Attentional Bias
and
Physical Symptom Reporting

A thesis submitted to the University of Manchester for the degree of
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Word count (excluding references, tables and appendices): 26,680
Attentional bias to health-threat information in the sphere of medically unexplained symptoms (MUS) is the focus of this thesis. Confusion and debate regarding the classification of MUS exists, and medical and psychiatric classifications of MUS have resulted in separate literatures in the two areas. In addition to “medical” and “psychiatric” diagnoses, there are habitual symptom reporters who are frequently seen in the general population. Contemporary psychological theories of MUS postulate attentional bias towards health-threat information as central in their development and maintenance, although a causal relationship has yet to be established.

Paper 1 provides an overview of the experimental paradigms used to examine attentional bias to health-threat information in “medical” MUS (functional somatic syndromes). This is provided within the theoretical context of attention. Eighteen studies satisfied inclusion criteria, and it was concluded that the evidence for an attentional bias in individuals with functional somatic syndromes is equivocal. The strengths and limitations of the individual studies are provided, together with recommendations for future research. The review has been prepared for submission to ‘Clinical Psychology Review’.

Paper 2 employed an attentional bias modification (ABM) paradigm to explore whether it is possible to generate an attentional bias towards health-threat information in a low symptom reporting population. Fifty-six non-clinical low symptom reports were randomly assigned to a ‘training’ or ‘no training’ version of the ABM paradigm. ABM increased the degree to which low symptom reporters were distracted by threat but this did not lead to increased physical symptoms or anxiety. The empirical paper has been prepared for submission to the ‘Journal of Abnormal Psychology’.

Paper 3 is a critical appraisal of the previous papers. Methodological considerations are discussed, together with theoretical and clinical implications.
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Special thanks go to my wonderful friends, parents and Joss for all of the love and laughter.
Section 1: Systematic Review

Title

Attentional bias to body-relevant information across functional somatic syndromes: a systematic review.

The following review was prepared for submission to ‘Clinical Psychology Review’.

Word Count (excluding abstract, tables and references): 11,868

Abstract: 172
Highlights

- An overview of experimental paradigms used to examine attentional bias in functional somatic syndromes is provided.
- Eighteen studies were included in the review and conclusions regarding attentional bias in this population are drawn within the context of the strengths and limitations of each study.
- The evidence for an attentional bias towards body and/or health threat information in individuals with functional somatic syndromes is equivocal.
- Future research should include:
  - experimental paradigms that enable specific types of attentional processing to be evaluated.
  - larger, more diverse samples and consider comparing patients with functional somatic syndromes, somatoform/somatic symptom disorders and well-documented organic pathology.
Abstract
Contemporary psychological models of functional somatic (i.e., medically unexplained) symptoms posit attentional bias towards bodily sensations or other health threats as an important factor in their development and maintenance. This paper provides a systematic review of experimental studies on attentional bias to body relevant information in patients with functional somatic syndromes, including chronic fatigue syndrome, fibromyalgia and irritable bowel syndrome. Eighteen studies satisfied inclusion criteria and were included in the review. Experimental paradigms adopted in the reviewed studies included the emotional Stroop task, dot-probe task, exogenous cueing task, body-scanning task and the extrinsic affective Simon task. Most studies used reaction times as the dependent variable, with a small number (N=3) using event-related brain potentials. Taken together, the available studies suggest that the evidence for attentional bias towards bodily sensations or health threat in patients with functional somatic syndromes is equivocal. Some evidence of attentional bias was demonstrated in all experimental paradigms but this was mixed within and between the functional somatic syndromes. Clinical implications are discussed along with recommendations for future research.

Keywords:
Functional somatic syndromes, medically unexplained symptoms, attention, attentional bias.
Introduction
Medically unexplained symptoms (MUS) are persistent physical symptoms for which no clear organic pathogenesis can be determined. Such symptoms are commonplace in the general population and are frequently encountered in clinical practice (Kellner, 1991; Mayou, Bass, & Sharpe, 1995). For the majority of individuals, these symptoms are few, or occur in isolation, and resolve before significant distress or disability is experienced. For others, symptoms are multiple and enduring and significantly affect daily functioning (Katon et al., 1991). As such, MUS are considered to exist on a spectrum of severity, such that the number, severity and chronicity of symptoms is positively correlated with degree of distress, disability and utilisation of health-care services (Barsky, Orav, & Bates, 2005; Jackson & Kroenke, 2006; Katon et al., 1991).

Individuals who experience persistent MUS report lower quality of life and have poorer perceived general health than individuals with organically explained illnesses (Smith, Monson, & Ray, 1986). Mental health problems such as anxiety, depression and personality disorders are common in this population (Crimlisk et al., 1998; Kroenke et al., 1994), although many individuals with chronic and persistent MUS have no identifiable mental health condition (Smith et al., 2005).

MUS represent a conceptual challenge and are considered to represent a heterogeneous group of conditions (see Brown, 2007 for review). Kirmayer and Robbins (1991) distinguished between three overlapping but theoretically and empirically distinct types of MUS:

1. **Presenting somatisation.** This refers to physical symptoms that are the somatic presentation of a psychiatric condition such as anxiety and depression, and are not recognised as such by the individual.

2. **Hypochondriacal somatisation.** This term is used to refer to physical symptoms that are misinterpreted as evidence of a serious illness or disease.

3. **Functional somatisation.** This term describes physical symptoms that cannot be attributed to a diagnosable mental or physical health condition, nor are they the product of catastrophic misinterpretation by the individual.

The literature in the field of MUS frequently does not distinguish between the above categories despite the fact that the first two categories imply a known origin for the symptoms, and as such cannot be considered truly unexplained. The ‘functional
somatisation’ category is therefore considered by specialists in MUS to epitomise the distinct phenomena of MUS (see Brown, 2007 for review).

Common physical complaints in adult primary care include; chest pain, fatigue, dizziness, headache, insomnia and symptoms involving the reproductive and digestive systems (Kirkwood et al., 1982). In a study of the most prevalent symptoms encountered in primary care, an identifiable organic basis for these symptoms was found in only 10 – 15% of cases (Kroenke & Manglesdorff, 1989). Within secondary care services, symptoms for which no organic basis can be found are common and vary according to the medical specialty in which the symptoms are encountered (Henningsen, Zipfel, & Herzog, 2007).

Individuals experiencing MUS with prominence in a specific bodily system may be referred to a hospital department specialising in that area. For example, a patient experiencing chronic unexplained symptoms largely affecting the musculoskeletal system may be referred to a rheumatology department, whereas unexplained symptoms primarily affecting the cardiovascular system would be managed by cardiology. When objective markers to account for the symptoms cannot be identified, the symptoms are referred to as medically unexplained or functional (Sharpe, 1995). Each medical specialty attaches its own label to unexplained symptoms that relate to the bodily system of interest (Wessley, Nimnuan, & Sharpe, 1999). MUS encountered within the different medical specialties are collectively referred to as ‘functional somatic syndromes’ (FSS; see Brown, 2007; Henningsen et al., 2007, for review). Table 1 describes some common unexplained symptoms and the various symptom syndrome labels adopted by diverse medical subspecialties.

Functional somatic syndromes are defined as persistent bodily symptoms for which objective tests and examinations do not reveal an organic, structural or biochemical basis (Sharpe, 1995; Smith, 1991) and thus suggests that these symptoms reflect abnormalities of function rather than structure (Mayou et al., 1995). The term ‘functional somatic syndrome’ does not provide information regarding aetiology of the symptoms.
Table 1.

Common unexplained symptoms, medical specialties and symptom syndrome labels

<table>
<thead>
<tr>
<th>Unexplained Symptoms</th>
<th>Medical Specialty</th>
<th>Syndrome Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bloating and swelling of the abdomen; abdominal pain and discomfort; erratic bowel movements</td>
<td>Gastroenterology</td>
<td>Irritable bowel syndrome, non-ulcer dyspepsia</td>
</tr>
<tr>
<td>Persistent physical and mental fatigue; muscular pain; joint pain; insomnia; sore throat; enlarged glands</td>
<td>Infectious diseases</td>
<td>Chronic fatigue syndrome (Myalgic encephalomyelitis)</td>
</tr>
<tr>
<td>Fatigue; headaches; widespread pain; muscle stiffness</td>
<td>Rheumatology</td>
<td>Fibromyalgia</td>
</tr>
<tr>
<td>Increased urgency and frequency of urination; pelvic and bladder pain</td>
<td>Gynaecology</td>
<td>Chronic pelvic pain, interstitial cystitis</td>
</tr>
<tr>
<td>Chest pain; nausea; sweating; palpitations</td>
<td>Cardiology</td>
<td>Atypical or non-cardiac chest pain</td>
</tr>
<tr>
<td>Headache; fatigue; dizziness; breathlessness; sore throat; muscular and joint pain</td>
<td>Allergy</td>
<td>Multiple chemical sensitivity (idiopathic environmental intolerance)</td>
</tr>
<tr>
<td>Can include any physical symptom that cannot be fully explained by a medical condition.</td>
<td>Psychiatry</td>
<td>Previously somatoform disorder or somatisation disorder. Now labelled somatic symptom disorder</td>
</tr>
</tbody>
</table>

Classification of MUS
As can be seen in Table 1, some of the individual syndrome labels are named according to the lead symptom (e.g. chronic pelvic pain), while others are named according to the implied cause (e.g. irritable bowel syndrome). Due to the fact that these syndromes are diagnoses of exclusion, a diagnosis of a particular FSS is only reached after extensive medical investigations have failed to identify an organic or structural basis for the symptoms.
There is no established list of FSS; some syndromes previously referred to as a FSS have fallen out of use (e.g. Da Costa’s syndrome; Barsky & Borus, 1999) and new syndromes continue to be identified (see Henningsen et al., 2007 for review). The objective criterion to arrive at a diagnosis varies widely across the various FSS. Some of the more well-known syndromes such as chronic fatigue syndrome (CFS) and irritable bowel syndrome (IBS) have well-defined diagnostic criteria, whereas others such as multiple chemical sensitivity rely more on self-reported symptoms, leading to some dispute as to whether they do indeed constitute distinct syndromes (see Henningsen et al., 2007 for review).

Despite attempts to classify clusters of MUS into distinct diagnostic categories, research suggests that there is significant overlap in symptomology between these conditions and as such may merely be different manifestations of the same phenomena (Wessley et al., 1999). Factors such as the medical specialty or the context in which an individual is assessed, are considered to influence the diagnostic label received (Blackwell, 1992).

The various FSS are currently classified as medical conditions in the International Classification of Diseases (ICD-10; World Health Organisation [WHO], 1992), within the ‘Other’, ‘Not otherwise specified’ and ‘Unspecified’ diseases of the various relevant medical sections. In the previous version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 1994), these conditions were classified on Axis III of that system as medical conditions.

If MUS are encountered in a psychiatric setting, however, a different label might be applied. ICD-10, for example, uses the term somatoform disorder (WHO, 1992) to refer to symptoms that cannot be accounted for by organic disease. A similar system was also used until recently in the DSM (DSM-IV; APA, 1994), which places them on Axis I reflecting the assumption that the symptoms are indicative of a mental disorder. Although the diagnosis of somatoform disorder required the exclusion of general medical conditions, there has been a lack of clarity as to which medical diagnoses constituted exclusion criteria. For example, it was not specified whether functional conditions such as irritable bowel syndrome would warrant exclusion (Mayou, Kirmayer, Simon, Kroenke, & Sharpe, 2005). Accordingly, people may end up being diagnosed with both a medical and a psychiatric condition for exactly the same set of symptoms (Mayou et al., 2005). Whether the somatoform disorders and functional somatic syndromes refer to discrete, overlapping or coterminous entities remains
unclear. Some authors are of the opinion that they refer to exactly the same group of patients (Mayou et al., 2005; Rief & Hiller, 1999); others acknowledge that there is a significant overlap but consider that there are some differences (Brown, 2007).

In response to this, the current version of the DSM (DSM-V; APA, 2013) has abandoned the concept of MUS (with the exception of conversion disorder), and no longer attempts to distinguish between medically explained and unexplained symptoms. The previous diagnosis of somatoform disorder has been replaced with “somatic symptom disorder” which relies less on number, severity and duration of symptoms and more on the degree to which an individual’s thoughts, feelings and behaviours associated with their symptoms are disproportionate or excessive. According to this system, individuals with any physical symptom (regardless of knowledge as to its aetiology) may receive a diagnosis of somatic symptom disorder if it is accompanied by positive psychological features. This diagnosis could therefore be equally applied to individuals with irritable bowel syndrome, cancer and those previously diagnosed as having somatoform disorder. It remains to be seen the way in which this will be managed when the current version of the ICD-10 (WHO, 1992) is updated.

Although this change in classification addresses some of the problems in this area, the existence of separate labels and classification systems for “medical” and “psychiatric” MUS has resulted in largely separate literatures for the two constructs. Although this separation may begin to reduce in time with the introduction of new classification systems, any review of previous research in this area needs to acknowledge the historic separation between these constructs and explore them individually, enabling any potentially important similarities and differences to emerge.

**Attention and MUS**

As biological models have proved unsuccessful in conceptualising the mechanisms underlying MUS, psychological factors have grown in importance. Cognitive and perceptual factors, specifically attentional processes, have since been implicated as central in the development and maintenance of MUS (Barsky & Wyshak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997; Rief & Barsky, 2005).

It is generally held that attentional processes have evolved to enable organisms to rapidly detect and focus on goal-relevant stimuli (such as threats) in their environment. An
attentional bias towards threatening information is inferred when there is evidence that threatening information is being attended to differently compared to non-threatening information (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; MacLeod, Mathews & Tata, 1986; Mogg & Bradley, 1998). Although some degree of attentional bias for threat is considered normal (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998), research suggests that this is exaggerated in certain clinical populations. Indeed, it has been demonstrated consistently in patients with anxiety disorders (Bar-Haim et al, 2007; Mogg & Bradley, 1998; Williams, Mathews, & MacLeod, 1996), with a recent meta-analysis yielding an aggregate effect size of $d = .45$ for attentional bias towards threat across anxious populations (Bar-Haim et al., 2007).

Evidence in support of the role of attentional processes in MUS has come from research demonstrating that focusing attention to the body leads to increased physical symptom reporting (Pennebaker, 1982; Schmidt, Wolfs-Takens, Oosterlaan, & van den Hout, 1994) and distracting attention away from the body reduces the valence of unpleasant physical sensations (Lautenbacher, Pauli, Zaudig, & Birbaumer, 1998). Non-clinical symptom reporters were observed to demonstrate delayed disengagement from tactile stimuli under conditions of neutral mood, but attentional avoidance under conditions of distressed mood (Brown, Danquah, Miles, Holmes, & Poliakoff, 2010).

The concept of attention is multi-faceted and different attentional mechanisms have been implicated in the development and maintenance of MUS, including filtering or inhibitory failure (Rief & Barsky, 2005), selective attention (Barsky & Wyshak, 1990; Kirmayer & Taillefer, 1997), hypervigilance, and difficulties in disengaging attention (Brown, 2004) from health threat. In general terms, psychological models of MUS postulate that benign somatic sensations are amplified through excessive body-focussed attention and these are interpreted as evidence of serious illness or disease. The physiological and behavioural changes in response to the misinterpretation of sensations as threatening leads to further physical sensations, creating a vicious cycle. This is referred to as ‘somatosensory amplification’ (Barsky & Wyshak, 1990) and is a key concept in models of MUS. Models differ, however, with regards the nature of the specific attentional processes involved. Kirmayer and Taillefer (1997) present a multicomponent model of MUS which extends the process of somatosensory amplification by incorporating social-interactional and emotional.
factors. Individuals are considered to selectively attend to somatic sensations, by way of narrowing attention onto potentially threatening stimuli in preference of neutral stimuli.

