

Claustrophobia in MRI: the role of cognitions.

ABSTRACT

Purpose to investigate of the role of cognitive and behavioural factors in the experience of claustrophobia in the context of magnetic resonance imaging (MRI) scanners.

Materials and Methods. 130 outpatients attending an MRI Unit completed questionnaires before and after their scans. Specific measures of experience in the scanner included subjective anxiety, panic symptoms, strategies used to stay calm and negative cognitions (such as 'I will suffocate' and 'I am going to faint in here'). Other general measures used included anxiety, depression, health anxiety and fears of restriction and suffocation.

Results Amount of anxiety experienced during the scan was related to perceived amount of time spent having physical symptoms of panic. Cognitions reported concerned: suffocation, harm caused by the machine and lack of perceived control. The number of strategies patients used to cope in the machine was also a related factor. Neither position in the scanner, head coil use, or previous experience of being in the scanner was related to levels of anxiety

Conclusion. The cognitions identified here may be used to construct a measure to identify those unable to enter the scanner or those most likely to become claustrophobic whilst undergoing the procedure, and to further inform future brief, effective, interventions.

Key Words: MRI, claustrophobia, cognition, fear, intervention

INTRODUCTION

Magnetic Resonance Imaging (MRI) has become increasingly important as a non-invasive diagnostic tool. As it involves orienting nuclear spins in living tissue with a high magnetic field, in the majority of cases the patient must be placed in the centre of a large magnet in a small space to optimise image resolution: the scanning procedure requires that the patient be inserted – either head first or feet first – into the bore of the machine (which has a diameter of 55 cm and a length of 180 cm) and that they remain there for a considerable length of time. Additionally, if the head is the focus of the scan, this is enclosed in a head coil in order to keep it still. Published reports typically indicate that 15% of patients describe severe claustrophobic reactions while in the bore of the machine. Apart from the distress caused by this, such reactions can result in the degrading of images obtained, or in premature termination of the procedure [1, 2, 3, 4]. Records at a local hospital for instance, indicate that over a seven year period, 1% of people undergoing MRI could not complete the scan as a result of claustrophobic reactions. Some patients, and non-patient participants in costly research programmes, refuse to enter the scanner at all.

It has been reported that 13% of patients undergoing MRI experience panic attacks during the procedure [5]. When such panic reactions occur in agoraphobic situations, they are known to be associated with the triggering and/or exacerbation of agoraphobic fear [6]. This observation would lead us to expect that in vulnerable individuals the MRI procedure alone could lead not only to the triggering of pre-existing claustrophobia, but to the onset of claustrophobia itself: there is some very limited evidence to suggest that in some patients claustrophobia may be initially provoked by the experience of being in the scanner [7].

Studies on claustrophobia, and the development of treatments, were previously largely behavioural

[8,9], but more recently, the focus has turned to the role of cognitions. Rachman and colleagues have demonstrated that the experience of claustrophobic anxiety and its reduction is closely related to beliefs about suffocation and restriction, indicating that cognitions play an important role in claustrophobia. In experiments looking at the reduction of fear in claustrophobia for example, [10] the authors found that they could identify two key cognitions which – if endorsed by people with claustrophobia – predicted those who did not benefit from repeated exposure to the claustrophobic situation and, in some instances, even experienced an increase in claustrophobic fear. Those beliefs were: “I am going to pass out” and “I am going to suffocate”. They also noted that the experience of intense bodily symptoms (similar to those usually associated with panic attacks) prevents people from becoming used to the situation. Those most frequently reported by participants were: shortness of breath (endorsed by 100% of the non-habitators), dizziness (86%) and choking/smothering sensations (57%). A follow up study, [11] gathered more extensive data relating to the interaction between cognition and peripheral physiology, which provided further evidence for the importance of beliefs and bodily sensations and confirmed that claustrophobia is composed of two main elements – fear of suffocation and fear of restriction. Rachman later went further and suggested that the beliefs ‘I will be trapped’, ‘I will suffocate’ and ‘I will lose control’ are critical cognitions in the maintenance of claustrophobia which, when eroded by treatment, can collapse the ‘cognitive constellation’ [12 p 179] surrounding the claustrophobic anxiety and lead to its elimination.

