Tischler, Victoria and Bronjewski, Emma and O'Connor, Katherine and Calton, Tim (2009) Magnetic resonance imaging (MRI) scanning for research: the experiences of healthy volunteers and patients with remitted depressive illness. Mental Health Review Journal, 14 (3). pp. 23-30. ISSN 1361-9322

Magnetic Resonance Imaging (MRI) Scanning for Research: The Experiences of Healthy Volunteers and Patients With Remitted Depressive Illness

Victoria Tischler* Lecturer, University of Nottingham.

Emma Bronjewski, Medical Student, University of Nottingham

Katherine O Connor, Medical Student, University of Nottingham

Tim Calton, Fellow, Institute of Mental Health

Address for correspondence:

*Division of Psychiatry- Behavioural Sciences. A Floor, South Block, Queens Medical Centre Nottingham. NG7 2UH victoria.tischler@nottingham.ac.uk

Magnetic Resonance Imaging (MRI) Scanning for Research: The Experiences of Healthy Volunteers and Patients With Remitted Depressive Illness

Abstract

We report the findings from a study exploring the experiences of individuals undergoing MRI scanning for research. Semi structured interviews took place before and after scanning with 17 participants; 12 were healthy volunteers and 5 were patients with a diagnosis of remitted depression. Themes of apprehension and curiosity prior to scanning were common in both groups. Patients were often confused about the procedure. Negative feelings were an issue at the outset, characterised by shock related to the physical surroundings, after which positive feelings, for example relaxation, were often experienced, and in the case of patients, learning more about their brain. Written information about imaging was deemed satisfactory; however the ability to 'experience' aspects of scanning beforehand was suggested. Scanning may be viewed as a process beginning prior to the procedure itself and involving positive and negative emotions. Increased information, reassurance and a more interactive intervention to reduce anxiety may be beneficial and may improve individuals' experience of this widely used procedure.

Keywords: magnetic resonance imaging scanning (MRI); qualitative; support; research; experiences

Introduction

Magnetic resonance imaging (MRI) is a widely used diagnostic tool in the health service. It is also increasingly used for research purposes in the mental health field, for example, to investigate structural brain abnormalities and to assess cognitive function. A range of literature suggests that MRI can be problematic psychologically (Brennan et al., 1988, Shellock, 2005). Respiration or swallowing may be increased in apprehensive patients (Grey et al., 2000) and motion artefacts arising from such increased movement result in images of no diagnostic value (Harris et al., 2004). Anxiety may also be attributed to the physical conditions of the scanner and to a lesser extent, fear of what the scan may discover (Flaherty and Hoskinson, 1989, Grey et al., 2000). Anxiety reactions also impose costs on the health care system as a result of aborted and cancelled scans (Melendez and McCrank, 1993). Individuals experiencing anxiety may go on to develop long term claustrophobia (Harris et al., 2004), leading to an increased rate of non-attendance for follow up (Phillips, 1995). MRI scanning of research volunteers has also been associated with anxiety reactions (Cooke et al., 2007), although this has received limited exploration.

It has been suggested that MRI combines the stress and uncertainty of more invasive procedures with sensory deprivation. Individuals may also be fearful of the equipment (Wilson-Barnett, 1990) in relation to the loud acoustic noise delivered during imaging (Spouse and Gedroyc, 2000), creating difficulties in communication (Mechefske et al., 2002). There have also been a range of complaints relating to a lack of information, the duration of scanning and the temperature within the scanner (Harris et al., 2004, Melendez and McCrank, 1993, Quirk et al.,

1989a). Patients may also anticipate pain, discomfort, loss of sense of control (Grey et al., 2000) and anxiety related to symptoms of panic experienced whilst being scanned (Thorpe, 2008).

A number of interventions are used to help reduce scan-related anxiety levels, for example the provision of information (Tornqvist et al., 2006a, Wilson-Barnett, 1982), sedation (Avrahami, 1990), practice of relaxation exercises, cognitive behavioural therapy (Phillips, 1995), listening to pre-recorded sounds of the scanner (Quirk et al., 1989b), listening to music and prone positioning in the scanner allowing the patient to see outside of the magnet bore (Hricak and Amparo, 1984, Melendez and McCrank, 1993). Use of scanners with a shorter and wider bore (Spouse and Gedroyc, 2000) and scanning simulation in 'mock scanners'(Rosenberg et al., 1997) have also been reported to help reduce anxiety. Patients can also employ coping strategies during the examination, for example making use of 'blinding' which involves closing or covering the eyes during the procedure (Quirk et al., 1989a, Melendez and McCrank, 1993).