Brown (2004) proposed that unexplained symptoms represent an alteration in body image resulting from the over-activation of symptom information ("rogue representations" of illness) stored in memory. This information may be acquired from numerous sources such as exposure to physical states in the self or others or verbal suggestion. If this information becomes sufficiently active it may be selected by a primary attentional system (PAS) as the best-fitting account of current events leading to the subjective experience of unexplained symptoms. A secondary attentional system (SAS) may then repeatedly allocate processing resources to these symptoms, thereby increasing their activation and reducing their threshold for selection into awareness. This model thus implicates hypervigilance and selective attention to health-relevant information and a difficulty in disengaging attention from such information in the creation and maintenance of MUS.

The information processing capacity of humans is considered to be limited such that the ability to filter out irrelevant information is necessary (Broadbent, 1958). Rief and Barsky (2005) proposed a psychobiological perception-filter model of MUS. Sensory information is filtered by a hypothetical filter system to prevent over-stimulation of the system by irrelevant information and to enable the selection of the most relevant inputs for conscious attention. In their model, MUS arise due to faulty filtering of bodily information, whereby selective attention and other factors reduce the efficiency of the filtering process, leading to heightened perception of sensory information.

Experimentally, attention is difficult to isolate from other cognitive processes. A number of experimental paradigms have been developed to explore the mechanisms involved in attentional biases in clinical populations. Following on from their review of the evidence for a cognitive behavioural conceptualisation of MUS, Deary, Chalder, and Sharpe (2007) suggested that cognitive processes, in particular attention and symptom appraisal, are still poorly understood and future research should seek to further elucidate these complex processes. Improving our understanding of the mechanisms underlying MUS may enable the development of improved treatment for this phenomenon.
Measures of attentional bias

Various experimental paradigms have been developed to isolate and measure different aspects of attentional bias. Attentional biases have been demonstrated in anxious populations across experimental tasks and across anxiety disorders (Bradley, Mogg, White, Groom, & de Bono, 1999; Buckley, Blanchard, & Hickling, 2002; Ohman, Flykt, & Esteves, 2001). Attentional biases to threatening body-relevant information have also been explored using different tasks in patients with chronic pain, although the findings here have been less consistent than in the anxiety literature (e.g. Asmundsen, Wright, & Hadjistavropoulos, 2005; Crombez, Hermans, & Adriaensen, 2000). Common assessment tasks to measure attentional bias are the modified Stroop task, dot-probe task, spatial cueing task and visual search task.

Modified Stroop task

The Stroop task (Stroop, 1935) has been modified to explore attentional bias in emotional disorders. This is a popular paradigm in the investigation of attentional processes and is considered to be a valid measure of attentional bias (Williams et al., 1996), although there is some uncertainty as to the precise aspects of attention it actually measures (deRuiter & Brosschot, 1994). Participants are presented with different coloured words that vary in semantic content, such as words related to clinical pathology, emotionally charged words, threat-relevant words or neutral words. Participants are instructed to ignore the meaning of the word and name its colour as quickly as possible. Pictorial stimuli can be used rather than linguistic stimuli, where participants may be required to name the colour of a face with either an angry or a neutral expression.

An attentional bias for threatening stimuli is inferred if response latencies (i.e. the duration between the delivery of a stimulus and the response) are slower when naming a negative stimulus compared to a neutral stimulus (MacLeod, 1991). That is, selective attention to negative information is inferred from the extent to which the presence of negative information interferes with task performance. Despite the fact that reading the word is task irrelevant and hinders performance, there seems to be a difficulty in inhibiting this process in vulnerable individuals, resulting in the “emotional Stroop effect”. In order to assess whether processing biases operate subconsciously or unconsciously, some researchers have adapted the modified Stroop task to incorporate ‘masked’ (stimulus is presented too quickly to be consciously processed) or ‘unmasked’ (stimulus is presented to enable conscious processing) conditions (Mogg,Kentish, & Bradley, 1993; Munafo, Mogg, Roberts, Bradley, & Murphy,

**Dot-probe task**

MacLeod et al., (1986) devised the dot-probe or visual probe task to measure attention to threatening stimuli. Participants are briefly exposed to two stimuli (words or pictures) which differ in emotional valence. These are presented simultaneously either at the top and bottom or the left and right of a computer screen. The stimuli disappear and a small visual stimulus (the ‘probe’) appears at the same location as one of the preceding stimuli. Participants are asked to determine the location of the probe as quickly as possible. In contrast to the modified Stroop task, an attentional bias for threatening information is inferred from quicker responses on trials in which the probe appears at the location of the threatening stimulus compared to those where it appears at the location of the neutral stimulus; this is interpreted as heightened vigilance to threat. Stimuli were originally exposed for 500ms before being replaced by the probe, although this has been varied in subsequent studies to enable measurement of early and later stages of emotional processing. Attentional biases for threatening pictorial stimuli in anxiety have been reliably observed using this task at short stimulus durations (up to 500ms) but not as reliably at longer stimulus durations (over 1250ms) (Bradley, Mogg, Falla, & Hamilton, 1998).

**Spatial cueing tasks**

Like the dot-probe task, spatial cueing tasks (Fox, Russo, Bowles, & Dutton, 2001; Posner, 1980; Posner, Walker, Friedrich, & Rafal, 1984) allow for the assessment of attentional allocation to spatial locations. Participants fixate on a central point on a computer monitor that is flanked by two rectangular boxes. A cue stimulus is briefly presented in one of the rectangles which can be a threatening word or image, followed by a target stimulus (e.g., circle) in one of the rectangles. Participants are typically asked to identify the location of the target as quickly as possible. On ‘valid’ trials the target stimulus appears in the same location as the cue and on ‘invalid’ trials the target is presented in the opposite location. Facilitated attention to threatening cues is inferred from accelerated response times on validly cued trials when the cue is threatening compared to neutral. Difficulty in disengaging attention away from threatening information is inferred by increased response times on invalidly cued
trials when the cue is threatening compared to neutral. An attentional bias score for each word type (i.e. threatening and neutral) can be calculated by subtracting response times on valid trials from invalid trials (Asmundsen & Hadjistavropoulos, 2007). The stimulus onset asynchrony (SOA) between the cue and target can be varied in this paradigm, enabling investigation of early (e.g. 100ms) and later (e.g. 500ms) stages of processing (Mogg, Bradley, De Bono, & Painter, 1997). Fox et al. (2001) demonstrated evidence of delayed disengagement of attention from threat in high-state anxious individuals. Using a spatial cueing task with transcutaneous electrocutaneous stimulus, van Damme et al. (2004) demonstrated evidence of a facilitating effect of pain stimulus and pain signals were found not to impair disengagement of attention from their location.

**Body scanning reaction time paradigm**

An alternative paradigm which is considered to assess the attentional mechanism of hypervigilance to bodily signals has been to measure response times to detect painful and non-painful sensations (Chapman, 1986; Lautenbacher & Rollman, 1993). Participants are delivered a body-relevant stimulus such as a physical electrical sensation and their task is to respond as soon as they detect the stimulus. This paradigm has been adapted to measure priority of attention by including an additional visual search task (Peters, Vlaeyen, & van Drunen, 2000). Hypervigilance to body-relevant information is inferred by faster detection of the body-relevant stimulus. Preferential allocation of attention to body-relevant information is inferred by greater interference in the dual task condition.

**Extrinsic affective Simon task (EAST)**

The EAST (de Houwer, 2003) is a variant of the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) and has been used to explore cognitive-emotional processing in specific phobias (Ellwart, Rinck, & Becker, 2006) and pain (Vancleef, Peters, Gilissen, & de Jong, 2007). Participants are presented with adjectives in white that have positive or negative valence (e.g. good, bad, nice, hostile) and are instructed to rate whether the word is positive or negative as quickly as possible. They are then presented with threatening or neutral words in different colours and are required to categorise the colour of the words as quickly as possible. Similar to the modified Stroop task, reading the semantic content of the word hinders task performance. Participants then have a trial which incorporates both types of stimulus. This paradigm is considered to measure emotional intrusion and automatic
association effects of threatening stimuli. Bias is calculated by the response time difference between extrinsically negative responses and extrinsically positive responses.

**Electrophysiological measures**

The experimental paradigms described thus far have measured response times to detect a stimulus and infer attentional bias from either slower or faster response times depending upon the paradigm in question. Event-related brain potentials (ERPs) are increasingly used as a dependent measure in studies of attention (Carretie, Mercado, Tapia, & Hinojosa, 2001; Finnigan, O’Connell, Cummins, Broughton, & Robertson, 2011). Electrical brain activity is recorded using an electrode cap and potentials pertaining to specific stimuli are averaged and extracted from the overall electroencephalogram (EEG); these form a grand average waveform consisting of several positive and negative waves or components. These are named P or N depending if it is positive or negative, followed by a number denoting either the position in the waveform or its latency in milliseconds. In contrast to behavioural reaction time data, ERP data enables assessment of the time course of attentional shifting. The time point at which waveforms elicited by attended to or ignored stimuli differ provides data regarding the effect of attention on the processing of the stimulus.

Bar-Haim, Lamy and Glickman (2005) explored attentional processes in high-anxious and low-anxious participants using a spatial cueing task consisting of pictorial stimuli depicting happy, neutral, angry, sad and fearful faces. Behavioural data revealed that high-anxious participants were slower to respond to all targets relative to low-anxious participants, regardless of the valence of the stimuli. ERP data demonstrated that high-trait anxious individuals had faster latencies and greater amplitudes of early ERP data to threat-related faces compared to low-anxious participants. This was interpreted as implicating difficulties in disengaging attention away from threatening information once it had been captured in attentional bias in individuals with high levels of anxiety.

**Aims of review**

As has been discussed, FSS represent medically unexplained symptoms encountered in the different medical specialties. FSS are associated with significant individual and societal costs. They are currently poorly understood and there is a lack of effective treatments available to alleviate or manage these conditions. FSS therefore represent an important issue that require better understanding before more effective interventions can be established. Models
of MUS cite attention to health-relevant information as a central concept in their
development and maintenance and the different models refer to the involvement of
different attentional processes such as selective attention, hypervigilance and difficulty
disengaging attention. Numerous experimental paradigms exist which enable attention to
be measured and can provide information regarding specific attentional processes. The
current review therefore sought to examine the evidence of a relationship between
attentional processes (specifically attention to health-relevant information) measured by
experimental tasks and FSS, in an attempt to further elucidate the underlying processes
involved in these conditions.

As has been discussed, the different classification systems for medical and psychiatric MUS
have resulted in largely separate literatures in the two areas, although there is uncertainty as
to whether they should be regarded as distinct. Despite changes to the diagnostic
classification of MUS in DSM-V (APA, 2013), this argument remains and as such, investigating
the two constructs separately may further inform this debate. For this reason, the current
review will concentrate on studies where the general medical classification system for FSS
has been used. For the sake of brevity, studies including individuals with a diagnosis of a
psychiatric somatic syndrome will be excluded and covered by a separate but parallel review.

There have been no known published reviews of relevant studies on the role of attention in
FSS. An existing review of the theoretical and empirical evidence for the cognitive
behavioural model of MUS in general, and for CFS and IBS in particular, explored cognitive
(including attention to bodily sensations as one of many factors), behavioural and
physiological factors in the maintenance and development of MUS (Deary et al, 2007). One
conclusion from this review was that attenional factors play an important part of the cycle
maintaining MUS but recommended that this specific area be explored further.
Method

Identification of search terms

As there is no accepted list of conditions considered to be FSS, search terms were identified with reference to existing reviews in this area (Barsky & Borus, 1999; Wessley et al., 1999). The terms chosen (and their related synonyms) appear in the ICD-10 (WHO, 1992) as syndromes for which the aetiology is unknown and as such constitute FSS. Attention search terms were selected on the basis of key terms adopted in relevant reviews (e.g. Richards, Benson, Donnelly, & Hadwin, 2014). The terms ‘Posner’ and ‘Flanker’ were incorporated in the ‘attention’ search terms as these well known attention tasks are occasionally referred to by these names rather than the specific name of the task (e.g., “Posner task” rather than “spatial cueing task”; Eriksen & Eriksen, 1974; Posner, 1980) and as such was an attempt to be inclusive.

An initial scoping exercise of the electronic databases including all the identified search terms indicated that this resulted in poor sensitivity in the identification of relevant literature (N > 9000). This was identified to be due to the large body of literature in the field of attention. In order to improve the sensitivity of the attention search terms, these were added to the functional somatic syndrome search terms on an individual basis. This enabled identification and removal of specific attention terms that yielded a large number of irrelevant literature. This process enabled ensured a search list with both sensitivity and specificity.

The aim of the literature search was to systematically identify studies that attempted to measure attention to body relevant stimuli in people with functional somatic syndromes (FSS) where the threat content/valence of the stimuli was varied within the experimental tasks. Three databases (PsycINFO, Medline and EMBASE) were searched individually up until May 2014. Titles and abstracts were searched using the following terms:

“(Chronic Fatigue Syndrome OR myalgic encephalomyelitis OR fibromyalgia OR functional syndrome* OR chronic pelvic pain OR tension headache OR irritable bowel syndrome OR functional abdominal pain OR hyperventilation syndrome OR functional dyspepsia OR non-cardiac chest pain OR atypical chest pain OR non-specific chest pain OR atypical facial pain OR temporomandibular joint disorder OR globus syndrome OR tinnitus OR multiple chemical sensitivity OR idiopathic environmental intolerance OR Gulf war syndrome OR Persian Gulf syndrome OR interstitial cystitis OR electrosensitivity OR environmental stress OR chronic
widespread pain) AND (atten* OR stroop OR dot-probe OR visual search OR orient* OR disengagement OR hypervigilance OR Posner OR Flanker OR probe detection)”.

Cross referencing was also employed in order to identify further studies not captured by the electronic search.

**Inclusion and exclusion criteria**

The following inclusion and exclusion criteria were applied to determine studies eligible for inclusion:

**Inclusion Criteria**
- Measures attention to body/health relevant information using an experimental paradigm enabling attention to this information to be determined.
- The level of threat content/valence of experimental stimuli is varied within experimental tasks.
- Participants have a primary diagnosis of a functional somatic syndrome (either by medical professional, scores on standardised criteria or description of symptoms).
- Experimental, cross-sectional, correlational/regressional, group-comparison study.
- English language.
- Peer reviewed.
- Quantitative methodology.

**Exclusion Criteria**
- Measures attention not related to body/health relevant information.
- Measure of attention is purely related to ability (i.e. neuropsychological assessment of attention).
- Participants have a diagnosis of somatoform disorder, multiple somatic symptoms or manifest high scores on standardised measures of somatic symptom reporting without a diagnosis of a functional somatic syndrome.
- Case report, review paper, conference or poster presentation.
- Not English language.
- Not peer reviewed.
- Qualitative methodology.
After consideration of the literature, studies exploring attention in the area of chronic pain were excluded. It was thought that the number of studies in chronic pain would warrant a review in itself, whilst potentially rendering the current review less useful in reviewing attention to health/body relevant stimuli across FSS. In a review of MUS, Deary et al. (2007) omitted chronic pain literature for this reason. Furthermore, a number of studies exploring chronic pain included individuals with chronic pain with an organic aetiology or migraine rather than functional pain (e.g. Quartana et al., 2007; Liossi, Schoth, Godwin, & Liversedge, 2014). The search process is demonstrated in Figure 1.

Duplicate articles were automatically excluded, while remaining results were assessed at abstract or full text level to determine eligibility for inclusion. This process yielded eighteen papers suitable for inclusion in the current review. Papers were screened by the first author and any cases in which there was some uncertainty as to the eligibility of a study for inclusion were resolved through discussions with the second author.