Studying claustrophobia in the context of MRI provides a further opportunity to examine the factors which may be involved in its aetiology, maintenance and treatment. In [5] for instance the authors assessed fear in relation to the claustrophobia-related cognitions of 80 patients undergoing first-time scans. Twenty five percent of the patients experienced moderate to severe anxiety, 13.75% suffered a panic attack and 4% stopped the scan prematurely due to anxiety. Scores on a multiple-item

claustrophobia questionnaire [11] predicted which patients would suffer the most distress and discriminated between those who did, and did not, report panic during the scan. Similarly, measures of subjective anxiety during the scan were correlated with thoughts characteristic of claustrophobia (restriction and suffocation). However, Harris et al. [13] using a questionnaire (MRI-FSS) derived from the Fear Survey Schedule [14] showed that fears associated with the unpleasant physical properties of the scanner itself (such as confinement, noise and isolation) were a better predictor of panic in the scan than either the claustrophobia questionnaire [11] or a measure of state anxiety. A later study, [15] evaluated the MRI-FSS and found that it could predict symptoms of panic and anxiety in the scanner better than a variety of other measures

The present study therefore aims to further explore the role of the above factors in the experience of claustrophobic anxiety, in the context of the MRI scanner, and to identify the related cognitions. It will examine the way in which this anxiety is related to negative cognitions such as fear of suffocation, of losing control or of being trapped and also how such anxiety is mitigated – or exacerbated - by the use of safety strategies and the individual's perception of the physical sensations experienced. In [16] for example the authors found that encouraging the use of safety behaviours by those undergoing treatment for claustrophobia was related to more fear both after treatment and later at follow-up.

Clearly in the case of MRI scans there are other issues to be taken into account which could increase the patient's level of anxiety and raise their vulnerability to claustrophobic reactions. As noted above, in many cases the scan is investigating a problem of a serious nature. In consideration of this the present study also investigates the patients' background levels of anxiety, depression and health anxiety in order to control for the effect of these on levels of anxiety. Subsidiary research questions

concern whether the patient's position in the scanner (head first or feet first) and whether or not they were put into the head coil had an impact on their anxiety level. The answers to these questions may have considerable practical value in improving patient experience of scanning procedures.

The aims of the study then, are: 1) establish the factors related to the anxiety experienced in the scanner; 2) to explore the cognitions most associated with this anxiety; 3) to investigate whether position in the scanner or wearing a head coil has an impact on anxiety levels; and finally 4) to explore whether previous experience in the scanner is related to the levels of anxiety experienced

METHOD

Participants

The participants were outpatients between the ages of 18 and 82 (mean age 45.34 years) at the Magnetic Resonance Imaging unit. Data were collected from patients over four consecutive weeks. One hundred and seventy two adult outpatients were approached initially; of these 146 agreed to participate. 16 pulled out for a variety of reasons (5 were too anxious to continue and 11 did not have time) after the first stage, leaving a final number of 130 people who agreed to take part. Finally, they were also given a pack of questionnaires to return by post: 100 people returned this set of questionnaires. A check was carried out as to whether the 33 people who did not complete the pre-scan questionnaires were different in their subsequent ratings of anxiety and claustrophobic symptoms to the 97 who did fill them in. There were no differences between the groups. A check was also carried out as to whether the 30 people who did not return the final set of questionnaires were different in terms of any of the measures, including claustrophobic anxiety, to the 100 who did return them: they were not. There were no significant differences between the groups on any of the

measures of claustrophobia, and we can therefore be confident that our sample was not biased.