Such interventions are not always practical; prone positioning is not suitable in patients with shortness of breath, fresh abdominal incisions and drainage tubes (Melendez and McCrank, 1993) and is dependent on what part of the body is being scanned. Written information has also been reported to be misleading, incomplete or absent (Brand, 1994, Melendez and McCrank, 1993). Strategies such as hypnotherapy place large demands on resources and time (Phillips, 1995) as do mock scanners. Evidence suggests that despite the range of interventions used, anxiety remains prevalent.

A few previous studies have used qualitative methodologies to examine participants' experiences of scanning. It has been reported that the strange environment and isolation inside the scanner made the experience unusual for patients, posing a threat to self control (Tornqvist et al., 2006b). Previous studies (Cooke et al., 2007, Shaw et al., 2008) with healthy research volunteers concluded that MRI scanning provokes increased anxiety due to the medical context and the potential diagnostic function. The current study follows from our previous research which indicated that anxiety was still an issue in 20% of English scanning centres leading to scan disruption (Tischler et al., 2008). The aim is to understand and compare the perspectives of individuals with mental health problems and healthy volunteers and undergoing MRI scanning, to help characterise the types of reactions encountered and what, if any, support is required.

Method

Semi structured interviews were used to explore the subjective experiences of participants, before, during and after scanning. Interview guides were developed based on a literature review, ensuring that topics considered crucial to the study were covered and that opportunities were given for participants to raise issues of interest (Mays, 2006, Pontin, 2000). Participants were interviewed immediately before and after scanning. The interviews were digitally recorded and transcribed verbatim. Participants were assigned pseudonyms to protect anonymity. Demographic information was also collected from all participants, including details of previous MRI scanning if relevant.

Volunteers undergoing structural and functional MRI scanning for academic research were recruited over two separate three month periods using purposive sampling. This is appropriate as

participants were being selected because of their knowledge of the phenomenon under scrutiny (Bluff, 2005). Healthy volunteers were recruited using posters advertising the research project. Patient volunteers were recruited via their responsible consultant psychiatrist. These individuals were also taking part in a separate study examining disease markers and predictors of clinical relapse in remitted unipolar depression. This group is hereafter referred to as the 'patient' group.

Volunteers were given information provided for MRI volunteers by the Brain and Body Centre and the Division of Psychiatry, University of Nottingham plus a consent form and a personal details questionnaire. Two scanners were used, both located in purpose built facilities on the University of Nottingham campus. The scan duration varied from 10 to 70 minutes, with an average of 40 minutes. Times varied as participants may have brain, abdomen, whole body or multiple scans due to motion artefacts requiring repeat scanning.

Ethical approval was obtained from the University of Nottingham Medical School Research Ethics Committee for the healthy volunteers and from the Local Research Ethics Committee for the patient volunteers. Full informed consent was obtained from all participants.

A thematic analysis was used to make sense of the data. This approach involves a progression from describing the data to interpretation, that is, making sense of the data related to the aims of the research. An essentialist framework was used which aims to report the experiences, meanings and reality of the research participants (Braun, 2006). The research team met regularly to discuss emergent themes and to refine these into over-arching themes. Care was taken to identify contradictory findings and disconfirming evidence. Analysis and interpretation of data was

completed when theoretical saturation was reached (Flick, 1998). Inter-rater reliability related to the themes was tested by an independent researcher (MN), using Boyatzis'(Boyatzis, 1998) method. The results demonstrated 90-92% agreement between raters. Nudist Vivo (version 7), a computer software programme was used to organise data and assist with analysis.

Results and Discussion

Twelve healthy volunteers, aged 20 – 34, seven males and five females, and five patients, aged 25 - 56, all male, participated. Most healthy volunteers were university students and all patients had experienced two or more episodes of major depression according to DSM-IV criteria.

Eight healthy volunteers and 4 patients were 'naïve' to scanning. English was the first language for 16 participants; the other participant had learnt English from an early age. Themes were identified semantically within three topic areas: feelings prior to scanning, scanning experiences and information and support needs.