Summary of studies

Preliminary data were extracted from the eighteen studies and included: (a) sample type; (b) sample size; (c) control group; (d) attentional bias task; (e) primary outcome measure; (f) any secondary measures; and (g) a summary of the main results. Table 2 provides a summary of the included studies. Papers were organised into six groups according to the specific FSS under investigation:

1. Chronic Fatigue Syndrome (CFS): four studies
2. Fibromyalgia (FM): three studies
3. Functional Abdominal Pain (FAP): three studies
4. Tinnitus: two studies
5. Idiopathic Environmental Intolerance (IEI): three studies
6. Irritable Bowel Syndrome (IBS): three studies

Quality assessment

In order to systematically assess the methodological quality of the studies, a bespoke quality assessment tool was developed (Appendix A) based on guidelines from Reichow, Volkmar and Ciccetti (2008). Factors considered particularly pertinent to the scientific integrity of studies in this area included: diagnostic ascertainment; homogeneity or comparability of experimental and control group; consideration of confounding factors; the validity of the independent variable; the validity of the primary outcome measure; the appropriateness of the statistical analyses; and effect sizes. Following the rating system for methodological quality of studies used by the National Institute of Clinical Excellence (NICE, 2007) studies were assigned a rating of high (++), acceptable (+) or unacceptable (-) quality in each of these domains. All of the studies were assessed for quality, the results of which can be found in Table 3.

The majority of the studies were deemed to be of acceptable to high quality. For each category, an overview of the study is provided followed by a critique of their methodological quality. Specific issues and recommendations arising from this are discussed.
Table 2.
Summary of studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Control Group</th>
<th>Design</th>
<th>Experimental method</th>
<th>Primary Outcome Measure/s(^1)</th>
<th>Additional Measures(^2)</th>
<th>Summary of main results</th>
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<tbody>
<tr>
<td>Chronic fatigue syndrome: N = 4</td>
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<tr>
<td>Martin &amp; Alexeeva (2010)</td>
<td>N = 33 Diagnosed by GP and reference to Centres for Disease Control and Prevention diagnostic criteria (self-report)</td>
<td>N = 33 Healthy Controls Age and gender not significantly different</td>
<td>Randomised: mixed 2 (group: CFS, control) x 2 (induction condition: distraction, rumination) x 3 (stimulus type: illness, social threat, neutral)</td>
<td>Exogenous cueing task SOA 150ms</td>
<td>Attentional bias score</td>
<td>Lexical decision task SDS</td>
<td>CFS group showed no evidence for attentional bias to illness-related information with or without rumination induction.</td>
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<tr>
<td>Moss-Morris &amp; Petrie (2003)</td>
<td>N = 25 Diagnosed by GP and reference to Centres for Disease Control and Prevention diagnostic criteria (self-report)</td>
<td>N = 24 Healthy Controls Age, gender and years of education not significantly different</td>
<td>Mixed 2 (group: CFS, control) x 2 (stimulus type: somatic/neutral word pair, depressed/neutral word pair)</td>
<td>Emotional Stroop task</td>
<td>Interference index</td>
<td>Ambiguous cues task NART HADS PANAS PFRS The somatic checklist VAS</td>
<td>CFS group slower to name all words compared to HC but no attentional bias towards illness or depressed words.</td>
</tr>
<tr>
<td>Hou et al. (2014)</td>
<td>N = 27 Diagnosed by specialist medical professional and reference to Chalder Fatigue Scale</td>
<td>N = 35 Healthy Controls Age, gender and years of education not significantly different</td>
<td>Mixed 2 (group: CFS, control) x 2 stimulus modality (pictorial, linguistic) x 2 stimulus type (threatening, neutral) x 2 SOA (500ms, 1250ms)</td>
<td>Dot-probe task</td>
<td>Attentional bias score</td>
<td>Attention Network Test CFS HADS SDSDS</td>
<td>CFS group had greater AB towards health threat words than pictures compared to HC. CFS and HC not significantly different in overall AB across stimulus modality, stimulus type and SOA.</td>
</tr>
<tr>
<td>Hou et al. (2008)</td>
<td>N = 11 Diagnosed by GP and reference to Centres for Disease Control and Prevention diagnostic criteria (self-report)</td>
<td>N = 17 Healthy Controls Age, gender, education and employment status not significantly different</td>
<td>Mixed 2 (group: CFS, control) x 2 stimulus modality (pictorial, linguistic) x 2 stimulus type (threatening, neutral)</td>
<td>Dot-probe task SOA 500ms</td>
<td>Attentional bias score</td>
<td>PFRS HADS SDSDS</td>
<td>CFS demonstrated attentional bias to threat-relevant linguistic and pictorial stimuli compared to HC.</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
<td>Control Group</td>
<td>Design</td>
<td>Experimental method</td>
<td>Primary Outcome Measure/s¹</td>
<td>Additional Measures²</td>
<td>Summary of main results</td>
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<tr>
<td>Mercado et al. (2013)</td>
<td>N = 21 Females</td>
<td>N = 15 Healthy Controls Females Age and educational level not significantly different</td>
<td>Mixed 2 (group: FM, control) x 4 word type (FM symptom-related, arousing negative, arousing positive, neutral)</td>
<td>Emotional Stroop task</td>
<td>Response latency</td>
<td>STAI</td>
<td>Fibromyalgia group demonstrated significantly larger frontal P450 amplitudes and enhanced activation within right frontal inferior frontal gyrus in response to symptom-related words compared to HC. Interpreted as related to cognitive inhibition processes. No difference between fibromyalgia group and HC in response times or errors.</td>
</tr>
<tr>
<td>Gonzalez et al. (2010)</td>
<td>N = 25 Females</td>
<td>N = 24 Healthy Controls Females Age and educational level not significantly different</td>
<td>Mixed 2 (group: FM, control) x 4 word type (FM symptom-related, arousing negative, arousing positive, neutral)</td>
<td>Emotional Stroop task</td>
<td>Response latency</td>
<td>STAI</td>
<td>No group differences in reaction time. FM group exhibited greater Stroop interference on neutral words. There was a statistical tendency of FM group being slower to name symptom words but this did not reach significance.</td>
</tr>
<tr>
<td>Peters, Vlaeyen, &amp; Drunen (2000)</td>
<td>N = 30 Females</td>
<td>N = 30 Healthy Controls Females Age not significantly different</td>
<td>Mixed 2 (group: FM, control) x 4 (position: left arm, right arm, left leg, right leg) x 2 (block: single task, dual task) x 2 (contingency: delay, contingent)</td>
<td>Exposure to body-relevant sensations</td>
<td>Response latency for visual stimuli Electrical stimulation detection latency</td>
<td>VAS BVS NEM PASS PCS PVAQ</td>
<td>Response time increased in the dual task but no significant difference between groups. FM patients did not demonstrate selective attention to body relevant stimuli relative to controls.</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
<td>Control Group</td>
<td>Design</td>
<td>Experimental method</td>
<td>Primary Outcome Measure/s&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Additional Measures&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Summary of main results</td>
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<tr>
<td>Hermann et al. (2008)</td>
<td>N = 14 Children aged 10 – 15</td>
<td>N = 15 Healthy Controls</td>
<td>Mixed 2 (group: FAP, control) x 2 (stimulus intensity: painful, non-painful)</td>
<td>Oddball standards paradigm: exposure to body-relevant sensations</td>
<td>ERP Response latency</td>
<td></td>
<td>FAP demonstrated significantly larger P3 amplitude and significantly shorter P3 latency to painful and non-painful stimuli than HC. Difference more pronounced for painful stimuli. FAP allocated attention earlier and automatically to pain stimuli but did not interfere with performance on detection task. Also demonstrated attentional bias for non-painful stimuli.</td>
</tr>
<tr>
<td>Van der Veek et al. (2014)</td>
<td>N = 30 Children aged 8 -17</td>
<td>N = 30 Healthy Controls</td>
<td>Mixed 2 (age group: 8-12 years, 13-18 years) x 3 (picture type: heart, gut, neutral) x 2 (congruency: congruent, incongruent) x 2 (SOA: 20ms, 1250ms)</td>
<td>Dot-probe task using sham pictures of bodily activity</td>
<td>Response latency Attentional bias score</td>
<td>API RCADS-25 CSI PVAQ Rating of abdominal pain</td>
<td>FAP group slower to respond than HC on all gut picture trials across both congruent and incongruent trials when presented supraliminally. No difference in attentional bias scores. All children had an attentional bias away from heart stimuli when presented supraliminally.</td>
</tr>
<tr>
<td>Beck et al. (2011)</td>
<td>N = 54 Children aged 10 – 16</td>
<td>N = 53 Healthy Controls Interview and self/parent report to ensure they were not pain patients</td>
<td>Randomised 2 (group: FAP, control) x 2 (feedback condition: success, failure) x 3 (word type: pain threat, social threat, neutral) x2 (time: pre-game, post-game) x 2 (SOA: 20ms, 1250ms)</td>
<td>Dot-probe task</td>
<td>Response latency Attentional bias score</td>
<td>Lexical decision task SER MASC</td>
<td>FAP displayed attentional bias for pain-related stimuli compared with neutral and HC when presented supraliminally. Following success and failure on a challenging game, FAP patients increased attention to pain stimuli when this was presented subliminally. HC exhibited no change. No significant difference between groups on attentional bias for social threat.</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
<td>Control Group</td>
<td>Design</td>
<td>Experimental method</td>
<td>Primary Outcome Measure/s$^1$</td>
<td>Additional Measures$^2$</td>
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<tr>
<td>G. Andersson et al. (2005)</td>
<td>N = 104 Recruited from waiting list at Audiology Department</td>
<td>N = 21 Healthy Controls Not age and gender matched</td>
<td>Randomised 2 (group: tinnitus, control) x 2 (noise condition: quiet, noisy) x 3 (word type: tinnitus related, neutral, strings of xxxx)</td>
<td>Emotional Stroop task conducted via the Internet</td>
<td>Response latency</td>
<td>TRQ, HADS</td>
<td>No difference in tinnitus participant’s response times in noisy or quiet conditions. Tinnitus participants faster to respond to tinnitus words than neutral words. No difference in control participant’s response times in noisy and quiet conditions. No difference in response times for tinnitus or neutral words. Did not analyse group comparison. Original Stroop: tinnitus participants were slower to respond than HC. Tinnitus Stroop: tinnitus participants slower to respond than HC. No main effect for word type or group or group x word interaction. Physical: tinnitus participants slower to respond than HC. Tinnitus participants and HC slower to respond to physical threat words.</td>
</tr>
<tr>
<td>G. Andersson et al. (2000)</td>
<td>N = 23 Prior diagnosis of tinnitus according to Klockhoff and Lindblom (1967) grading system</td>
<td>N = 23 Healthy Controls Age and gender not significantly different</td>
<td>Mixed 2 (group: tinnitus, control) x 3 (word type: colour words, physical-threat words, tinnitus words)</td>
<td>Emotional Stroop task</td>
<td>Response latency</td>
<td>WAIS-R, STAI, BDI, S-TQ</td>
<td>IEI and SFD demonstrated higher emotional intrusion effects for symptom words but not for IEI trigger words compared to controls. No difference between groups for IEI trigger words. IEI group showed greater negative association effects towards IEI-trigger words compared to SFD and CG.</td>
</tr>
</tbody>
</table>

Tinnitus: N = 2

Idiopathic environmental intolerance: N = 3

Witthoft et al. (2009)

IEI: N = 49 Diagnosis by medical examination, a psychiatric interview (SCID) and the IEI interview

Healthy control group: N = 54 Somatoform disorder group: N = 43 Age, gender and years in education not significantly different

Mixed 3 (group: IEI, SFD, control) x 2 (word type: symptom words, IEI-trigger words)

The extrinsic affective Simon task (EAST)

Response latency

COSS, SOMS, PHQ-15, PHQ-9, STAI
<table>
<thead>
<tr>
<th>Author</th>
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<th>Summary of main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witthoft et al. (2006)</td>
<td>IEI: N = 54 Diagnosis by psychiatric interview (SCID) and the IEI interview. Interviews conducted by Clinical Psychologists with specific training.</td>
<td>Healthy control group: N = 54 Somatoform disorder group: N = 44 Age, gender and years in education not significantly different</td>
<td>Mixed 3 (group: IEI, SFD, control) x 2 (word type: symptom words, IEI-trigger words)</td>
<td>Modified Stroop task</td>
<td>Interference indices</td>
<td>COSS ESQ CABAH ACQ SOMS PHQ-15 STAI Self-Assessment Manikin</td>
<td>IEI and SFD groups had a greater interference effect for symptom words but not IEI-related words on the modified Stroop task. Groups did not differ in dot-probe task. IEI group rated IEI-trigger words as more unpleasant. There was a trend for better recognition performance for trigger words in the IEI group compared to CG and SFD group but did not reach significance.</td>
</tr>
<tr>
<td>L. Andersson et al. (2009)</td>
<td>N = 21 Diagnosis by self-report questionnaire (CSS-SHR)</td>
<td>N = 17 Healthy Controls Age not significantly different. Not gender matched.</td>
<td>Repeated measures: ABBA 2 (group: chemical sensitivity group, control group) x 2 (attention type: attend, ignore) x 3 (modality: chemosomatosensory, olfactory, auditory) x 3 (electrode site: Fz, Cz, Pz) x 4 (time: time 1, time 2, time 3, time 4) x 2 (part: 1, 2)</td>
<td>Exposure to body-relevant sensations</td>
<td>ERP's</td>
<td>Magnitude estimations of perceived intensity</td>
<td>ERP data: CS group had shorter chemosensory and olfactory P2 latencies than CG in the ignore condition. No group differences in attend condition or in auditory ERP components. Magnitude estimations: CS group did not habituate to CO2 exposure but CG did. Sensitisation: CG N1 amplitudes reduced in the second part of the task for all sensory modalities. Response times: CS group had faster overall response times.</td>
</tr>
</tbody>
</table>
Primary outcome measures description: 1: Attentional bias scores derived by subtracting valid trials response times from invalid trial response times for each stimulus type. Positive values indicate attentional bias towards threat. Negative values indicate attentional avoidance of threat. 2: Engagement index is calculated by subtracting response times on valid threat trials from response times on valid neutral trials. Positive values on engagement index are interpreted as attentional engagement with threat stimuli. Disengagement indices are calculated by subtracting response times on invalid neutral trials from response times on invalid threat trials. Positive values interpreted as difficulty disengaging from threat. 3: Interference index is calculated by subtracting the response time to name neutral stimuli from time taken to name threat stimuli. This provides a measure of how much more interference is experienced when colour naming threat stimuli relative to neutral stimuli. 4: Response latency refers to the duration between the delivery of a stimulus and the response. 5: Accuracy is the proportion of correct responses. 6: Magnitude estimations of perceived intensity are calculated by asking participants to rate how intense they perceive a stimulus to be. 7 Additional measures: ACQ, Asthma Control Questionnaire; API, Abdominal Pain Index; BDI, Beck Depression Inventory; BVS, Body Vigilance Scale; CABAH, Cognitions About Body and Health Questionnaire; CFS, Chalder Fatigue Scale; COSS, Chemical Odor Sensitivity Scale; CSI, Children’s Somatisation Inventory; ESQ, Environmental Symptoms Questionnaire; FIS, Fatigue Impact Scale; HADS, Hospital Anxiety and Depression Scale; MASC, Multidimensional Anxiety Scale for Children; NART, National Adult Reading Test; NEM, Negative Emotionality Subscale; PANAS, Positive and Negative Affect Schedule; PASS, Pain Anxiety Symptoms Scale; PCS, Pain Catastrophising Scale; PFRS, Profile of Fatigue Related Symptoms; PHQ-9, Patient Health Questionnaire-9; PHQ-15, Patient Health Questionnaire-15; PVAQ, Pain Vigilance and Awareness Questionnaire; RCADS-25, Revised Child Anxiety and Depression Scale-25; SDES, Social Desirability Scale; SER, Symptom/Emotion Report; SIAS, Social Interaction Anxiety Scale; SOMS, Screening for Somatoform Symptoms; SPS, Social Phobia Scale; SSS, Somatic Symptoms Scale; STAI, State-Trait Anxiety Inventory; S-TQ, Swedish Tinnitus Questionnaire; TRQ, Tinnitus Reaction Questionnaire; VAS, Visual Analogue Scale; WAIS-R, Wechsler Adult Intelligence Scale-Revise