Demographic details gathered were: age, gender and marital status. Details were also obtained of their position in scanner (head or feet first), whether or not their scan necessitated their head being held stable in the head coil (a quadrature bird cage design), length of time since last scan, and number of previous scans.

As the demographic details questions were part of the pack returned by post, details of only those 100 people who returned them are available: 57 patients were female and 43 male; mean age 44.31, range 18 to 82; years of education since age 12 mean 6.63 years, range 0 to 18 years; mean number of previous scans was 0.71, range 0 to 6, (60 patients had had no previous scan, 22 had had one previously, 10 two previously, 5 three previously, 2 four previously and 1 six previously). The mean time since last scan was 17 months (range 1 week to 9 years); 61 were married, 27 single, 6 divorced, 4 widowed and 2 separated.

Not all of the participants were able to fill in all the questionnaires, hence the varying number of participants reported in the various analyses in the results section below.

Measures

Anxiety score

This is a single-item measure of subjective anxiety. It asked patients to rate how often they experienced anxiety in the scanner on a 9-point scale from 0 ('never') to 8 ('all the time'). Additional prompts were above the number 2 ('rarely'), 4 ('about half the time') and 6 ('often'). As a check on the reliability and validity of this measure, scores were compared with scores on the Spielberger State anxiety index (STAI), completed before and after the scan, and the Beck Anxiety Inventory (BAI). See below for further details of these. Anxiety scores were highly correlated with

the pre-scan STAI ($r=0.576$, $p<0.01$), the post scan STAI ($r=0.650$, $p<0.01$) and the BAI ($r=0.565$, $p<0.01$).

State-Trait Anxiety Inventory (STAI) [19]

Spielberger STAIy-2 (State-Trait Anxiety Index) self evaluation questionnaire. This study only uses the 'state' part of the questionnaire in order to reduce the burden on participants and because trait anxiety is not the focus of the study. This was included as a check on the validity on the single item measure of anxiety. This consists of a series of 20 statements (e.g. I feel calm; I feel at ease; I am jittery; I am overexcited and rattled; I feel confident) which the respondent is asked to endorse on a four-point scale (not at all, moderately so, very much so) according to how they feel "right now at this minute". Initial construction and validation of this questionnaire was extremely rigorous and it has been used extensively as an anxiety measure. The internal consistency for the version, used here, is a Cronbach-Alpha coefficient of .92.

Claustrophobic Situations Questionnaire (CLAUSITQ)

The most widely used measure of claustrophobia has been the Rachman and Taylor claustrophobia questionnaire [11]. However a large proportion of the items on this scale refer to situations that the patient is unlikely to have experienced (e.g. '200 feet below the surface of the water in a small submarine' and 'standing for 15 minutes in a straitjacket') so its ecological validity may be compromised. The 21-item questionnaire used in the present study was designed by the authors to additionally assess level of claustrophobic fear in everyday situations - which all of the subjects were expected to have experienced. Examples are, 'going into a small cubicle in a public toilet' or 'going into a lift', 'going into a cupboard under the stairs'. An initial pool of items was generated on the basis of pilot work, consisting of situations which involved going into or staying in small spaces. After further piloting, this list was modified so that only items which reflected claustrophobic fear

remained while items which showed ceiling or floor effects were removed. Participants were required to rate their level of anxiety in these situations on a 9-point scale with anchors at every second point: 0 = not at all anxious, 2 = slightly anxious, 4 = moderately anxious, 6 = very anxious, 8 = extremely anxious. The internal consistency of the questionnaire, assessed using Cronbach's alpha was $\alpha = 0.93$ indicating high internal consistency.