Apprehension, nervousness and worry

Feelings of apprehension, nervousness, confusion or worry regarding the upcoming scan were commonly reported. Such feelings have been reported previously (Brennan et al., 1988). All 'naïve' participants reported these feelings. The problematic nature of such reactions in the medical environment may result in terminated scans (Melendez and McCrank, 1993) and images of no diagnostic value (Harris et al., 2004) therefore we considered it important to explore the reasons for such feelings. Apprehension was largely attributed to the fact that scanning was a

novel experience. The lack of previous life experience from which to draw upon seemingly made the situation more difficult to deal with:

> I'm not really sure what is going to happen…it must just be the fear of the unknown and the fact that it's not a normal experience is it? It's not something you've ever experienced before like being stuck in a tube…I suppose, you've got no other life experiences like that to draw on to prepare yourself for it (healthy volunteer).

The 'unknown' referred to participants' limited knowledge of the scanner environment, the procedure itself and what would be expected of them. This was a particular issue for patient participants.

Most participants' knowledge of MRI was limited to it being: "something to do with magnets". Discrepancy between knowledge of different aspects of the scan may have led to confusion and ultimately feelings of nervousness. For example, some perceived the scanner to be: "overwhelming" and "scary". Persisting uncertainty before scanning combined with the complexities of the technical function of the scanner may have led to such perceptions of threat (Wilson-Barnett, 1990).

One patient thought he was about to have an electroencephalogram (EEG) rather than MRI scan: "I presumed there'd be lots of wires and stuff…not actually wires stuck in me but you know them sort of like shower cap things with wires coming out of them."

Another participant who described the scan as "non invasive" beforehand, commented afterwards that he felt the magnetism may affect his brain:

> I was kind of imagining this kind of slice being taken…just wondering what on earth it was doing to the inside of my brain with this magnetism…I did get some little twinge, I don't know what it was, it was strange just when the, I guess when the magnets turn on or just some, just a strange sensation in the fingers (patient).

Furthermore uncertainty surrounded the purpose of the scan. A few individuals' knew that researchers were not actively looking for abnormalities, whereas others considered that the scan was assessing health, resulting in worry and nervousness regarding outcome. Also, health risks and possible negative outcomes highlighted in the information given beforehand were of concern to participants confirming previous findings (Cooke et al., 2007). Even healthy volunteers had concerns about health and insurance issues: "They'll pick up any large abnormalities … tumors or stuff like that… soon find out. I guess it's a bit erm unnerving really to think that there might be something wrong with me."

The uncertainty felt by participants reflects the limited information given before scanning and their queries not being wholly addressed before the procedure. This could be a particular issue for patients who might be apprehensive about having scans for diagnostic reasons. It has been well documented that a description of the nature and purpose of medical procedures is reassuring (Hawkins, 1979) enabling the individual to keep a sense of control (Grey et al., 2000).The

concerns about the ‘unknown’ and lack of reassurance meant that apprehension and negative expectations were commonplace. Specifically, negativity embodied an expectation of feeling anxious, bored, fed-up and uncomfortable in the scanner.

Curiosity and excitement

A feeling of curiosity has been previously identified as a factor which encourages research participation (Cooke et al., 2007, Shaw et al., 2008). Some patients also reported altruistic motives for taking part in the research. Excitement is a relatively novel concept which has been little considered in the context of medical procedures. Curiosity and excitement were reported by healthy volunteers only. This indicates that the sense of the ‘unknown’ can create feelings of apprehension but also positive emotions in some individuals.

Some healthy volunteers anticipated personal gains from taking part in the research, this was particularly true of those studying to be health professionals who viewed it as a useful opportunity to learn about medical diagnostics. Others were curious to see images of their internal organs, confirming findings from other studies (Cooke et al., 2007).

Although much curiosity and excitement appears to result from being able to experience technology not usually available in non-clinical settings, certain aspects of this finding might be relevant to a patient population. Patients might be curious to view scanning images of their organs, therefore providing this could encourage individuals to undergo scans. Indeed a number of patients commented on how interesting it was to see a scan of their brain. It could be that

visualising the organ and any abnormalities present might give patients a fuller understanding of their illness.

"In the tube"

Negative feelings during scanning have been well documented in previous studies (Fishbain et al., 1988, Melendez and McCrank, 1993, Spouse and Gedroyc, 2000). The current study explored in more detail why such feelings might occur. Most negative experiences were related to the physical confines of the scanner which was referred to as restrictive and narrow by both healthy volunteers and patients. It was felt that discrepancy between expectation and experience might have caused negative feelings such as shock.

> I thought that my head would actually be popping out the other end. But it doesn't, it just stays in the tube so I was like "oh" and at first I was a bit panicky, well not panicky just a bit "wow this is close" but then, it was ok… yeah, at the beginning I felt a bit scared (healthy volunteer).