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<tr>
<th>Author</th>
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<th>Additional Measures</th>
<th>Summary of main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afzal et al. (2006)</td>
<td>N = 15 Diagnosed but not with reference to independent criteria</td>
<td>N = 15 Healthy Controls Age and gender not significantly different</td>
<td>Mixed 2 (group: IBS, control) x 2 (word type: symptom-related, neutral) x 2 (exposure: masked, unmasked)</td>
<td>Modified Stroop task</td>
<td>Interference index</td>
<td>IBS group slower to respond to symptom-related words when presented subliminally. HC slower to respond to symptom-related words when presented supraliminally.</td>
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<tr>
<td>Martin &amp; Chapman (2010)</td>
<td>N = 33 Females Rome criteria or professional medical diagnosis</td>
<td>N = 27 Healthy Controls Females Age and years in education not significantly different</td>
<td>Randomised. Mixed 2 (group: pFGID, control) x 2 (induction: rumination, distraction) x 2 (block: pre- or post-induction) x 3 (word type: pain, social threat, neutral) x 2 (SOA: 150ms, 550ms)</td>
<td>Exogenous cueing task</td>
<td>Attentional bias score</td>
<td>HADS VAS</td>
<td>pFGID group did not demonstrate bias towards pain words relative to controls and this was not influenced by induction.</td>
</tr>
<tr>
<td>Chapman &amp; Martin (2011)</td>
<td>N = 20 Rome criteria and/or professional medical diagnosis</td>
<td>N = 33 Healthy Controls Significantly higher proportion of females in IBS group. Age not significantly different</td>
<td>Mixed 2 (group: IBS, control) x 3 (word type: pain, social threat, neutral)</td>
<td>Exogenous cueing task SOA 150ms</td>
<td>Attentional bias score Engagement and disengagement indices</td>
<td>HADS SPS SIAS SSS VAS</td>
<td>IBS group more biased towards pain than neutral words compared to controls with faster engagement with pain words.</td>
</tr>
</tbody>
</table>
Table 3. 
*Quality Assessment*

<table>
<thead>
<tr>
<th>Study</th>
<th>Participant characteristics and ascertainment</th>
<th>Control group</th>
<th>Confounding factors</th>
<th>Independent variable</th>
<th>Dependent variable</th>
<th>Statistical analysis</th>
<th>Effect sizes</th>
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<tbody>
<tr>
<td><strong>Chronic fatigue syndrome</strong></td>
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<td>Hou et al. (2014)</td>
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<td><strong>Fibromyalgia</strong></td>
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<td><strong>Functional abdominal pain</strong></td>
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<td>Van der Veek et al. (2014)</td>
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*Note: ++ High quality, + Acceptable quality, - Unacceptable quality.*
Results

Chronic Fatigue Syndrome

There is very limited evidence for an attentional bias towards body relevant information in individuals with CFS according to the findings of the reviewed studies. Although this has been explored using a range of paradigms (exogenous cueing task, emotional Stroop task and dot-probe task), attentional bias has only been observed in one study using the dot-probe task with an SOA of 500ms in CFS patients compared to healthy controls. Hou, Moss-Morris, Bradley, Peveler, and Mogg (2008) found that CFS participants were faster to respond when the threat stimulus and probe were in the same position relative to when these were in different positions; this implies that the threatening information had a facilitating effect. The effect was not influenced by mode of presentation and was unrelated to anxiety, depression and psychomotor speed. In contrast, Hou et al. (2014) did not find evidence of an attentional bias to health threat information on a dot-probe task with the same stimuli when participants with CFS with poor executive control were excluded. Thus, the attentional bias effect appeared to be dependent reflect poor executive attention in the CFS participants; however, there was no comparison with non-CFS participants with poor executive attention, making it difficult to draw firm conclusions. No effects at an SOA of 1250ms were found.

Using an unmasked emotional Stroop task, Moss-Morris and Petrie (2003) did not find evidence of an attentional bias towards threatening information at later stages of information processing. Another study using an adapted modified exogenous cueing task with threatening health-related, social threat and neutral words with an SOA of 150ms found no evidence of an attentional bias in people with CFS compared to healthy controls at an early stage of automatic processing (Martin & Alexeeva, 2010). This study attempted to manipulate attentional focus on bodily sensations by incorporating ‘rumination’ and ‘distraction’ conditions and this was not found to influence performance.

Using the quality assessment tool (see Table 3), two of the studies in CFS were rated as being of high quality (Hou et al., 2014; Martin & Alexeeva, 2010) and the other two as acceptable in quality (Hou et al., 2008; Moss-Morris & Petrie, 2003). All studies recruited participants on the basis of diagnosis by a medical professional and with reference to standardised criteria such as the Centres for Disease Control and Prevention diagnostic criteria (Fukuda et al., 1994). The study by Hou et al. (2014) was the strongest study in terms of participant characteristics and diagnostic ascertainment. They recruited participants from a specialist
gastrointestinal outpatient clinic and participants received a diagnosis of CFS from a specialist CFS practitioner and with reference to the Chalder Fatigue Scale (Chalder et al., 1993) and the Centres for Disease Control and Prevention diagnostic criteria (Fukuda et al., 1994). This strict approach to diagnostic ascertainment would have reduced potential sampling bias by reducing the likelihood of individuals without CFS being included in the experimental group. Two of the studies recruited CFS participants from CFS support groups (Hou et al., 2008; Martin & Alexeeva, 2010). Individuals with CFS choosing to attend a support group may differ from CFS patients in the wider community in terms of degree of impairment (Sharpe, Hawton, Seagroatt, & Pasvol, 1992). The negative valence of health threat information, and thus its propensity to capture attention, may be perceived as greater by individuals with higher levels of functional impairment. This calls into question the generalisability of the findings from these studies to individuals with CFS not attending a support group. The positive finding of an attentional bias to health-threat information in individuals with CFS recruited from a support group (Hou et al., 2008) can thus only be taken as evidence of an attentional bias in this specific population rather than individuals with CFS more generally.

All of the studies attempted to match the control group for age, gender and educational attainment and all attempted to account for potentially relevant confounding variables such as anxiety, depression and concurrent medical conditions. None of the studies accounted for medication use which could be a potentially important factor. The studies all compared CFS patients with healthy controls. The inclusion of an illness control group would have enabled conclusions to be made as to whether any differences in attentional bias were due to the condition of interest or due to a more general effect of experiencing unpleasant symptoms. All studies used well-validated and established experimental tasks to measure bias. Dependent variables were described with operational precision and bias was minimised. Only one study raised doubts about potential bias with regards to the measurement of attentional bias (Moss-Morris & Petrie, 2003). In this study, Stroop stimuli were presented on pieces of card rather than electronically, meaning that reaction times were measured manually by the experimenter operating a stop-watch. The authors did not clarify whether the experimenter was blind to condition allocation, which clearly introduces the potential for experimenter error and bias, raising some doubts as to the reliability and validity of the findings from this study.
Statistical analyses were conducted appropriately with data being transformed to correct skewed data prior to conducting parametric analysis (Hou et al., 2014) or analysing data using non-parametric test if data did not meet assumptions for parametric analysis (Moss-Morris & Petrie, 2003).

It is worth noting that the threatening health relevant stimuli used in the studies were related to general health concerns and were not specific to CFS-related concerns. It may be that in order for threatening stimuli to trigger an attentional bias it needs to be pertinent and salient to the specific health concerns of the individual. Future studies should manipulate the content of the threat-relevant stimuli to address this.

The findings from these studies suggest that the evidence for an attentional bias for health-threat information in CFS is equivocal. All of the studies, with the exception of Hou et al., (2014) had some specific methodological issues relating to validity and reliability which should be acknowledged when interpreting the findings from these studies. Future studies should recruit individuals from wider sources so that samples are more representative. Participant recruitment should also involve strict inclusion criteria for CFS participants, specifically diagnosed by a CFS specialist and with reference to objective criteria. Future research would also benefit from larger sample sizes with consideration of functional ability, stage of illness and number of symptoms experienced.

**Fibromyalgia**

The studies in fibromyalgia provide little evidence of an attentional bias for body relevant threat information in individuals with FM compared to healthy controls. The two emotional Stroop studies used the same stimuli (FM symptom related words; arousing negative words; arousing positive words; neutral words) and presented stimuli for 300ms. Response latencies and accuracy rates demonstrated no significant difference between FM participants and healthy controls with regards to attentional bias towards health-threat relevant stimuli (Gonzales et al., 2010; Mercado et al., 2013).

Gonzales et al. (2010) found a non-significant trend for FM participants to be slower in colour-naming symptom words and arousing words relative to healthy controls. The tendency to be slower was not mediated by trait or state anxiety but was mediated by the perceived unpleasantness of the arousing-negative stimuli. Effect sizes were medium to large.
and the non-significant trend for FM participants to be slower to colour-name symptom words might have become significant with more power (i.e. larger sample size).

Mercado et al. (2013) measured ERPs whilst participants completed the Stroop task. The experimental group demonstrated larger P450 amplitudes and enhanced activation within right frontal inferior gyrus in response to symptom-related words compared to healthy controls. Other studies measuring ERPs during classical Stroop tasks have suggested that incongruence between the word and ink colour requires greater cognitive inhibition to reduce interference (suppressing the learned routine to assess the meaning of a word rather than just naming its colour) and is associated with greater N450 amplitudes (Lansbergen, van Hell, & Kenemans, 2007). Despite the differences in polarity of ERP data yielded in previous studies and the current study, the authors posited that their findings were related to cognitive inhibition processes. However, the lack of significant behavioural differences makes these findings difficult to interpret. One possibility is that FM patients require greater processing resources in order to produce normal task performance, hence a difference in ERP but not behavioural data. Similar findings have been obtained in patients with chronic pain (McNeely, Lau, Christensen, & Alain, 2008), suggesting that the presence of chronic pain rather than fibromyalgia per se may be responsible for this.

Using a body scanning reaction time paradigm, Peters et al. (2000) found no evidence of an attentional bias towards threatening body-relevant stimuli. This study incorporated single and dual task conditions in an attempt to manipulate attentional load and sensory competition. Attention manipulation was successful as response latencies on the electrical stimulation task increased in the dual task condition but this was not different between the groups. The electrical stimuli in the task were weak and selective attention was to be inferred by shorter response times to detect the stimuli. It is a possibility that this stimulus was not experienced and interpreted as threatening by individuals with FM such that attentional processing was not influenced. More intense electrical stimulation may be required in order to demonstrate an attentional bias.

In terms of quality, all of the studies were rated as being of high quality (see Table 3). The main weakness in all of the studies in this area was concerned with controlling for potentially confounding variables. None of the studies measured or accounted for depression. Two studies considered the impact of anxiety (Gonzales et al., 2010; Mercado et al., 2013). One
study did not account for any potential confounding factors (Peters et al., 2000). Only one study accounted for medication use (Mercado et al., 2013) despite all of the studies identifying that the majority of fibromyalgia participants were taking some form of medication such as benzodiazepines or selective serotonin reuptake inhibitors. Many individuals with fibromyalgia take medication to reduce their experience of painful sensations. Research has demonstrated the cognitive interfering effect of pain and medication (Glass et al., 2011) and this should be considered as a factor and controlled for in future research.

Diagnostic ascertainment was generally of a high quality, however one study recruited participants on the basis of self-report data alone (Gonzales et al., 2010). All used well validated measures of attention and provided a high level of information regarding dependent variables. Information regarding effect sizes was of an acceptable (Peters et al., 2000) to high (Gonzales et al., 2010; Mercado et al., 2013) standard. All studies compared individuals with fibromyalgia to a healthy control group. As previously discussed, this calls in to question the generalisability of any findings.

The findings from these studies suggest that there is little evidence that individuals with fibromyalgia display an attentional bias for body-relevant stimuli. The studies in this area were of high quality however, the lack of consideration of potentially important confounding factors across these studies calls in to question the reliability and validity of their findings. The findings from these studies therefore need to be considered within the context of other potentially important differences between the experimental and control groups, rather than just the presence or absence of fibromyalgia. Studies in this area would benefit from more consideration of potentially confounding variables and more robust procedures towards diagnostic ascertainment.

*Functional Abdominal Pain*

All of the studies demonstrated some evidence for an attentional bias towards body-relevant stimulus in children with FAP. The bias was for mechanical stimuli (both painful and non-painful), linguistic stimuli (pain threat, social threat and neutral words) and sham pictures of bodily activity (fictional pictures intended to depict participants’ current gut activity, heart rate and laptop activity). Children with FAP were found to allocate attention earlier and more automatically to both painful stimuli and innocuous stimuli as evidenced by larger P3
amplitudes and shorter latencies to detect such stimuli relative to healthy controls (Hermann, Zohsel, Hohmeister, & Flor, 2008). The differences in ERP data were not associated with differences in response times and intensity ratings, however.

Using a dot-probe task with sham pictures of bodily activity, children with FAP were found to respond slower on gut-activity trials when presented supraliminally relative to healthy controls (van der Veek et al., 2014). This was not associated with symptoms of anxiety, depression, pain vigilance or current pain levels. As there was no difference in FAP groups’ response times to detect targets replacing gut stimuli and those replacing laptop stimuli, the authors suggested that this did not constitute evidence of bias. However, the relative slowing to detect targets on trials in which gut relevant stimuli was present (regardless of congruency) suggests that this information distracted FAP children from task performance (detecting the targets). Both FAP children and healthy controls demonstrated an attentional bias away from heart stimuli when this was presented supraliminally as evidenced by negative attentional bias scores for this type of stimuli. This difference highlights the importance of stimuli type in measuring attentional bias as the findings were very different for the two types of body-relevant stimuli. There were no differences between the groups in response times or attentional bias for any stimuli when these were presented subliminally.

The findings suggest that gut relevant information may capture FAP children’s conscious attention leading to increased response times when this is presented anywhere in foveal vision.

Using linguistic stimuli, Beck et al., (2011) found evidence in their FAP group of an attentional bias towards pain-related stimuli when these were presented supraliminally relative to healthy controls as evidenced by positive attentional bias scores. This study also attempted to explore the potentially mediating effect of stress in attentional bias by incorporating a stress manipulation in which participants would either succeed or fail in completing a challenging computer game. It was found that bias was also present when stimuli were presented subliminally but only when measured alongside a stressful concurrent task regardless of success or failure.

These studies provide some evidence that children with FAP have an attentional bias towards body relevant information at a later, conscious stage of processing. The ERP data suggest that children with FAP also demonstrate greater allocation of attention at an early
stage of processing. The P3 component is considered to indicate an unintentional and preconscious shift of attention or orienting response towards salient stimuli (Garcia-Larrea, Lukaszewicz, & Mauguiere, 1992). This may also be influenced by arousal and anxiety levels. This, together with the finding that children with FAP demonstrated an attentional bias towards subliminally presented pain relevant words that was only present when completing a stressful task, highlights the potential implication of stress in automatic attentional bias in children with FAP.

With regards to methodological quality, all of the studies were rated as being of acceptable quality using the quality assessment tool (see Table 3). All of the studies recruited participants with FAP with reference to standardised criteria (either parent or self-report depending on age of participant) or by definition of symptoms. The participants comprising the experimental group had previously undergone medical investigations to rule out possible organic causes for their abdominal pain however, the studies would have been more robust had investigations been conducted by a gastrointestinal specialist prior to recruitment to the studies. Control groups were matched for age, gender and education and attempts were made to rule out concurrent medical conditions.

Attempts to account for other potential confounding factors varied across the studies. One measured anxiety and depression (van der Veek et al., 2014), one just anxiety (Beck et al., 2011) and one did not take into account either as a potentially contributing or mediating factor (Hermann et al., 2008). All of the studies used a healthy control group for comparison. All of the studies provided sufficient information to calculate effect sizes and analyses were conducted appropriately. The independent variables and dependent variables were well validated and described with replicable and operational precision with the exception of one study (van der Veek et al., 2014). This study adopted a modified version of the dot-probe task in which sham pictures intended to depict participants’ own bodily activity were used as stimuli. This required participants to believe that the stimuli were reflecting their own bodily activity. The authors completed a ‘credibility check’ after the procedure to determine whether the children in the study thought that the images were in fact demonstrating their own bodily activity. This relied on the participants stating whether they had believed the experimenter or not which clearly introduces the potential for response, as well as experimenter bias. Additionally, children were given the option to conduct the experiment in their own homes further introducing the potential for bias. Although the study was
methodologically sound in other areas, the validity of using sham pictures of bodily activity is questioned, and the potential sources of bias suggest that the findings from this study should be treated with caution.