The Strategies Questionnaire (STRATQ)

The Strategies Questionnaire, was designed by the authors to measure common avoidance and safety-seeking behaviours, was constructed using patients' reports of their experiences of the scan collected during the pilot study. It consisted of 8 items assessing how often people used particular strategies to help them cope with the scan. These were: closed your eyes, used deep breathing, tried to relax, tried to visualise other things, tried to blank the whole thing out, tried to think about other things, tried to keep control over your mind and tried to concentrate on the procedure. The questionnaire asked the participants to rate 'how often you did the following things during your MRI scan' on a 9-point scale with anchors at the following points: 0 = never, 2 = rarely, 4 = about half the time, 6 = often and 8 = all the time. Internal consistency, assessed using Cronbach's alpha was $\alpha=0.65$.

The Panic Symptoms Questionnaire (PSQ)

This is a 13 item scale. Items are the 13 common physical symptoms of panic as specified by DSM IV [17]. Participants were required to rate how often they experienced these symptoms on a scale of 0 (never) to 8 (all the time). Internal consistency, assessed by Cronbach's alpha was high: $\alpha = 0.89$.

Claustrophobia Restriction and Suffocation Questionnaire (CRSQ)

A short (12-item) version of the Rachman and Taylor questionnaire described above [11], adapting

previous items to make them more specifically relevant to the restriction and suffocation components of claustrophobia. For example, where in the longer questionnaire the item was 'getting into a sleeping bag', the item here is 'lying in a tight sleeping bag enclosing legs and arms, tied at the neck unable to get out for 15 minutes. This is a 5 point scale and participants are asked to indicate how anxious they would be 'having a pillow over your face', 'in a public washroom and the lock jams', handcuffed for 15 minutes' 'swimming with a nose plug' and so on. Anchors were 'not at all anxious' to 'extremely anxious'. Each scale has 6 items belonging to it: the Restriction items have a Cronbach's Alpha of $\alpha = 0.90$ and the Suffocation items a Cronbach's Alpha of $\alpha = 0.82$

The Claustrophobic Cognitions Questionnaire (CCOGQ)

The Claustrophobic Cognitions Questionnaire is based on the Phobic Cognitions Questionnaire [18]. Additionally, it contains items derived from verbal reports of patients collected during pilot work. It asks participants to rate how often each of the 21 thoughts occurred to them while in the scanner. Items were scored on the same 9-point scale (where 0 = never and 8 = all the time. In order to save time, only the frequency of the thoughts (rather than the distress associated with them) was elicited: previous studies have shown that there is such a high correlation between scales relating to frequency of and distress (caused by intrusive thoughts in this instance), that one is redundant. The cognitions listed are a combination of thoughts directly related to the experience of the machine such as, 'I am going to get stuck in here', 'The machine is harming me' and negative thoughts as to the consequences of anxiety such as 'I am going to faint in here', 'I will have a heart attack'. The Cronbach alpha value was $\alpha = 0.94$ indicating high internal consistency. Concurrent validity was tested by examining the relationship between it and the full 21 item standardised measure of claustrophobia (CLC: Rachman and Taylor 1993) described above: $r=0.452$, $p<0.0001$

Other measures

Standardised clinical questionnaires were as follows:

Beck Anxiety Inventory (BAI) [20].

Depression: Beck Depression Inventory (BDI) [21].

Health anxiety: Health Anxiety measure (consisting of three parts, the HAI, measuring hypochondriacal symptoms, HypA measuring avoidance of illness-related issues and HypR measuring reassurance seeking about health [22]).

Procedure

Pre-scan

Patients were approached five minutes before their scan and invited to participate in the study.

If they agreed they completed the measure of state anxiety (STAI). In addition they were given an information sheet to read about the study, and written consent was obtained. If patients were called within five minutes, completion of this questionnaire was not always possible. Staff in the unit were very aware of the anxiety-inducing aspects of the process and were very supportive and helpful to anxious patients. The diameter of the scanner bore was 58 centimetres horizontally, and 42 centimetres vertically.

