	3	4
4. Tied up with hands behind back for 15 minutes.	0	1	2	3	4
5. Caught in tight clothing and unable to remove it.	0	1	2	3	4
6. Standing for 15 minutes in a straitjacket.	0	1	2	3	4
7. Lying in a tight sleeping bag enclosing legs and arms, tied at the neck, unable to get out for 15 minutes.	0	1	2	3	4
8. Head first into a zipped up sleeping bag, able to leave when you wish.	0	1	2	3	4
9. Lying in the trunk of a car with air flowing through freely for 15 minutes.	0	1	2	3	4
10. Having your legs tied to an immovable chair.	0	1	2	3	4
11. In a public washroom and the lock jams.	0	1	2	3	4
12. In a crowded train which stops between stations.	0	1	2	3	4
13. Having a nylon stocking over your face for 15 minutes.	0	1	2	3	4

Appendix M

BAI (post-scan)

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by each symptom AS YOU FELT IN THE MRI by circling the most appropriate number. Use the following scale:

0 = Not at all
1 = Mildly; It did not bother me much.
2 = Moderately; It was very unpleasant but I could stand it.
3 = Severely; I could barely stand it.

1. Numbness or tingling. 0   1   2   3

2. Feeling hot. 0   1   2   3

3. Wobbliness in legs. 0   1   2   3

4. Unable to relax. 0   1   2   3

5. Fear of the worst thing happening. 0   1   2   3

6. Dizzy or lightheaded. 0   1   2   3

7. Heart pounding or racing. 0   1   2   3

8. Unsteady. 0   1   2   3

9. Terrified. 0   1   2   3

10. Nervous. 0   1   2   3

11. Feelings of choking. 0   1   2   3

12. Hands trembling. 0   1   2   3

13. Shaky. 0   1   2   3

14. Fear of losing control. 0   1   2   3

15. Difficulty breathing. 0   1   2   3

16. Fear of dying. 0   1   2   3

17. Scared. 0   1   2   3

18. Indigestion or discomfort in abdomen. 0   1   2   3

19. Faint. 0   1   2   3

20. Face flushed. 0   1   2   3

21. Sweating (not due to heat). 0   1   2   3

Appendix N

Cognitions Questionnaire (Post)

These are some thoughts or ideas that people may have *during* MRI testing. Please indicate how much you experienced each thought *while in the MRI machine* by circling the appropriate number.

1 = Not at all
2 = Mildly
3 = Moderately
4 = Extremely

During the test I thought that:

1. The procedure is going smoothly. 1 2 3 4

2. I feel relaxed and calm. 1 2 3 4

3. I will find out I have a serious illness or medical problem. 1 2 3 4

4. I need to use the bathroom during testing. 1 2 3 4

5. I am trapped. 1 2 3 4

6. I am going to suffocate. 1 2 3 4

7. I find it disturbing because I can't move. 1 2 3 4

8. The technologist has a kind voice. 1 2 3 4

9. I am not able to control what is happening to me. 1 2 3 4

10. My friend or relative is with me so I feel safe. 1 2 3 4

11. I am helpless. 1 2 3 4

12. The sound of the machine frightens me. 1 2 3 4

13. I can't stand pain. 1 2 3 4

14. I can't control myself. 1 2 3 4

15. The technologist is caring. 1 2 3 4

16. I am going to panic. 1 2 3 4

17. I feel peaceful. 1 2 3 4

18. The technologists and doctors are informative. 1 2 3 4

19. I am going to faint. 1 2 3 4

20. I feel like I can't breathe. 1 2 3 4

21. I'm experiencing pain and discomfort. 1 2 3 4

22. I fear that I am acting foolishly. 1 2 3 4

23. I am having a heart attack. 1 2 3 4

24. The temperature in the machine was unpleasant. 1 2 3 4

25. The examination took a long time. 1 2 3 4

26. I am looking forward to getting the results of my MRI test. 1 2 3 4

Appendix O

Avoidance Questionnaire

Please indicate the degree to which you <u>avoid</u> the following places or situations <u>because of discomfort or anxiety</u>. Rate your amount of avoidance using the following scale:

1	2	3	4	5
Never avoid	Rarely avoid	Avoid about half the time	Avoid most of the time	Always avoid

Places

1. Theatres. 1   2   3   4   5

2. High places. 1   2   3   4   5

3. Enclosed places (e.g. tunnels). 1   2   3   4   5

4. Hospitals. 1   2   3   4   5

5. Elevators. 1   2   3   4   5

Riding in

6. Buses. 1   2   3   4   5

7. Subways. 1   2   3   4   5

8. Small automobiles. 1   2   3   4   5

9. Large automobiles. 1   2   3   4   5

10. Airplanes. 1   2   3   4   5

11. Trains. 1   2   3   4   5

Situations

12. Wearing a seatbelt. 1   2   3   4   5

13. The sight of blood. 1   2   3   4   5

14. Enclosed in snug bed sheets. 1   2   3   4   5

15. Injections or minor surgery. 1   2   3   4   5

16. Wearing tight clothing. 1   2   3   4   5

17. Parties or social gatherings. 1   2   3   4   5

18. Going to the dentist. 1   2   3   4   5

Appendix P

O/U Questionnaire (Post)

Using the rating scale below please answer the following questions.

1	2	3	4
Not at all	Slightly	Moderately	Extremely

1. Rate how *interesting* you found the MRI test. 1   2   3   4

2. Rate the level of *anxiety* you experienced while in the MRI machine. 1   2   3   4

3. Estimate how *long* you think the MRI test took. ...._____(min.)

4. Rate how *anxious* you are now. 1   2   3   4

A panic attack is the sudden onset of intense apprehension, fear, or terror, often associated with feelings of impending doom. Some of the most common symptoms experienced during an attack are dizziness, shortness of breath, chest pain or discomfort, and trembling or shaking.

5. Based on this definition, did you experience a panic attack while in the MRI? _____Yes _____No

       a. If yes, what was your most distressing symptom? _____

Appendix Q

Pain Assessment Questionnaire

Pain Description:

The following words represent pain of increasing intensity:

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

A) Choose the number of the word which best describes your <u>current</u> pain:

	Your pain right now