The studies in this area would benefit from more robust procedures for diagnostic ascertainment to improve generalisability of findings and to make further attempts to reduce bias. Potential confounding factors should also be given more consideration. With the exception of the study using sham pictures (van der Veek et al., 2014), and other than the methodological limitations previously highlighted, the findings from these studies were considered reliable and valid.

_Tinnitus_

The studies exploring Tinnitus (N=2) varied greatly in quality with one being considered to be of unacceptable quality (G. Andersson, Bakhsh, Johansson, Kaldo, & Carlbring, 2005). This study was rated as being of unacceptable quality across all areas of the quality assessment and due to its poor quality, its findings were rendered invalid (see Table 3). The other study was of acceptable quality (G. Andersson, Eriksson, Lundh, & Lyttkens, 2000).

G. Andersson et al. (2000) did not find any Stroop interference effect in tinnitus participants with either tinnitus related or physical threat words. In terms of quality, this study recruited participants with a previous diagnosis of tinnitus and made reference to standardised criteria. There is question as to the representiveness of this sample however as participants with varying severity of tinnitus and related disability were included. The study would have benefited from including experimental groups based on symptom severity (e.g. tinnitus in one ear and tinnitus in both ears as separate groups) in order to improve generalisability. The study accounted for anxiety and depression in both groups but did not make reference to whether any concurrent health problems were accounted for in either group. The study used a well-validated measure of attention and information regarding the dependent variable was of a high standard. Sufficient information was provided to calculate effect sizes. However, the measurement of the dependent variable was subject to potential bias, as response times were calculated by the experimenter and no information was provided as to whether the experimenter was blind to condition allocation, thus calling in to question the reliability and validity of the findings.
Idiopathic Environmental Intolerance

The studies in idiopathic environmental intolerance (or multiple chemical sensitivity) again used different paradigms making direct comparison of findings problematic. Using a modified Stroop task, Witthoft, Gerlach, and Bailer (2006) found that individuals with IEI and somatoform disorder (SFD) demonstrated greater Stroop interference compared to healthy controls for physical symptom words in general but not for IEI-related words. Groups did not differ on a dot-probe task. Witthoft, Rist, and Bailer (2009) attempted to further explore cognitive schemata and attention using the extrinsic affective Simon task and found that the IEI and SFD groups demonstrated greater attention allocation to physical complaint words, consistent with their previous findings with the emotional Stroop (Witthoft et al., 2006). Both studies also found no difference between the groups on attention for IEI-trigger words. Thus, the findings from these two studies demonstrate more similarities in attention to physical complaint words in people with IEI versus SFD, than differences.

L. Andersson, Bende, Millqvist, and Nordin (2009) explored attention to body-relevant sensations and attempted to manipulate attentional focus by incorporating conditions in which participants were instructed to attend to or ignore the stimulus. It was found that the IEI group had shorter chemosensory and olfactory P2 latencies than the control group when instructed to ignore the stimulus. Previous studies have demonstrated that attention allocation leads to decreased P2 latencies (Krauel, Pause, Sojka, Schott, & Ferstl, 1998). This suggests that IEI participants had greater difficulty ignoring the chemical exposure, which was of personal relevance. As there were no group differences in the attend condition it is suggested that an attentional bias is due to a difficulty disengaging attention from chemical exposure. Findings also suggested that the IEI group did not habituate to the chemical exposure to the same extent as the control group. The authors highlight, however, that the measurement of habituation was crude due to difficulties extrapolating the ERP data from only one of the four blocks and comparing only the first and second parts of the recordings. They found that the IEI group were faster to detect all stimuli types when instructed to attend to them.

The studies in this area were of acceptable to high quality. Two of the studies stood out as particularly strong among all of the papers in this review (Witthoft et al., 2006; Witthoft et al., 2009) and were rated as high quality across all aspects of the quality assessment (see Table 3). Participants in these studies were identified by medical examination, a psychiatric
interview and an Idiopathic Environmental Intolerance interview (Witthoft et al., 2006). Standardised interviews were conducted by specially trained medical professionals. These studies answered one of the main criticisms of the other studies by including a comparison group with somatoform disorder diagnosed with reference to DSM-IV criteria (APA, 1994), in addition to a healthy control group. Potential confounds (anxiety and depression) were accounted for. They used well-validated measures of attention, described dependent variables with operational precision and provided effect sizes for all hypotheses. As such these studies appeared to have minimised sources of bias or responded to potential sources appropriately (e.g. by calculating interrater reliability), and as such the findings would be considered reliable and valid.

The study by L. Andersson et al. (2009), although not deemed as methodologically robust as the previous studies in this area, was still of acceptable quality. This study recruited participants on the basis of self-report only, and employed only a healthy comparison group. Little information was provided potentially confounding variables such as concurrent physical or mental health problems. Aside from these factors, there were no concerns regarding its methodological rigour and as such its findings would be considered reliable and valid.

Thus, on the basis of these studies, there does seem to be some evidence of an attentional bias towards body-relevant information in individuals with IEI.

Irritable Bowel Syndrome

Findings from the IBS studies are mixed. Attentional bias was explored using the emotional Stroop task and exogenous cueing tasks. The body-relevant stimuli used in the tasks consisted of IBS relevant stimuli in the Stroop task and pain words in the exogenous cueing tasks. The findings of the emotional Stroop demonstrated that individuals with IBS demonstrated greater interference of symptom-related words (relative to neutral words) in the masked condition but not in the unmasked condition whereas healthy controls had greater interference of symptom-related words (relative to neutral words) in the unmasked condition but not in the masked condition (Afzal, Potokar, Probert, & Munafo, 2006).

One exogenous cueing study provided evidence suggesting that individuals with IBS engaged more rapidly with pain-relevant words relative to social threat-relevant and neutral words
and compared to healthy controls using an SOA of 150ms (Chapman & Martin, 2011). Analysis of engagement and disengagement indices suggested that individuals with IBS engaged more with pain-relevant words compared to neutral words and healthy controls as indicated by faster response times to detect pain words. There was no difference with regards to disengagement. Analysis of bias scores found a significant interaction between word type and group. There was no significant difference in orienting to pain and neutral words in the IBS group whereas controls oriented more quickly to neutral words than pain words.

Another exogenous cueing study using the same stimuli and SOAs of 150ms and 550ms did not replicate these findings (Martin & Chapman, 2010). The authors also considered the role of rumination in attentional bias by incorporating a ‘rumination’ and ‘distraction’ condition. They found no difference between the groups in response times to pain words and this was not influenced by rumination or distraction. Results remained unchanged when controlling for baseline anxiety, depression and mood state.

The studies in IBS were rated as being of acceptable quality (see Table 3). These studies could have adopted more robust procedures for diagnostic ascertainment. All of the studies recruited participants by self-report and/or medical professionals’ diagnosis. Martin and Chapman (2010) chose to use a ‘putative functional gastrointestinal disorder’ group rather than a strict IBS group due to the recruitment procedure of the experimental group. Experimental participants were recruited on the basis of a medical practitioners’ diagnosis or if they met the Rome II criteria for IBS (Drossman et al., 1999). The authors highlighted that this may have led to the inclusion of participants with other organic or functional gastrointestinal disorders. Similarly, Chapman and Martin (2011) recruited participants on the basis of doctors’ diagnosis and/or Rome II checklist criteria. In a mixed gastrointestinal sample, the Rome II criteria has a positive predictive value of 78% for IBS diagnosis (Vanner et al., 1999), suggesting that further testing and diagnosis by a gastrointestinal specialist is required to ensure an accurate diagnosis of IBS. In another study (Afzal et al., 2006), the IBS status of individuals in the experimental group was derived with reference to ‘Rome-like’ criteria. The authors did not provide information about these criteria but the reference to ‘Rome-like’ criteria suggests that this was similar to the standardised measure used in the diagnosis of IBS (i.e. Rome II; Drossman et al., 1999) but did not use this as an objective measure of clinical diagnosis. All of the studies therefore potentially included participants
with gastrointestinal conditions other than IBS and would benefit from discerning IBS status through diagnosis by a medical professional specialising in IBS as well as reference to objective standardised criteria such as Rome II (Drossman et al., 1999). These studies may therefore not have been a reliable measure of attentional bias in individuals with IBS specifically. Rather, they explored attentional bias in individuals with unpleasant gastrointestinal symptoms more generally which should be borne in mind when interpreting their findings.

One of the studies made no reference to any potential confounds (Afzal et al., 2006). Factors such as anxiety and depression might have a mediating or causal role in attentional bias and as such the extent to which the positive findings from this study can be considered evidence for an attentional bias to health-threat information in individuals with IBS is questioned. The other studies accounted for anxiety and depression (Chapman & Martin, 2011; Martin & Chapman, 2010). No studies however, accounted for any concurrent physical health condition. All of the studies adopted well-validated measures of attention. Enough information to calculate effect sizes was provided and dependent variables were described to a high standard. One study was subject to potential bias due to the fact that participants were able to choose the location of their choice for the experimental procedure (Martin & Chapman, 2010). The authors stated that this was done to reduce potential anxiety about bathroom facilities in the IBS group, however this could be an important factor when exploring attentional processes in this population. In order to generalise findings and reduce potential sources of bias, it would be preferable if all participants were tested in the same controlled environment. Despite the issues identified, the findings of Chapman and Martin (2011) and Martin and Chapman (2010), were considered reliable and valid. Only the study by Afzal et al. (2006) raised enough concern to question the reliability of the findings in this area.
Discussion

A detailed overview of the experimental paradigms used to measure attentional bias in FSS has been provided followed by a review of the evidence generated from these paradigms. Eighteen studies exploring attentional bias towards body/health threat information in individuals with FSS were reviewed and factors relevant to the interpretation of findings have been highlighted. The review has demonstrated that attentional bias towards body-relevant information in FSS is an under-researched area. The review found only six FSS that have been studied and findings are mixed. Ten of the reviewed studies demonstrated some evidence of an attentional bias towards body/health relevant information in five of the FSS using a range of paradigms and stimuli. Eight of the studies produced negative findings of the hypothesised bias.

All of the studies in functional abdominal pain (N = 3) demonstrated some evidence of an attentional bias towards health threat information relative to healthy controls as measured by performance on the dot-probe task (Beck et al., 2011; van der Veek et al., 2014) and an oddball standards paradigm (Hermann et al., 2008), although the validity of the findings of one study was called in to question (van der Veek et al., 2014). One study in fibromyalgia revealed evidence of an attentional bias as evidenced by differential ERP data during completion of the emotional Stroop task (Mercado et al., 2013), whereas two studies observed negative findings (Gonzales et al., 2010; Peters et al., 2000). One study in CFS demonstrated that these participants had an attentional bias to health threat pictorial and linguistic stimuli using a dot-probe task with an SOA of 500ms (Hou et al., 2008). Three further studies in CFS demonstrated no evidence of such a bias using a dot-probe task (Hou et al., 2014), emotional Stroop task (Moss-Morris & Petrie, 2003) and exogenous cueing task (Martin & Alexeeva, 2010). In IIE, all of the studies (N = 3) demonstrated some evidence of an attentional bias in these individuals using the emotional Stroop task (Witthoft et al., 2006), exposure to bodily sensations (L. Andersson et al., 2009) and the EAST (Witthoft et al., 2009). Studies in IBS found evidence of an attentional bias using the modified Stroop (Afzal et al., 2006) and exogenous cueing task (Chapman & Martin, 2011), whereas negative findings were also found using an exogenous cues task (Martin & Chapman, 2010). Neither of the tinnitus studies revealed evidence of an attentional bias in this population.

The mixed findings observed may in part be due to the fact that different paradigms were employed to measure attentional bias. The modified Stroop task measures the degree of
interference on task performance related to the presence of threatening information and is a distinct process from selective attention. Therefore, this may actually reflect increased attention to the word meaning at the expense of task performance or decreased attention to the stimulus as a whole including its meaning (Algom, Chajut, & Lev, 2004). The dot-probe task and the exogenous cueing task measure spatial allocation of attention and can distinguish between facilitated attention, delayed disengagement and attentional avoidance. Tasks exposing participants to body-relevant sensations measure hypervigilance for threat. This makes the direct comparison of findings using different paradigms problematic as they are measuring different processes.

There is a poor correlation between attentional bias in the emotional Stroop task and dot-probe task highlighting that these measure discrete attentional processes (Mogg et al., 2000). Positive findings from studies using the emotional Stroop task therefore merely demonstrate that different stimuli are being attended to differently but does not indicate the attentional processes underlying this. Although attempts have been made to modify this paradigm in order to explore automatic and strategic processing (through the inclusion of masked and unmasked stimuli) there remain methodological and interpretative difficulties when using this as a measure of attentional bias. The dot-probe task is considered to be a more valid measure of attentional bias as it enables the specific mechanisms of selective attention to be observed. The dot-probe task has been criticised, however, as threatening and neutral stimuli are presented simultaneously, meaning that it does not provide a baseline measure of attention from which to make comparisons (Cisler, Bacon, & Williams, 2009).

The majority of the studies (N = 15) measured attentional bias with response times or latencies as the dependent measure. A criticism of reaction time tasks is the fact that a stimulus is presented and followed by a response with no further information regarding the cognitive processing between presentation and response. Evidence suggests that attentional focus can shift numerous times in the very early, automatic stages of processing which reaction time tasks do not measure (Yiend, 2010). Eye-tracking studies and ERPs enable assessment of the locus of selection and measures the time course of attentional bias. It was therefore surprising to find that none of the studies employed eye-tracking and only three of the studies also included ERP data. Indeed, all of the studies adopting this measure of attentional bias observed significant differences between experimental and control groups.
Selective attention is considered to have evolved to enable relevant stimuli to be attended to when large amounts of competing stimuli are present. The dot-probe and exogenous cueing tasks predictably present one or two stimuli at a time to be attended to in the absence of other competing stimuli and thus represents a simple visual environment. Visual search tasks which require participants to identify threatening information in a complex visual array may be a more appropriate method of measuring selective attention to specific information (Dolan & Vuilleumier, 2003). This paradigm however, was not adopted by any of the studies in the review.

The role of executive attention was demonstrated as potentially relevant in attentional bias in CFS. Posner and Rothbart (2007) proposed that executive attention is made up of the ability to process competing stimuli as well the ability to switch tasks (Eysenck, Derakshan, Santos, & Calvo, 2007). In the anxiety literature, there is evidence to suggest that poor attentional control is implicated in attentional bias to threat in this population (Derryberry & Reed, 2002). Further research exploring attentional biases in FSS could consider the relationship between attentional biases and cognitive flexibility.

A review of the phenomenological characteristics of experimental measures of attentional bias concluded that their psychometric properties are questionable (Cisler et al., 2009). Attentional bias scores have also been found to have poor test-retest reliability (Kindt, Bierman, & Brosschot, 1996). It is suggested that attentional bias scores are an unreliable measure of attentional bias but the response latencies from which these were calculated are valid over time (Eide, Kemp, Silberstein, Nathan, & Stough, 2002). It may therefore be beneficial for studies to include analyses of both attentional bias scores and response latencies, as important information regarding the differential processing of threatening information may be missed if only attentional bias scores are calculated. Indeed, one of the studies in this review (van der Veek et al., 2014) concluded that an overall slowing to detect threatening information relative to neutral information and healthy controls in children with FAP did not constitute an attentional bias.
The paradigms measured attentional bias towards different types of body-relevant stimuli reflecting different bodily concerns. Some included threatening stimuli relevant to the specific FSS whereas others used general threat or pain relevant stimuli. It may be that studies in this area have failed to utilise stimuli which is salient enough to trigger an attentional bias and that words and pictures are not the most appropriate means to assess bias towards one’s own body. Some studies have identified that attentional bias alters when the threat value is manipulated (Koster, Crombez, Verschuere, van Damme, & Wiersema, 2006). Many of the reviewed studies did not explore this as a factor in attentional bias.