Post-scan

Five minutes after the scan, patients were given the single item anxiety measure, the STAI again, the Panic Symptoms Questionnaire (PSQ), the Strategies Questionnaire (STRATQ) and the Claustrophobic Cognitions Questionnaire (COGQ). In view of the large number of questionnaire measures to be completed participants were allowed to complete some of the post scan measures at home and were given a prepaid addressed envelope (for the purposes of analysis no distinction was

made between post scan measures completed in the clinic or at home). The home pack contained the Claustrophobic Situations Questionnaire (CLAUSITQ), the Beck Anxiety Inventory (BAI), the Beck Depression Inventory (BDI), The Health Anxiety, Hypochondriacal Avoidance and Reassurance seeking scales (HAI, HypA and HypR) and the claustrophobia restriction and suffocation scale (CRSQ). Figure 1 shows this process graphically.

FIGURE 1

RESULTS

Factors related to the experience of anxiety in the scanner.

The first analysis addressed the question of which factors were important in the experience of anxiety in the scanner.

First, the data set was split into three groups in line with the wording of the anxiety measure:- a low anxiety group who scored 2 or under on the measure of subjective anxiety experienced during the scan (i.e. they rarely felt anxious or felt no anxiety at all) a medium anxiety group who scored 3, 4 or 5 (i.e. they were anxious less than half the time but more often than rarely) and a high anxiety group who scored 6 or more on the anxiety measure (i.e. they felt anxious about half the time or more).

Of the 130 people who responded to this item, 70 (53.85% of the sample) were in the high anxiety group, 35 (26.93%) in the medium anxiety group and 25 (19.23%) were in the low anxiety group. There were no differences between these three groups on measures of health anxiety, hypochondriacal avoidance and reassurance-seeking, or depression.

Concurrent validity of the anxiety measure was explored by one way analysis of variance: a significant difference was found between these groups on the standardised measure of state anxiety (STAI) administered immediately after the scan ($F_{2,94}=37.93$, $p=0.0001$). Tukey's test revealed that

the groups were all different from each other, with means of 27.43, 39.11 and 47.22 on the STAI in the low, medium and high anxiety groups respectively.

The relationship between levels of anxiety and a variety of measures were then explored. The three groups (low, medium and high anxiety) were examined in relation to their scores on the measures of claustrophobic restriction and suffocation (CRSQ), strategies employed to contain claustrophobic anxiety in the scanner (STRAT), symptoms of panic felt in the scanner (PSQ) and cognitions about the consequences of being in the scanner (CCOGQ). The groups differed on all measures, however, Tukey's test revealed that the differences were to be found between the high and low anxiety groups, with the medium group not being different to either, except with regard to panic symptoms and claustrophobic cognitions, where all three groups were significantly different from each other. Table 1 below shows these results in full.

INSERT TABLE 1 ABOUT HERE

The relationship between cognitions and anxiety

The second research question was first addressed by exploring whether particular cognitions are related to the amount of anxiety experienced during the scan, and the relative importance of these. A stepwise multiple regression was carried out using the same variables as above: claustrophobic restriction and suffocation, strategies employed to contain claustrophobic anxiety in the scanner (STRAT), symptoms of panic felt in the scanner (PSQ) and cognitions about the consequences of being in the scanner (CCOGQ). The single-item measure of anxiety was the outcome variable. Only three of five possible explanatory variables were significantly predictive of anxiety: the order in which they were entered into the regression model is shown in Table 2.

INSERT TABLE 2 ABOUT HERE

The strongest predictor of anxiety appears to be the perception of the amount of time spent having panic symptoms in the scanner, followed by the number of thoughts about the (negative) consequences of being in the machine and finally by the number of techniques employed to control the anxiety.