Previously feelings of confinement have been associated with claustrophobic responses (Kilborn and Labbe, 1990, Spouse and Gedroyc, 2000). Such feelings came as a shock to participants. This suggests that the information provided beforehand had not sufficiently prepared them for the experience. Even individuals who did not normally consider themselves 'claustrophobic' reported discomfort, suggesting that routine screening for claustrophobia (Flaherty and Hoskinson, 1989) might not identify all individuals likely to experience such responses.

> It was a real shock; I was like oh my god. I thought I was going to explode or something. I was actually quite scared. I was more scared than I thought I would have been. When I first went in I was like… oh my god this is really close. I kind of thought to myself at that point… I started to feel a bit claustrophobic which is really silly cos I'm not claustrophobic really… I didn't like it (healthy volunteer).

In accord with previous studies (Harris et al., 2004), the loud noise of the scanner was found to be unpleasant, not only because of its volume but also due to its intermittent and 'unnatural' sound.

> You just feel like you're going to be swallowed or whatever, I was very scared, I even thought that I was not going to do it at the beginning. I don't like that much that noise. It's just like, you're sinking with the submarine, going deep, deep, deep inside the mouth of a big octopus and you're going to be swallowed. I felt like if I was going to be closed up into a box or something…I was very frightened (healthy volunteer).

Remaining uncertainties at the beginning of the scan had a negative impact on the scanning experience, adding to the suggestion that information provided was insufficient. These uncertainties were largely related to lack of communication during the scan, in relation to whether using the call button could be used for non-emergencies and also in relation to breath-holding tasks.

> At the beginning it was a bit strange because I wasn't sure exactly what he meant by not being able to move - did that mean that I wasn't allowed to twitch my fingers or did it just

mean big movements? I wasn't sure whether I was allowed to cough, at one point I felt like I needed to cough but I didn't just in case (healthy volunteer).

Acclimatisation

Positive experiences are less well documented in existing literature although they have been noted elsewhere (Cooke et al., 2007). This suggests that preparatory information could be improved by highlighting positive aspects of scanning as well as alerting individuals to potential negative reactions. Relaxation and feeling sleepy was reported. Indeed, many negative feelings were transient, being remedied after having adjusted and acclimatised to the new situation as one patient describes: "the noise didn't bother me, it did at first when I heard it but after a while, after the test progressed, I just put it at the back of my mind"

The findings suggest that despite limited knowledge of the procedure and negative expectations, the scanning experience is often better than expected and that negative feelings often subside following acclimatisation. Also, curiosity, excitement and altruism can provide positive motivation for scanning. Such findings could be used to tailor information and preparation for scanning.

Communication, Distraction and Information

A number of reassuring factors were identified by participants. Communication with staff was particularly important as participants felt they could ask questions and alert someone if they were uncomfortable. The patients were also reassured by the presence of medically qualified staff.

Several participants commented that talking about their expectations was beneficial. This suggests that similar support offered before scanning could be of value. It has already been documented that participating in qualitative interviews can have a beneficial effect on participants (Mays, 2006).

> Talking to you has actually lessened the anxiety a bit because just talking it through with someone, even though you haven't given me any additional information has helped…so I'm not sitting… left to my own devices thinking about what's coming, I suppose I'm being a bit distracted even though we're talking about what's coming (healthy volunteer).

The knowledge that communication with the 'outside world' was possible during scanning using a call button provided reassurance for participants. Functional tasks, music and 'blinding' were viewed as being a welcome distraction from negative environmental factors. Although music was widely regarded as being a welcome distraction, an ability to choose music to be played during the scan was suggested by several of the participants. Many scanning centres have such protocols in place but this finding could also be indicative of a more general need for control. The ability to maintain control in medical procedures improves patient satisfaction (Quirk et al., 1989b), and should be considered when developing future interventions. Several participants noted that previous experience of scanning, and positive reports of scanning from friends and family members made them feel more comfortable about the experience.

A number of needs were identified which suggested that individuals were not adequately prepared for scanning. These included a need for detailed information, control during the procedure and familiarisation with the scanning environment.