Evidence of attentional bias towards body relevant information appears to be more consistent in the somatoform disorders than in FSS (Karademas, Christopoulou, Dimostheni, & Pavlu, 2008; Lim & Kim, 2005). This may provide evidence that somatoform disorders and FSS are in fact distinct disorders accompanied by differential underlying processes. It may, however, be the case that individuals with FSS are a heterogeneous population, which differ on various dimensions including degree of functional disability. This review has highlighted a more general issue of conducting research in the area of functional somatic syndromes in terms of the validity of diagnoses. Medical science has not as yet identified an organic basis for these conditions and as such they are currently diagnoses of exclusion. Some of the more well known FSS such as CFS and IBS have well-established and validated criteria to aid diagnosis however, other conditions such as functional abdominal pain only refer to a description of symptoms and ruling out obvious organic pathology for diagnosis. There is the possibility that an identifiable organic basis for these conditions will be identified with further medical research and the different FSS may be heterogeneous conditions.

With the exception of the studies by Witthoft and colleagues (2006; 2009), all of the studies in this review compared individuals with the condition of interest to a healthy control group. It is therefore not possible to conclude whether any attentional bias observed is due to the presence of a specific syndrome or due to a more general effect of having an illness. Studies comparing individuals with FSS and those with organic physical illnesses will help to address this limitation and further clarify whether an attentional bias towards body relevant information is implicated in the development and/or maintenance of medically unexplained physical symptoms in individuals with FSS.
The Witthoft studies demonstrated interesting similarities between individuals with IEI and somatoform disorder. In these studies, individuals with IEI and somatoform disorders did not demonstrate an attentional bias towards symptom-relevant information but to general physical complaint words. This highlights the importance of the content of the threat-relevant stimuli used in paradigms to explore attentional bias. More importantly, these studies highlight that there may be a similarity with regards to attentional processing of physical threat-relevant information in individuals with IEI and somatoform disorder. Although it would be premature to suggest that this might generalise to all FSS, it does indicate that future research should explore attentional processes in individuals with different FSS and somatoform disorders. Considering the debate surrounding the classification of these conditions, research such as this may further elucidate the underlying attentional mechanisms involved in MUS and provide evidence as to the differences or similarities of these conditions.

In summary, the findings from this review do not provide conclusive evidence of an attentional bias towards body-relevant threatening stimuli in individuals with FSS, and as such do not support or refute the models of physical symptom reporting described in the introduction. The studies employed experimental paradigms which measure different mechanisms of attention, frequently adopted a broad inclusion criteria, some had small sample sizes and most often lacked the inclusion of an illness control group. Due to these factors it is not possible to discern whether the positive findings of an attentional bias are due to the presence of the specific FSS in question or due to experiencing unpleasant symptoms more generally. It is therefore recommended that future research of attentional bias towards body-relevant threatening information in FSS includes larger, more diversely recruited samples with reference to strict diagnostic criteria and the inclusion of control groups with organic illnesses and other medically unexplained symptoms.

The majority of the studies measured existing bias and did not attempt to manipulate attention which can inform about sources of maintenance and/or causality. Of the studies that did attempt to manipulate attention, a potential effect of stress in attentional bias in functional abdominal pain was found (Beck et al., 2011). Also, when instructed to ignore health-relevant information, individuals with IEI had greater difficulty on this task compared to a healthy control group (L. Andersson et al., 2009). None of the studies attempted to manipulate the spatial allocation of attention using a spatial cueing paradigm. In the anxiety
literature, research on attentional bias modification is increasing to further understand the causal relationship between attentional bias and anxiety. This attempts to create a bias towards or away from threatening information by way of spatial cueing and the impact on anxiety symptoms is measured. Further research exploring the effect of attentional bias modification in individuals with FSS will enable a deeper understanding of the causative or associative relationship between attentional bias and medically unexplained symptoms.
References


Section 2: Empirical Paper

Title

Attentional bias modification and physical symptom reporting:
An experimental investigation

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The following paper has been prepared for submission to the
‘Journal of Abnormal Psychology’.

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Abstract

Background: Theory suggests that attentional bias towards medically unexplained symptoms is central to their development and maintenance. Attentional bias modification (ABM) has demonstrated that attentional bias has a causal impact on anxiety, and has generated clinically significant results. ABM has rarely been investigated within the area of physical symptom reporting.

Aims: to investigate whether it is possible to generate an attentional bias towards threatening health-related information in low symptom reporters using ABM and to measure whether this results in a tendency to report more anxiety and physical symptoms following a health-related stressor.

Method: fifty-six low symptom reporters were randomly assigned to a ‘training’ or ‘no training’ version of an ABM paradigm. Attentional bias was compared before and after the experimental task. Physical symptoms and anxiety were measured before and after a health-relevant mood induction.

Results: following training there was a main effect of threat that was not contingent upon cue validity. Compared to the control group, the experimental group demonstrated greater cognitive interference in the presence of threatening stimuli relative to neutral. Training did not generate an increase in physical symptoms or anxiety.

Conclusions: the findings suggest that ABM can increase the degree to which low symptom reporters are distracted by threatening health-relevant information but this has no direct effect on anxiety or symptom reporting. Future research on ABM and physical symptom reporting should be conducted to explore the effect of attentional avoidance of (rather than attentional bias towards) threatening health-relevant information in a low symptom reporting population.

Key words: Attentional bias modification, attention, medically unexplained symptoms, physical symptom report.
Introduction
Physical symptoms are extremely common in the general population (Rief, Hessel, & Brahler, 2001). Physical symptoms are also the typical reason for primary and secondary care consultations, and the more symptoms someone reports the more they use healthcare services and the more distressed and disabled they tend to be (e.g., Fink, Sorensen, Engberg, Holm, & Munk-Jorgensen, 1999; Jackson & Kroenke, 2008; Katon et al., 1991; Smith, Monson, & Ray, 1986). Whilst we might consider physical symptoms as signifying physical illness or injury, the actual correlation between symptom reports and objective markers is low, and not as high as the correlation between symptom reports and psychological factors such as negative affect (Watson & Pennebaker, 1989). A particularly compelling illustration of this is medically unexplained symptoms (MUS). Research suggests that physical symptoms are frequently experienced in the absence of identifiable organic pathology and thus can be considered ‘medically unexplained’ (Kroenke & Manglesdorff, 1989). It is thought that approximately 80% of the population experience these symptoms (Hiller, Rief, & Brahler, 2006). MUS are considered “to exist on a continuum of severity” (Brown, 2007, p. 770). Most people will experience individual symptoms that resolve spontaneously, whereas others will experience multiple, persistent symptoms that are associated with significant distress and disability (Barsky, Orav, & Bates, 2005; Brown, 2007; Jackson & Kroenke, 2008). Although objective tests are unable to identify an organic basis for these symptoms, they are nonetheless experienced by the individual as subjectively ‘real’, and are often distressing and disabling.

MUS are heterogeneous conditions and there is some debate and confusion regarding their classification (see Brown, 2007 for review). Kirmayer and Robbins (1991) distinguished between three general types of MUS, comprising those that are: (i) the product of a diagnosable anxiety or affective disorder; (ii) normal physical sensations that are misattributed to disease by a health anxious individual; and (iii) physical symptoms that cannot be attributed to organic pathology or accounted for by anxiety, low mood or illness worry. This third category is referred to as ‘functional somatisation’ and is the main focus here.

Medical and psychiatric classifications of MUS have created further confusion in the classification of these phenomena. In medicine, MUS are classified as functional somatic syndromes and are diagnosed according to the specific bodily system in which the majority
of symptoms present. Some of the most well-known examples are chronic fatigue syndrome (CFS), irritable bowel syndrome (IBS) and fibromyalgia. In the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association [APA], 1994) these conditions were categorised on axis III of that system as medical disorders. It is queried whether the different functional somatic syndromes are in fact discrete syndromes or whether they are merely different manifestations of the same core construct (Mayou, Kirmayer, Simon, Kroenke, & Sharpe, 2005; Wessley, Nimnuan, & Sharpe, 1999). Within psychiatry, MUS are classified within the ‘neurotic, stress-related and somatoform disorders’ in the International Classification of Diseases (ICD-10; World Health Organisation [WHO], 1992) and, until recently\(^1\), as ‘somatoform disorders’ in the DSM-IV (APA, 1994). There is confusion and debate about whether or not the functional syndromes and the somatoform disorders are referring to the same conditions. These different approaches to classification have resulted in separate literatures on the features, correlates and causes of these phenomena making it difficult to determine whether they are the same or not.

In addition to those who receive a formal diagnosis of a somatoform disorder or functional somatic syndrome, habitual symptom reporters (i.e. individuals who report being distressed by multiple physical symptoms, regardless of whether an objective cause has been found) are frequently seen in the general population (Kroenke & Manglesdorff, 1989). It is unclear exactly how these map onto the concepts of MUS but it is generally held that habitual symptom reporters and people with a tendency to experience multiple MUS are overlapping (if not the same) groups. It is possible to distinguish high symptom and low symptom reporters using self-report measures such as the Patient Health Questionnaire (PHQ-15; Kroenke, Spitzer, & Williams, 2002) and the Pennebaker Inventory of Limbic Languidness (PILL; Pennebaker, 1982). Individuals who score highly on the PILL have been observed to make more doctor visits and have higher levels of occupational absenteeism than low PILL scorers (Pennebaker, 1982). As previously noted, subjective health complaints and objective health indicators are poorly correlated suggesting that individuals who report having more physical symptoms do not necessarily have more symptoms (Watson & Pennebaker, 1989). This highlights that although MUS can occur at the extreme

\(^1\) The fifth version of the DSM (DSM-V; APA, 2013) has changed the way in which MUS are classified such that any physical symptom may receive a diagnosis of somatic symptom disorder if it is associated with positive psychological features regardless of the origin of the symptom.
end of the continuum and are associated with significant distress and disability, they also occur at the lower end of the spectrum in individuals who do not meet the threshold for a clinical diagnosis. The exact psychological mechanisms of MUS and habitual symptom reporting remain to be determined. However, attentional processes, specifically an attentional bias towards body-relevant information, are often regarded as a central concept in their development and maintenance (Barsky & Whysak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997; Rief & Barsky, 2005).

Although psychological models vary with regards the specific attentional processes underlying MUS and habitual symptom reporting, there is a consensus that focusing attention excessively on symptoms is a crucial component. Cognitive behavioural accounts of MUS refer to a process of ‘somatosensory amplification’ whereby focusing one’s attention excessively on novel, unusual and even benign bodily sensations leads to an increase in the salience of these symptoms (Barsky & Wyshak, 1990). This leads to physiological and behavioural changes that cause further symptoms to be experienced, setting up a vicious cycle. Kirmayer and Taillefer (1997) proposed a similar model implicating selective attention to somatic sensations in the development and maintenance of MUS but incorporated emotional and social-interactional factors. Rief and Barsky (2005) proposed that MUS arise due to ‘faulty filtering’ of bodily information whereby attention to sensations leads to a heightened perception of sensory information. Similarly, Brown’s integrative model of MUS implicates attentional processes in both the development (through hypervigilance for symptom-relevant information) and maintenance (through difficulty disengaging attention away from such information) of symptoms in the absence of an obvious organic basis (Brown, 2004).

Consistent with these accounts, it has been observed that increasing attention to physical symptoms intensifies these symptoms while distraction reduces them (Barsky, Goodson, Lane, & Cleary, 1988; Pennebaker & Skelton, 1981). Individuals with MUS have also been observed to score higher on self-report measures of body-scanning (Rief, Hiller, & Margraf, 1998). When instructed to focus more attention to the body, individuals with hypochondriasis report an increase in physical sensations (Schmidt, Wolfs-Takens, Oosterlaan, & van den Hout, 1994). However, these findings do not provide evidence of attentional bias towards body-relevant information, rather they highlight that paying attention to symptoms and distracting attention away from symptoms has an effect on the
perceived intensity or number of symptoms. Attentional processes can be difficult to disentangle from other cognitive processes such as attributions of symptoms and unhelpful illness beliefs which lead to an increased focus of attention onto symptoms (see Deary, Chalder, & Sharpe, 2007 for review). For example, if an individual considers symptoms to be threatening or perceive themselves to be at high risk of developing a serious illness, they may be more likely to monitor their symptoms than individuals without these beliefs.

In order to directly measure attentional bias a number of experimental paradigms have been developed. An attentional bias towards threatening information is considered to manifest as the differential allocation of attention to threatening versus neutral stimuli (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1998). Spatial cueing tasks such as the dot-probe task (MacLeod et al., 1986) and exogenous cueing task (Posner, 1980) enable the nature of attentional bias to be measured. Attentional biases are thought to involve distinct underlying processes, including facilitated orienting towards threat (i.e. faster detection of threat), difficulties disengaging from threat (i.e. slower to shift attention away from threat) or avoidance of threat (i.e. attention is diverted away from threat) (Cisler & Koster, 2010).

Experimental paradigms have revealed an attentional bias to threatening body-relevant information in individuals with a range of unexplained symptoms, including those with a psychiatric or medical diagnosis for their unexplained symptoms and also members of the general population considered to be high symptom reporters. Some studies have found that individuals with functional somatic syndromes attend more to health threat words and pictures (Hou, Moss-Morris, Bradley, Peveler, & Mogg, 2008), pain threat words (Beck et al., 2011; Chapman & Martin, 2011) and symptom-relevant words (Afzal, Potokar, Probert, & Munafo, 2006; Witthoft, Gerlach, & Bailer, 2006; Witthoft, Rist, & Bailer, 2009) relative to healthy controls. When exposed to threatening body-relevant pictures, individuals reporting high levels of somatoform dissociation have been observed to develop a bias towards their body after exposure to a body-relevant mood inductor (Brown, Danquah, Miles, Holmes, & Poliaff, 2010). Individuals with somatoform disorders and those considered high symptom reporters have been observed to have an attentional bias towards health threat words relative to neutral words and healthy controls (Karademas, Christopoulou, Dimostheni, & Pavlu, 2008; Lee et al., 2013; Lim & Kim, 2005).
Attentional processes have also been considered to be implicated in the development and maintenance of anxiety disorders in a similar fashion to that proposed in MUS/habitual symptom reporting. Attentional bias modification (ABM) has increased since its inception in the 1990’s and has been developed based on cognitive theory of anxiety disorders which postulate that information-processing biases, specifically cognitive bias towards threat, are central in the development and maintenance of anxiety disorders (Beck & Clark, 1997; Eysenck, 1992, 1997; Williams, Watts, MacLeod, & Mathews, 1988). Whilst cognitive behavioural therapy attempts to alter the dysfunctional thoughts evident in anxiety disorders, attentional bias modification is designed to alter the cognitive processes leading to such disordered thinking. ABM attempts to manipulate the way in which particular information is processed, such that particular information elicits greater allocation of attentional resources or increases the degree to which such information is ignored (Eldar & Bar-Haim, 2010; Monk et al., 2008). Research in ABM has been motivated by a number of factors, namely; to evaluate its potential as a therapeutic intervention to reduce attentional bias towards threat and thus reduction in symptoms and/or distress; to further elucidate the precise mechanisms underlying attentional bias; and to seek to determine whether attentional bias plays a causative or maintaining role in anxiety disorders (see Bar-Haim, 2010 for review).