The details of the second research question were further investigated. Given the apparent importance of the number of negative thoughts to the experience of anxiety, this variable was further assessed in order to determine the relative importance of type of thought to the experience of anxiety. To do this the cognitions were divided into 6 categories: fear of being trapped (TRAP e.g. I am going to get trapped in here, I am going to get stuck); fear of suffocation (SUFF e.g. I will not be able to breathe; I will suffocate in here); fear of losing control (CONTROL e.g. I will lose control; I will go insane); fear of coming to harm (HARM e.g. I am going to have a stroke in here; I will die in here; I will have a heart attack); fear of the machine causing harm (M-HARM e.g. Something will go wrong with the machine when I'm in it; the machine is harming me); fear of making a fool of oneself (FOOL e.g. I will do something that will spoil the scan; I will make a fool of myself). These items were entered into a multiple regression analysis with scores on the anxiety measure as the outcome variable. Only three of the six possible explanatory variables (types of thought) were significantly predictive: the order in which they were selected as predictors is shown in Table 3

INSERT TABLE 3 ABOUT HERE

So, looking at the relative importance of types of beliefs within the set of claustrophobic cognitions alone, the frequency of fears of suffocation, of the machine causing harm and of losing control to were found to predict the amount of anxiety felt in the scanner most effectively.

Position in the scanner or wearing a head coil: the impact on anxiety levels

The third question to be addressed was whether more anxiety was experienced by: those with a head coil or those without; and those who were put into the scanner feet first as opposed to head first. There were no between group differences in initial levels of state anxiety. Importantly there were also no differences in the specific post scan measure of scanner related anxiety in either the comparison of head coil and no head coil condition or the head vs feet first condition. In all cases, $t < 1$.

The relationship between previous experience in the scanner and levels of anxiety.

The final analysis explored whether there were any differences in anxiety ratings as a function of number of previous scans, and length of time since last scan.. Patients were grouped according to whether they had had no previous scans (n=78), one previous scan (n=30), or more than one previous scan (n=22, range 2-6). Due to the different sizes of participant in each of these groups, a Kruskal-Wallis test was used, with anxiety as the dependent variable. There was a significant difference between the groups ($F_{2,127}=4.23$, $p=0.016$), with mean ranks of 71.78, 63.32 and 46.23 respectively, indicating that the more often the patient had been scanned previously, the less anxiety they reported. However, there was no relationship between anxiety and the amount of time since last scan.

DISCUSSION

There were four research questions in the present study.:- to establish the predictors of the anxiety experienced in the scanner; to explore which cognitions are most associated with this anxiety; to investigate whether position in the scanner or wearing a head coil had an impact on anxiety levels; and to explore whether previous experience in the scanner is related to the levels of anxiety experienced.

A variety of factors were found to be of possible importance in the experience of anxiety in the scanner, including the amount of time spent having physical symptoms of panic, the number and type of cognitions judged to have been experienced while in the machine and the number of strategies employed to control levels of anxiety. This finding is in line with McIsaac et al. [5]. The results suggest that the most important predictor of the amount of anxiety perceived during the scan was the perceived amount of time spent having physical symptoms of panic. The number of strategies employed to offset this was also predictive and while unsurprising – in that anxiety symptoms and coping mechanism/safety strategies are always closely related – this does nevertheless contribute to our understanding of the process.

The most interesting finding concerned the cognitions most associated with this anxiety. These were specific claustrophobic cognitions to do with suffocation, with the harm caused by the machine and with ideas of control. The next most important predictors were strategies used to cope in the machine. This is broadly in line with the findings of the authors of [13] who suggest that it is the unpleasant physical properties of the scanner itself which is the most important factor in the triggering of anxiety, and with other research[23] which notes the importance of beliefs around the subject of self control, to the experience of being in the scanner.

Additionally, it was found that there was no effect of position in the scanner or use of a head coil on the level of anxiety experienced in the scanner. This contrasts with the results of the McIsaac et al [5] study. However, given that fear of suffocation seems to be more salient than fear of restriction, and the head coil is open, this may be a partial explanation of this lack of effect. Similarly, as the bore in the machine used in this study was open at both ends the final resting position is the same whichever way it is entered. It may also be the case that for many, MRI is stressful regardless of position or use of head coil and possibly those who interpret bodily symptoms in a catastrophic manner may already be at the ceiling of possible responses, so whether or not there are added stressors will make little difference.