It was suggested that an account of the experience provided by someone who had already undergone the scan as well as detailed, step-by-step procedural handouts would be helpful. This information related to the actual procedure as well as operational issues such as what they'd be expected to wear and where belongings could be left securely. Participants largely felt the experience could not adequately be described on paper, many suggesting more exposure to the practical aspects of scanning would be helpful. For example one healthy volunteer stated: "I would have liked a bit more about…you know, how you actually… sit, what the machine looks like, what will happen as the machine scans you - things like that" Participants also requested a need for more information relating to "how the scanner works" and to have more information on the purpose of their scan so that they knew exactly what was being investigated. Contrary to findings suggesting insufficient information about procedure, most participants stated that the written information that was provided was sufficient, yet they still reported feelings of apprehension, negativity and in some cases confusion. It might be however, that the type of information being provided is not optimal.

Familiarisation with the environment and procedure might also be helpful in encouraging individuals to attend appointments as most participants, regardless of whether they had been naïve to scanning beforehand, noted that they would be less hesitant about attending any potential future scans.

Finally, the need for support after scanning was highlighted, for example, for someone with medical training to scrutinize the scan to check everything was ‘normal’ and showing no abnormalities, this has been previously suggested (Mackenzie et al., 1995).

Conclusion

In this article we aimed to explore the expectations and experiences of patients with mental health problems and healthy volunteers undergoing MRI scanning for research and to identify support and information needs. The results add context to previous quantitative findings related to scan-related anxiety and builds on previous studies as we explored expectations prior to scanning, perceptions of the experience itself and ways to support individuals throughout the procedure in two different study populations.

The results suggested that negative expectations and experiences are common in both patients and healthy volunteers and might be due to inadequate knowledge regarding scanning. The findings suggest that negative feelings were largely transient once the scan was underway, with most reporting a positive experience subsequently. The reports of pre-scan curiosity and excitement and positive experiences such as feeling relaxed and sleepy have received little previous attention in the literature. Provision of scanning images might create curiosity about the procedure and so help to motivate individuals as it gives them something unique to ‘take away’ These findings could be incorporated into pre-scanning information given to individuals and might help to alleviate negative expectations related to the procedure. Also, we would advocate that researchers spend time before scanning to fully explain any written materials given to

participants to address any uncertainties. Interactive material related to the environment of the scanner and other related issues could also be beneficial in helping individuals prepare for the procedure.

Acknowledgements: Professor's Peter Liddle and Tomas Paus and Dr's Graham Worwood and Neil Nixon for help with recruiting participants, Marina Nicolaou for assistance with analysis and all research participants for taking part in the study.

Conflict of Interest: There are no conflicts of interest to declare.

Funding: A grant was received from Nottinghamshire Healthcare R&D Small Grants Fund.

Implications for practice

- Research participants are often concerned about MRI scanning, and some may be anxious and confused about what to expect.
- Researchers should provide full information about scanning including verbal reinforcement of what may be expected and reassurance during procedure
- Opportunities for research participants to familiarise themselves with the scanner environment may be beneficial
- Scanning images give research participants something to 'take away'

References

Avrahami, E. (1990) Panic Attacks During Mr Imaging - Treatment with Iv Diazepam. American Journal of Neuroradiology, 11, 833-835.

Bluff, R. (2005) Grounded Theory: the methodology. IN HOLLOWAY, I. (Ed.) Qualitative Research in Health Care. Berkshire, Open University Press.

Boyatzis, R. E. (1998) Thematic Analysis and Code Development: Transforming Qualitative Information, London, Sage.

Brand, K. P. (1994) How Well Is Your Patient Prepared for an Mri - an Insiders Perspective. Cancer Nursing, 17, 512-515.

Braun, V., & Clarke, V. (2006) Using Thematic Analysis in Psychology. Qualitative Research in Psychology. Edward Arnold.

Brennan, S. C., Redd, W. H., Jacobsen, P. B., Schorr, O., Heelan, R. T., Sze, G. K., Krol, G., Peters, B. E. & Morrissey, J. K. (1988) Anxiety and Panic During Magnetic-Resonance Scans. Lancet, 2, 512-512.

Cooke, R., Peel, E., Shaw, R. L. & Senior, C. (2007) The neuroimaging research process from the participants' perspective. International Journal of Psychophysiology, 63, 152-158.

Fishbain, D. A., Goldberg, M., Labbe, E., Zacher, D., Steele-Rosomoff, R. & Rosomoff, H. (1988) Long-term claustrophobia following magnetic resonance imaging. Am J Psychiatry, 145, 1038-1039.

Flaherty, J. A. & Hoskinson, K. (1989) Emotional Distress During Magnetic-Resonance Imaging. New England Journal of Medicine, 320, 467-468.