The majority of studies in the anxiety literature have utilised ABM to create a bias away from threatening information and has successfully induced the desired bias and a reduction in anxiety symptoms has been observed in generalised anxiety disorder (Hazen, Vasey, & Schmidt, 2009) and social anxiety (Amir et al., 2009; Schmidt, Richey, Buckner, & Timpano, 2009). However, to prove causality, it is also necessary to demonstrate that it is possible to induce a bias towards threat and that this then impacts upon symptoms. To that end, Macleod, Rutherford, Campbell, Ebsworthy and Holker (2002) demonstrated that it is possible to create an attentional bias towards threatening information in non-anxious individuals and this results in significantly greater state anxiety following a stress induction relative to participants who received training in the opposite direction. This finding was replicated in non-anxious children (Eldar, Ricon, & Bar-Haim, 2008).

Although there is a theoretical basis for, and empirical evidence of, an attentional bias towards body-relevant information in MUS/habitual symptom reporting, ABM has rarely been applied in this area. Considering the hypothesised similarities in attentional
processing in MUS/habitual symptom reporting and anxiety disorders, ABM could have the potential to further the understanding of the attentional mechanisms involved in this area and be a potential treatment to reduce symptoms.

Studies using ABM in anxiety disorders have been based on experimental paradigms traditionally used in the measurement of attentional bias such as the dot-probe task (MacLeod, et al., 1986). In the dot-probe paradigm, two stimuli (one threatening; one neutral) are presented simultaneously in different locations on a computer screen. A target probe appears in the location of one of the previously presented stimulus and participants are required to indicate the location of the probe as quickly as possible. Faster response times to detect the dot when it replaces a threatening stimulus are interpreted as an attentional bias in the form of enhanced attention to threatening information. Delayed disengagement from threat is considered to be evidenced by slower response times on cue invalid threatening trials. Avoidance of threat is thought to manifest as faster response times on cue valid trials than invalid trials when the cue is neutral and slower response times on cue valid trials than invalid trials when the cue is threatening (MacLeod et al., 1986). For the purposes of measurement and comparison of existing attentional bias, the target probes replace threatening and neutral stimuli with equal probability.

Using these paradigms, it has been demonstrated that response times are faster to detect validly cued targets than invalidly cued targets as the probe draws attention to its location and facilitates subsequent processing there (Posner, 1980). This is known as a cue validity effect that varies according to the threat value of the cue, with some people being quicker to respond to validly cued targets when the cues are threatening and some people being slower. These paradigms have utilised this cue validity effect such that the ease of detecting particular types of stimuli (i.e. threatening or neutral) is enhanced by acquiring a bias for that information. For the purpose of ABM, the probes appear in the same location as the threatening stimuli (if attempting to create a bias towards threatening information) or neutral stimuli (if the direction of bias to be created is towards neutral information) more frequently than for the purpose of measurement. It is assumed that because attending to such contingencies can assist in task performance, an implicitly learned bias towards or away from threat (depending upon the desired direction) can be induced with repeated presentations (Bar-Haim, 2010). Studies using spatial cueing paradigms have demonstrated a cue validity effect using different lengths of stimulus-onset asynchrony.
(SOA; Amir, Elias, Klumpp, & Przeworski, 2003; Mogg, Holmes, Garner, & Bradley, 2008), that is, the duration between the start of the cue and the start of the target.

The present study adopted a modified exogenous spatial cueing paradigm (Posner, 1980) to explore whether it is possible to induce an attentional bias towards threatening information in a low symptom reporting population. The exogenous cueing task and dot-probe task are similar such that they are both spatial cueing paradigms and both enable assessment of the spatial allocation of attention. However in the exogenous cueing paradigm, only one stimulus is presented at a time. This reduces the potential confounds of presenting threatening and neutral stimuli simultaneously as response times to detect the targets might be influenced by the other.

It is predicted that (1) response times to validly cued stimuli in the threat condition will be significantly faster at Time 2 (i.e. after training) than Time 1 (before training) for the training group but not the control group. This will be tested by comparing response time differences between valid and invalid trials for threatening and neutral stimuli for both groups at both time points using a four-way ANOVA with follow-up tests as appropriate; and (2) participants in the training group will report a greater increase in physical symptoms and anxiety after exposure to a body-relevant mood induction compared to no-training controls. This will be tested by comparing scores between groups on a physical symptom and an anxiety measure before and after the mood induction, using two-way ANOVA with follow-up tests as appropriate.

**Method**

**Design**
A $2 \times 2 \times 2 \times 2$ mixed-model design was used. Experimental group (Attentional Bias Modification training; no training) was a between-subjects factor and cue validity (valid; invalid), stimulus type (threatening; neutral) and time (before training; after training) were within-subjects factors. The primary dependent variable was response time to detect stimuli on an exogenous attentional cueing paradigm. Following the attentional bias task, anxiety and physical symptoms were measured before and after a health-relevant mood induction.
Sample size determination
A priori power analysis indicated that the sample size required given a power level of 0.8 was 28 in each group, giving a total of 56. Testing assumed a two-tailed Alpha level of 0.05 and employed an effect size of 0.77 taken from an average effect size of 3 comparable studies (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Klumpp & Amir, 2009; See, MacLeod & Bridle, 2009).

Participants
Fifty-six participants (42 female, 14 male; Age M = 24.5, SD = 6.49) from a UK university were recruited via advertisement on the University intranet and University notice boards. There were no significant differences in age (F(1, 54) = .74; p = .395), gender (X²(1, N = 56) = .381, p = .537) or health anxiety (t(54) = 1.44, p = .155) between the groups. All participants scored ≤5 on a physical symptom screening questionnaire (PHQ-15; Kroenke et al., 2002) and were considered to be ‘low symptom reporters’. The PHQ-15 was used as a general symptom screen. As the measure does not discriminate between symptoms that do and do not have a disease basis, participants with either may have been included in the study. However, the cut-off used ensures that none of the participants were experiencing high levels of concern about their symptoms, whatever the cause.

Recruitment
Recruitment consisted of a screening phase and an experimental phase. The screening phase was conducted in collaboration with a parallel but separate study exploring ABM in high symptom reporters. None of the experimental data were shared between the studies, however the screening data were obtained together. Advertisements directed potential participants to a web-link containing an information sheet for the screening phase, a consent form and an online version of the PHQ-15 (a copy of the participant information sheet and consent form for the screening phase is provided in Appendix B). In total, 263 participants completed the initial screening questionnaire. Of these participants, 76 scored below the clinical cut off for symptom reporting (≤5). They were informed that they were eligible for inclusion in the study and were directed to an information sheet and consent form for the experimental phase (an information sheet and consent form for the experimental phase can be found in Appendix C). Twenty of these participants did not attend or cancelled, resulting in a total of 56 participants taking part in the study.
Participants were able to view examples of the types of images to be used in the study prior to providing consent and were directed to book an appointment slot to take part the following week. Participants who scored above the clinical cut off for high symptom reporting (≥10; n = 85) were directed to a separate study exploring ABM in high symptom reporters. Participants scoring in the middle range on the PHQ-15 questionnaire (6 – 9; n = 102) were informed that they were not eligible for inclusion in either study. Figure 2 represents the recruitment process.

All participants who completed the screening phase were entered into a prize draw to win a £10 voucher, regardless of whether they were eligible to take part in the experimental phase. In return for participation in the experimental phase, participants received academic credit or a small monetary reimbursement (£5).

**Materials**

**Measures**

The Patient Health Questionnaire (PHQ-15; Kroenke et al., 2002) comprises 15 somatic symptoms and participants are asked to rate each symptom as to the degree it has bothered them during the past two weeks. It is considered a reliable and valid measure for use in the assessment of somatic symptoms (Interian, Allen, Gara, Escobar, & Diaz-Martinez, 2006). Scores of 5 or below are considered to indicate low somatic symptom severity, and scores of 10 or above are considered to be above the clinical cut off for high levels of symptom reporting (Korber, Frieser, Steinbrecher, & Hiller, 2011; Kroenke et al., 2002). This was used as a screening measure to identify low and high symptom reporting participants.

The Health Anxiety Inventory: Short Form (SHAI; Salkovskis, Rimes, Warwick, & Clark, 2002) is an 18 item questionnaire designed for screening of health anxiety and is considered to be sensitive across the full range of health anxiety intensity, from mild concern to hypochondriasis. Questions relate to thoughts about health and illness and are scored on a scale of 0 - 3. Higher scores are considered to reflect heightened concern about health and illness and a score above 15 is considered to indicate clinical caseness (Salkovskis et al., 2002). This was used to measure baseline health anxiety.
The Pennebaker Inventory of Limbic Languidness (PILL; Pennebaker, 1982) is considered to be a well validated and sensitive measure of change in physical symptoms (Greenberg & Stone, 1992). Participants are asked to indicate on a 5-point scale the frequency they experience 54 common physical symptoms. This was used to measure physical symptoms before and after the mood induction.

A visual analogue scale was used to measure state anxiety levels before and after the mood induction. These are regularly used in clinical research and practice and are thought to be an adequate substitute for more time consuming measures of anxiety (Davey, Barratt, Butow, & Deeks, 2007). This consists of a horizontal line 100mm in length, anchored by word descriptors at each end (“no anxiety at all” and “extremely anxious: the worst it has ever been”). Participants are asked to mark the point that they feel reflects their current anxiety state. A copy of all the measures is provided in Appendix D.

**Stimuli**

Picture stimuli consisted of 40 threatening and 40 neutral photographs of parts of the body (such as hands, arms and feet) taken from Google images. The threat stimuli were chosen on the basis of noticeable signs of disease or injury such as swelling, deformity, a red rash or bleeding. Neutral pictures featured healthy body parts. The threatening and neutral picture sets were matched for body part, background and orientation. Photographs of faces were not included due to the possibility that they may contain information other than that of interest such as facial expression or attractiveness. In order to ensure the stimuli selected were appropriately threatening and neutral, a student sample (n = 15) rated 100 potential images using a 10-point Likert scale for emotional valence and arousal. These participants were not included in the main study. Images with a mean emotional valence score of ≤1 were included in the final sample of 40 neutral images. Images with a mean emotional valence score of ≥3 were considered to be threatening and were included in the final sample of 40 threatening images (these values were chosen as it was thought that this would reflect a sufficient difference in emotional valence). Participants rated all of the images as low for arousal so this was not used as a factor for image selection.
**Mood induction**

A five minute video from the television medical drama *Casualty* was presented to participants on the same computer screen as the ABM task to explore the effect of ABM on anxiety and physical symptoms. The film depicted distressing scenes of a train crash followed by physical injury and medical treatment and has been shown to increase anxiety and physical symptoms in a non-clinical population (Chapman, 2014).

**Apparatus**

Data were collected using E-prime software. Participants were tested individually in a quiet cubicle and were positioned approximately 50cm in front of a 17-inch computer screen.

**Attentional Bias Modification Paradigm**

A modified exogenous spatial cueing paradigm (Posner, 1980) was utilised for the purpose of the study. In order to determine the SOA to be used in the present study, three pilot trials were conducted with varying lengths of SOA (175ms, 250ms and 300ms). Ten participants (a student sample not included in the main study) completed each pilot. An SOA of 250ms produced the most consistent cueing effect, as indicated by faster response times to detect validly cued targets, and so was adopted in this study.

Participants were seated in front of a computer screen and presented with a central fixation cross 1cm in size flanked by two blank rectangles (10x8cm in size). Presentation of the fixation point was randomised between 700 and 1000ms. A threatening or neutral picture cue was then presented in one of the rectangles for 200ms followed by a blank screen for 50ms (producing a total SOA of 250ms). A target shape (either a solid yellow circle or triangle) then appeared in the same position previously held by the cue (cue valid trial) or in the opposite location (cue invalid trial). Participants were required to press a key on the computer keyboard to discriminate whether the target was a triangle (< key) or a circle (> key). If participants responded incorrectly an error message ('wrong') appeared on the screen to enable them to correct their response on subsequent trials.
**Attentional Bias Assessment**

To measure attentional bias, participants completed 200 trials before training and a further 200 trials after training. There was the option to take a break after each 100 trials. For the pre training attentional bias assessment, 20 images (10 threatening; 10 neutral) were used and a different set of 20 images (again, 10 threatening; 10 neutral) were used for the post training attentional bias assessment, the order of which was counterbalanced. The cue (threatening or neutral picture) and target (circle or triangle) appeared in the same location with equal probability meaning that the threat value of the cue provided no information as to the location of the proceeding target. This produced a cue validity of 50%. Figure 1 demonstrates the presentation of an experimental trial.

![Diagrammatic representation of experimental trial. (Example shown: cue valid neutral trial).](image)

**Attentional Bias Modification Training**

Both the experimental and control group completed 200 training trials in between the assessment trials described previously. These trials consisted of 40 different images (20 neutral, 20 threatening) to those used in the measurement phase. In the training group, the target appeared in the same location as the threatening picture cue on 76% of trials so that threatening picture cues were followed by a valid target more frequently than were
neutral picture cues. In the control group, the target appeared in the same location as the threat picture cue on 50% of trials so that threatening and neutral picture cues were followed by a valid target on an equal number of trials. A ratio of 80% valid and 20% invalid trials has typically been adopted in exogenous cueing tasks to produce a cue validity effect (Fox, Russo, Bowles, & Dutton, 2001; Posner, 1980). Due to the conditions of stimulus type, cue validity and target type in the present study, a ratio of 76% valid and 24% invalid was adopted in order to counterbalance the conditions. Previous ABM studies have adopted training trials ranging from 160 (e.g. Amir et al., 2009; Klumpp & Amir, 2009; Schmidt et al., 2009) and 480 (e.g. Eldar & Bar-Haim, 2010; Li, Tan, Qian, & Liu, 2008) and so 200 training trials was considered to be acceptable here.

Procedure
Participants were randomly allocated using a random number generator to the training or control condition and both participant and experimenter were blind to condition allocation. All participants first completed the Health Anxiety Inventory. The experimental task was then explained and participants were directed to the computer monitor and keyboard. The attentional bias modification paradigm began with the initial attentional bias assessment. The training group then completed the ‘training’ version of the paradigm and the control group completed the ‘no training’ version. This was followed by a further attentional bias assessment. Participants then completed the PILL and visual analogue scale before the body-relevant mood induction. The PILL and visual analogue scale were then repeated. Figure 2 demonstrates the experimental procedure.

Ethical considerations
Ethical approval was granted from the University’s research ethics committee (Appendix E). In the event that any participants became distressed during the experiment, a distress protocol and information regarding sources of support were available (Appendix F). Participants in the experimental condition were trained such that their attention was biased towards noticing physical threat stimuli. Reverse training was offered to all participants in the experimental condition (i.e. the training task repeated but with 76% neutral cue validity). No participants reported any distress or opted to undertake reverse training.
PHQ-15 Initial screening  
\(n = 263\)

- Not eligible for inclusion  
  PHQ-15 score 6-9  
  \(n = 102\)

- Eligible for inclusion  
  PHQ-15 score \(\leq 5\)  
  \(n = 76\)

- Total participants  
  \(n = 56\)

- Health Anxiety Inventory

**Attentional Bias Modification Task**  
Time 1 Threat Focused Attentional Bias Assessment

- **Training group**  
  Attentional Bias Modification Training  
  \(n = 28\)

- **Control group**  
  No Training  
  \(n = 28\)

**Measures Time 1**  
PILL  
Visual analogue scale

**Mood induction**

**Measures Time 2**  
PILL  
Visual analogue scale

---

*Figure 2. Flow diagram of experimental procedure: recruitment, experimental group and self-report measures (PHQ-15, Patient Health Questionnaire; PILL, Pennebaker Inventory of Limbic Languidness).*
Results

Analysis

All statistical analyses were performed with IBM SPSS Statistics, version 20. Response times for incorrect answers were removed as were response times more than 2.45 standard deviations from the individual participant’s mean. Normality testing revealed non-normality of the response time data. Normality was achieved by inverse transformation of the response time data therefore satisfying assumptions for parametric analysis. The anxiety data were also non-normal and transformation failed to achieve normality. Due to the increased probability of Type I error incurred by calculating numerous non-parametric tests, and the fact that ANOVA is considered relatively robust in the face of deviations from normality, this data was analysed using parametric test. Outlier identification was conducted on all of the dependent variables. One outlier was identified in the anxiety data. This was managed as recommended by Field (2013) by replacing the outlier with the next highest score plus one unit.