Finally, there is some evidence to suggest that people undergoing a series of scans become less anxious over time. However, as the majority of people only undergo one scan, this does not significantly affect the fact that it is important to understand the triggers of anxiety for those undergoing their first experience.

This study does suffer from some methodological limitations. A few of the participants were called away to their scans before being able to complete the initial state anxiety questionnaire. Most of the questionnaires were filled out after the scan in the clinic, or at home. However as the claustrophobia questionnaires have been shown to have high reliability, and are thus robust over time, it would not be expected that they would be affected by this. Again, although some 30 people did not send back the questionnaires, 100 people did, which is a very high response rate. Additionally, there was no difference on any of the target variables between participants who did and who did not fill in all the questionnaires so the sample does not appear to be subject to any particular bias. Another limitation is that the participants were required to complete quite a large number of questionnaires: however, in

an exploratory study such as the one reported here it is important to be inclusive in order to capture as many of the possibly relevant psychological factors as possible.

Another possible limitation of the study is that different staff were dealing with the patients at different times. Physicians' communication styles and ways of dealing with patients have been found to have an influence on treatment adherence for example [24, 25]. This was not examined in the present study but could be a fruitful area for future research, as could staffing levels and work flow speed.

Taken together, the present study and the studies described above also suggest that the claustrophobic response to MRI has much in common with other anxiety disorders, (particularly panic disorder and of course other specific phobias), in terms of characteristic beliefs about threat and catastrophe. There is also evidence that underlying the claustrophobic reaction is a vestigial, powerful and primitive fear of being suffocated: human fear reactions when trapped in enclosed spaces are very similar to those shown by animals when prevented from escaping a situation [26]. However, this is not to say that such fears are beyond the reach of reason – as has been illustrated here, the cognitive component may be important even when the origin of the fear can be described as innate.

Another important point is that while there may be individual differences in the degree to which people fear restriction or suffocation, as in other phobias, the catastrophic *interpretation* of this fear and the bodily sensations that go along with it appear to be driven by specific and particular beliefs such as those identified here about the perception of possible harm, of control and of coping strategies: this could be the distinguishing factor between those who panic in enclosed spaces and those who experience identical physiological symptoms of anxiety but who do not panic.

The implications of this study for hospital and clinical staff are that they may be able to identify patients who are likely to terminate the scan prematurely, or become extremely anxious and restive during the scan, using a brief measure targeting the factors here found to be important in the experience of claustrophobia in the scanner. This could be sent out to patients before their appointment, potential claustrophobia identified and ameliorative measures put in place: they may be given for example, additional information about the amount of air needed to sustain life and the air flow in the scanner, as well as factual information about the physical properties of the scanner, with an emphasis on the safety aspects. Some patients may need more specific interventions relating to panic and this can be drawn from the literature on cognitive models of panic disorder. New advances in the technology may also bring their own challenges: the development of array coils for example, which involve laying flat panels around the targeted area, in some cases several together, possibly in addition to the patient being strapped to the scanner table, may increase the incidence of claustrophobic reactions and would be useful to investigate in the future.

One session treatment for specific phobias has been found to be highly effective (e.g.[25]) and those patients with pre-existing claustrophobia may benefit from one-session treatment – particularly if there is a replica (non functioning) scanner such as those found in research departments. The first author of the study presented here for example, building on the findings reported, was able to carry out a brief but effective intervention with a severely claustrophobic woman who was unable to tolerate the thought of entering a scanner in order to have a vital head examination. This intervention was based on the factors found to be most associated with anxiety in the scanner and the strategies commonly used to combat it: she was given information about the nature and course of anxiety, the type of experiences she may expect, and facts about the safety of the equipment. She was also taught

a very simple breathing exercise. All of these contributed to an increase in her sense of being able to exercise some control over herself in the situation and enabled her to tolerate being in the scanner for a considerable length of time. These are techniques derived from cognitive behaviour therapy and relaxation training, shaped by findings from the present study and targeted at the specific situation of being in a scanner - a situation which shares many of characteristics found in the more general experience of claustrophobia.