Flick, U. (1998) An Introduction to Qualitative Research, California, Sage Publications.

Grey, S. J., Price, G. & Mathews, A. (2000) Reduction of anxiety during MR imaging: a controlled trial. Magnetic Resonance Imaging, 18, 351-355.

Harris, L. M., Cumming, S. R. & Menzies, R. G. (2004) Predicting anxiety in magnetic resonance imaging scans. International Journal of Behavioral Medicine, 11, 1-7.

Hawkins, C. (1979) Patients Reactions to Their Investigations - Study of 504 Patients. British Medical Journal, 2, 638-640.

Hricak, H. & Amparo, E. G. (1984) Body Mri - Alleviation of Claustrophobia by Prone Positioning. Radiology, 152, 819-819.

Kilborn, L. C. & Labbe, E. E. (1990) Magnetic-Resonance-Imaging Scanning Procedures - Development of Phobic Response During Scan and at One-Month Follow-Up. Journal of Behavioral Medicine, 13, 391-401.

Mackenzie, R., Sims, C., Owens, R. G. & Dizon, A. K. (1995) Patients Perceptions of Magnetic-Resonance-Imaging. Clinical Radiology, 50, 137-143.

Mays, N., & Pope, C. (2006) Qualitative Research in Health Care, Malden Mass, Oxford, Blackwell Publishing.

Mechefske, C. K., Wu, Y. H. & Rutt, B. K. (2002) MRI gradient coil cylinder sound field simulation and measurement. Journal of Biomechanical Engineering-Transactions of the Asme, 124, 450-455.

Melendez, J. C. & McCrank, E. (1993) Anxiety-Related Reactions Associated with Magnetic-Resonance-Imaging Examinations. Jama-Journal of the American Medical Association, 270, 745-747.

Phillips, S., & Deary, RY, I.J. (1995) Interventions to Alleviate Patient Anxiety During MRI: A Review. Radiography, 29-34.

Pontin, D. (2000) Interview. Chpt 24. IN CORMACK, D. (Ed.) The Research Process in Nursing. 4th ed. Oxford, Blackwell Science.

Quirk, M. E., Letendre, A. J., Ciottone, R. A. & Lingley, J. F. (1989a) Anxiety in Patients Undergoing Mr Imaging. Radiology, 170, 463-466.

Quirk, M. E., Letendre, A. J., Ciottone, R. A. & Lingley, J. F. (1989b) Evaluation of 3 Psychologic Interventions to Reduce Anxiety During Mr Imaging. Radiology, 173, 759-762.

Rosenberg, D. R., Sweeney, J. A., Gillen, J. S., Kim, J., Varanelli, M. J., O'Hearn, K. M., Erb, P. A., Davis, D. & Thulborn, K. R. (1997) Magnetic resonance imaging of children without sedation: Preparation with simulation. Journal of the American Academy of Child and Adolescent Psychiatry, 36, 853-859.

Shaw, R. L., Senior, C., Peel, E., Cooke, R. & Donnelly, L. S. (2008) Ethical Issues in Neuroimaging Health Research: An IPA Study with Research Participants. J Health Psychol, 13, 1051-1059.

Shellock, F. G. (2005) Reference Manual for Magnetic Resonance Safety, Implants and Devices, Los Angeles, Biomedical Research Publishing Group.

Spouse, E. & Gedroyc, W. M. (2000) MRI of the claustrophobic patient: interventionally configured magnets. British Journal of Radiology, 73, 146-151.

Tischler, V., Calton, T., Williams, M. & Cheetham, A. (2008) Patient anxiety in magnetic resonance imaging centres: Is further intervention needed? Radiography, 14, 265-266.

Tornqvist, E., Mansson, A., Larsson, E. M. & Hallstrom, I. (2006a) Impact of extended written information on patient anxiety and image motion artifacts during magnetic resonance Imaging. Acta Radiologica, 47, 474-480.

Tornqvist, E., Mansson, A., Larsson, E. M. & Hallstrom, I. (2006b) It's like being in another world - patients' lived experience of magnetic resonance imaging. Journal of Clinical Nursing, 15, 954-961.

Wilson-Barnett, J. (1982) Interventions to Alleviate Patients' Stress: A Review. Journal of Psychosomatic Research, 28, 63-72.

Wilson-Barnett, J. (1990) Diagnostic Procedures - Stress & Medical Procedures, Oxford, Oxford University Press.