Brief interventions have been found to be particularly effective in the treatment of specific phobias: Öst et al. for instance [26] compared one versus five sessions of exposure and five sessions of cognitive therapy in the treatment of claustrophobia and found that all were equally effective. Other studies have focussed on the importance of the availability of aids to safety (such as the ability to communicate with the experimenter, access to fresh air), even when these are not actually used [27]. This resonates with the finding here that issues around the perception of control may be important. Previous studies of interventions with people who were phobic of undergoing dental treatment using video information and coping techniques for example, have been highly effective [28, 29] as have techniques involving emotional processing (e.g.[30])

The study presented here has provided more evidence to enable further refinement and distillation of such techniques in the context of MRI scanning. It is hoped that this may be helpful in preventing early termination of scans or reducing motion artefact in the image produced. The next stage will be to further refine and test a short MRI-specific diagnostic instrument in order to be able to accurately identify those people most in need of help before they attend the examination session, and to test the efficacy of a targeted intervention in a clinical setting.

Acknowledgements

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Table 1. Mean scores by group

Measure	Low Anxiety n=25	Medium Anxiety n=35	High Anxiety n=70	f	p=
Restriction	7.95*	10.36	14.18*	8.11	.001
Suffocation	6.26*	9.00	10.81*	6.75	.002
STRAT	30.90*	36.36	41.52*	9.36	.000
PSQ	7.94*	20.69*	34.60*	48.13	.000
CCOGQ	7.17*	26.20*	51.44*	41.93	.000

In each row means with asterisks are significantly different from each other

STRAT=strategies, PSQ= Panic Symptoms Questionnaire; CCOGQ= Claustrophobic Cognitions Questionnaire

Table 2: Multiple Regression: Models for measure of anxiety.

Anxiety		%variance explained
1 st model: PSQ	$F_{1,93}=132.03, p<.0005$	58
2 nd model: PSQ + CCOGQ	$F_{2,92}=79.04, p<.0005$	62
3 rd model: PSQ + CCOGQ + STRAT	$F_{3,91}=58.47, p<.0005$	65

PSQ = Panic Symptoms Questionnaire; CCOGQ= Claustrophobic Cognitions Questionnaire; STRAT=strategies,

Table 3: Multiple Regression: Models for measure of anxiety.

Anxiety		% variance explained
1 st model: SUFF	$F_{1,126}=68.02, p<.0005$	35
2 nd model: SUFF + M-HARM	$F_{2,125}=52.39, p<.0005$	45
3 rd model: SUFF + M-HARM + CONTROL	$F_{3 241}=39.11, p<.0005$	47

SUFF=perceptions of suffocation; M+HARM= perceptions that machine will cause harm;
 CONTROL=perceptions of control

Figure 1: Overview of questionnaire administration

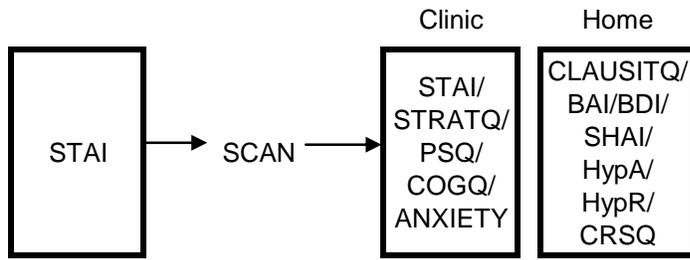


Figure 1: Overview of questionnaire administration