Hypothesis 1: Does ABM create attentional bias?

Mean response times before, during and after training are presented in Table 1. A graphical representation of response times at all time points by stimulus type is presented in Figure 5, and by cue validity in Figure 6. The main hypothesis was that response times to validly cued stimuli in the threat condition would be significantly faster at Time 2 (after training) than Time 1 (before training) for participants in the training group but not the control group. A significant four-way interaction between group, cue validity, stimulus type and time was predicted. In order to test this a 2x2x2x2 mixed measures ANOVA was conducted on the transformed RT data from the spatial cueing task, with group (training; control) as a between-subjects factor and cue validity (valid; invalid), stimulus type (threatening; neutral) and time (before training; after training) as within-subjects factors. The predicted four-way interaction was non-significant ($F(1, 54) = .259, p = .613, \eta^2_p = .005$) and so did not support the hypothesis that ABM would create an attentional bias.

The other effects were then explored. All participants demonstrated slower response times on threatening compared to neutral trials ($F(1, 54) = 34.86, p < .001, \eta^2_p = .392$), faster response times for valid cues relative to invalid cues ($F(1, 54) = 33.07, p < .001, \eta^2_p = .380$), and faster response times at Time 2 compared to Time 1 ($F(1, 54) = 41.52, p < .001, \eta^2_p = .435$). There was a significant validity x time interaction ($F(1, 54) = 5.50, p = .023, \eta^2_p = .093$).
Paired-samples t-tests were conducted to explore the source of this interaction. At Time 1 response times for invalid cues ($M = 517.15$, $SD = 66.81$) were significantly slower than valid cues ($M = 509.58$, $SD = 66.16$), $t(55) = 2.621$, $p = .011$. This difference was also significant at Time 2 (invalid cue: $M = 490.36$, $SD = 75.13$; valid cue: $M = 475.91$, $SD = 69.15$), $t(55) = 6.893$, $p < .001$, but was much more pronounced. Valid trials were significantly faster at Time 2 ($M = 475.91$, $SD = 69.15$) compared to Time 1 ($M = 509.58$, $SD = 66.16$), $t(55) = 6.702$, $p < .001$, as were invalid trials (Time 2: $M = 490.36$, $SD = 75.13$; Time 1: $M = 517.15$, $SD = 66.81$), $t(55) = 5.614$, $p < .001$. The cueing effect (invalid minus valid RT’s) at Time 1 ($M = 7.57$, $SD = 21.96$) was significantly smaller than Time 2 ($M = 14.46$, $SD = 18.06$), $t(55) = 2.298$, $p = .025$. This is represented in Figure 3.

![Figure 3](image.png)

Figure 3. Mean response times on valid and invalid trials before and after training for both groups combined. Note: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

The stimulus type x time x group interaction was also significant ($F(1, 54) = 12.27$, $p = .001$, $\eta^2_p = .185$), as demonstrated in Figure 4. This was explored using post-hoc Bonferroni-corrected analyses. This revealed a significant stimulus type by time interaction for the training group ($F(1, 27) = 6.56$, $p = .016$, $\eta^2_p = .195$) and the control group ($F(1, 27) = 5.28$, $p = .030$, $\eta^2_p = .164$), and a significant stimulus type by group interaction before training ($F(1, 54) = 5.78$, $p = .020$, $\eta^2_p = .097$) and after training ($F(1, 54) = 4.93$, $p = .031$, $\eta^2_p = .084$). At Time 1, response times on threatening ($M = 523.46$, $SD = 79.58$) and neutral ($M = 517.82$, $SD =$...
77.52) trials were not significantly different for the training group, t(27) = 1.693, p = .102. In contrast, the control group were significantly slower on threat trials (M = 513.44, SD = 52.2) compared to neutral trials (M = 498.75, SD = 50.20) at Time 1, t(27) = 5.364, p < .001. This suggests that the groups responded differently to threat at baseline. At Time 2, the training group were significantly slower on threat trials (M = 499.35, SD = 84.28) compared to neutral trials (M = 483.08, SD = 80.19), t(27) = 3.595, p = .001. There was no significant difference between threat (M = 477.44, SD = 62.68) and neutral (M = 472.67, SD = 59.87) trials for the control group at Time 2, t(27) = 1.866, p = .073. All of these effects were present regardless of cue validity. All effects were unchanged after controlling for baseline health anxiety. All other interactions were non-significant.

Table 1. Means (and Standard Deviations) of response times (ms) for threatening and neutral stimuli by cue validity before, during and after training.

<table>
<thead>
<tr>
<th>Trial Condition</th>
<th>Before Training</th>
<th>During Training</th>
<th>After Training</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training Group</td>
<td>Control Group</td>
<td>Training Group</td>
</tr>
<tr>
<td>Neutral Cue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid</td>
<td>514.52 (79.23)</td>
<td>497.25 (53.75)</td>
<td>482.54 (72.09)</td>
</tr>
<tr>
<td>Invalid</td>
<td>521.13 (78.68)</td>
<td>500.25 (51.89)</td>
<td>505.98 (84.19)</td>
</tr>
<tr>
<td>Threat Cue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid</td>
<td>520.39 (77.35)</td>
<td>506.18 (55.49)</td>
<td>499.02 (79.56)</td>
</tr>
<tr>
<td>Invalid</td>
<td>526.54 (86.02)</td>
<td>520.7 (52.39)</td>
<td>520.7 (87.91)</td>
</tr>
</tbody>
</table>
Figure 4. Mean response time (ms) on threatening and neutral trials (valid and neutral trials combined) before and after training for training and control group. Note: * p ≤ 0.05, ** p ≤ 0.01, *** p ≤ 0.001.
Hypothesis 2: Does ABM increase physical symptom reporting and anxiety following a health-related stressor?

Means of physical symptoms scores and medians of anxiety scores are presented in Table 2. To explore the effect of ABM on physical symptom reporting following a health-related stressor, a 2x2 mixed measures ANOVA was conducted with time (PILL score before mood induction; PILL score after mood induction) as a within-subjects factor and group (training; control) as a between-subjects factor. There was no significant effect of time ($F(1,54) = 1.86, \ p = .178, \ \eta^2_p = .033$) and the time by group interaction was also non-significant ($F(1,54) = .14, \ p = .706, \ \eta^2_p = .003$). There was a near significant main effect of group ($F(1,54) = 3.93, \ p = .053, \ \eta^2_p = .068$). This effect disappeared when controlling for health anxiety ($F(1,53) = 2.08, \ p = .155, \ \eta^2_p = .038$).

The effect of training on anxiety ratings before and after a health-related stressor were analysed by 2x2 mixed measures ANOVA with time (before mood induction; after mood induction) as a within-subjects factor and group (training; control) as a between-subjects factor. This revealed a significant main effect of time ($F(1,54) = 45.3, \ p <.001, \ \eta^2_p = .456$) suggesting that the mood induction was successful in increasing state anxiety. The time by group interaction was non-significant suggesting that this increase in anxiety did not differ between the groups.

Table 2. Means (and standard deviations) of Pennebaker Inventory of Limbic Languidness (PILL) and medians (and inter-quartile range) of Visual Anxiety Scale before and after mood induction for training and control group.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Before mood induction</th>
<th>After mood induction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training Group</td>
<td>Control Group</td>
</tr>
<tr>
<td>PILL score</td>
<td>103.36 (17.72)</td>
<td>95.5 (13.57)</td>
</tr>
<tr>
<td>VAS score</td>
<td>10.5 (10.25)</td>
<td>6 (8)</td>
</tr>
</tbody>
</table>
Figure 5. Mean response times (ms) on threatening and neutral trials (valid and invalid trials combined) before, during and after training by group. Note: * \( p \leq 0.05 \), ** \( p \leq 0.01 \), *** \( p \leq 0.001 \).

Figure 6. Mean response times (ms) on valid and invalid trials (threatening and neutral trials combined) before, during and after training by group. Note: * \( p \leq 0.05 \), ** \( p \leq 0.01 \), *** \( p \leq 0.001 \).
Training data
Due to the finding that the training group did not display the anticipated increased cueing effect on threat trials after training, the training data were analysed to determine whether performance during training was as anticipated. It was expected that response times to validly cued stimuli in the threat condition would be faster during training than at baseline for the training group but not for the control group. A 2x2x2x2 mixed measures ANOVA was conducted, with group (training; control) as a between-subjects factor and cue validity (valid; invalid), stimulus type (threatening; neutral) and time (before training; during training) as within-subjects factors. Consistent with the main analysis, there were significant main effects of threat (F(1, 54) = 46.86, p < .001, ηp^2 = .465), cue validity (F(1, 54) = 22.62, p = <.001, ηp^2 = .295), and time (F(1, 54) = 25.51, p < .001, ηp^2 = .321). There was a significant validity x time interaction (F(1, 54) = 5.92, p = .018, ηp^2 = .099). During training, response times for invalid cues (M = 502.71, SD = 72.65) were significantly slower than for valid cues (M = 487.6, SD = 65.59) t(55) = 5.044, p < .001. The cueing effect (invalid minus valid RT’s) at Time 1 (M = 7.57, SD = 21.96) was significantly smaller than during training (M = 15.11, SD = 22.64), t(55) = 2.185, p = .033.

There was a significant stimulus type x time x group interaction (F(1, 54) = 4.69, p = .035, ηp^2 = .080), and a significant time x cue validity x group interaction (F(1, 54) = 6.81, p = .012, ηp^2 = .112). The predicted four-way interaction was not significant. Post-hoc Bonferroni-corrected analyses were conducted to explore the significant interactions. The stimulus type by time interaction was significant for the training group (F(1, 27) = 7.47, p = .011, ηp^2 = .217). This interaction was non-significant for the control group (F(1, 27) = .142, p = .709, ηp^2 = .005). The stimulus type by group interaction was significant before training (F(1, 54) = 5.78, p = .020, ηp^2 = .097) but non-significant during training (F(1, 54) = .241, p = .625, ηp^2 = .004). The difference between threat and neutral trials was not significant for the training group at Time 1, however this was significant during training (threat: M = 509.86, SD = 82.7; neutral: M = 494.26, SD = 76.84), t(27) = -5.922, p < .001.

The cue validity by time interaction was significant for the training group (F(1, 27) = 11.75, p = .002, ηp^2 = .303). This was non-significant for the control group (F(1, 27) = .050, p = .824, ηp^2 = .002). The cue validity by group interaction was not significant (F(1, 54) = .03, p = .960, ηp^2 = .000) before training. During training there was a significant interaction between cue validity and group (F(1, 54) = 5.01, p = .029, ηp^2 = .085). The training group were significantly faster on valid trials during training (M = 490.78, SD = 74.05) compared to Time 1 (M =
The difference on invalid trials during training and Time 1 was not significant. The difference between valid and invalid trials was not significant for the training group at Time 1. This was significant during training (valid: $M = 490.78$, $SD = 74.08$; invalid: $M = 513.34$, $SD = 85.53$), $t(27) = 5.081$, $p < .001$. During training, the cueing effect (invalid minus valid RT’s) was significantly larger for the training group ($M = 22.56$, $SD = 23.01$) compared to the control group ($M = 7.66$, $SD = 19.99$), $t(54) = 2.587$, $p = .012$.

Discussion
As discussed in the introduction, theories of excessive physical symptom reporting posit attentional bias towards health-relevant threatening information as central in its development and maintenance (Barsky & Wyshak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997; Rief & Barsky, 2005). In order to test this theory, the current study set out to determine whether it is possible to train low symptom reporters to have an attentional bias towards threatening body-relevant stimuli using ABM. The main hypothesis was that following training, there would be a stronger cue validity effect for threatening stimuli in the group undergoing ABM but not for the control group. As previously mentioned, response times on validly cued targets are faster than invalidly cued targets (Posner, 1980), and therefore it was expected that response times on validly cued threat stimuli would be faster after training as threatening stimuli were repeatedly presented in the cued location. That is, an attentional bias manifesting as facilitated engagement with threat in the group undergoing ABM was expected to be acquired. It was expected that the acquisition of this bias would create a vulnerability to experience more physical symptoms and anxiety after exposure to a health-relevant negative mood induction, which was our second hypothesis. Contrary to expectation, however, the current study was not successful in generating an attentional bias to threat in low symptom reporters using ABM, and training did not lead to an increase in physical symptoms or anxiety.

Both groups displayed the anticipated cue validity effect, responding more quickly to targets when the cue was valid rather than invalid. At baseline, all participants were also slower on threatening relative to neutral trials but this difference was only significant for the control group. This is consistent with an established non-spatial interference effect of threat on processing (Ohman, Flykt, & Esteves, 2001; Yiend & Mathews, 2001), although it
is unclear why it was only present in one of the groups at baseline. The cueing effect was the same for threatening and neutral stimuli as indicated by a lack of a significant cue validity by stimulus type interaction. This pattern of responding at baseline suggests that low symptom reporters in this study did not have an attentional bias towards threat. Studies in low-anxious individuals yielded similar patterns of responding (Yiend & Mathews, 2001).

After training, all participants displayed faster response times overall, suggesting a practice effect. The difference in response times on threatening and neutral trials reduced over time in the control group, becoming comparable after training. In the training group, in contrast, the response time difference on threatening compared to neutral trials increased over time, with threat trials becoming slower relative to neutral. This effect was independent of cue validity, indicating that it was not attributable to attentional avoidance of threat (which would manifest as faster response times on cue-valid trials compared to invalid trials when the cue is neutral, and slower response times on cue-valid trials compared to invalid trials when the cue is threatening; MacLeod et al., 1986). Rather, the general interference effect for threatening stimuli which was exhibited by both groups at baseline (although only significantly for the control group) reduced for the control group but increased for the training group and became significant. One interpretation of this is that the repeated presentation of threatening stimuli in the cued location during the training procedure interrupted the natural ‘habituation’ process to threatening information. This is reminiscent of the non-associative learning mechanism of sensitisation, which is characterised by a progressive increase in responses to repeated stimulus exposures when the stimulus is highly unpleasant (Kimbel & Ray, 1965; Overmier, 2002).

Studies using spatial attention tasks in physical symptom reporting are limited and have produced conflicting results. Dot-probe tasks have shown evidence of attentional bias for health-relevant information in individuals with CFS (Hou et al., 2008) but one study failed to find such a bias with the same population (Hou et al., 2014). Exogenous cueing tasks have yielded similarly conflicting results. No attentional bias for health-relevant information was found in individuals with CFS using this paradigm (Martin & Alexeeva, 2010). In patients with IBS an attentional bias for health-relevant words was found (Chapman & Martin, 2011) but no such bias was found in another study by the same authors using the same paradigm (Martin & Chapman, 2010).
Much of the empirical evidence of a relationship between attentional bias to health-threat information and physical symptoms has come from studies using the emotional Stroop task (Afzal et al., 2006; Lecci & Cohen, 2002; Lim & Kim, 2005; Karademas et al., 2008; Witthoft et al., 2006). An attentional bias in the form of selective attention to threatening information was interpreted from longer colour-naming latencies for health-relevant threat words relative to neutral words. Directing greater attentional resources to the threatening information was thought to produce greater cognitive interference thus impeding task performance. However, this interference effect could be due either to greater engagement with threat or attempting to avoid processing the threatening stimulus (deRuiter & Brosschot, 1994). Dawkins and Furnham (1989) for example, found that people who are classed as ‘repressors’ showed greater interference than high trait anxious participants on an emotional Stroop task, which is more consistent with avoidance of negatively valenced stimuli in the former. Interestingly, a study run in parallel to the current one (Thompson, Poliakoff, & Brown, 2014) found that high symptom reporters were avoidant of threatening information at baseline, and that ABM designed to reduce attentional bias towards threat was therefore unsuccessful. Indeed, in that study, the experimental group (who had effectively been trained to be more avoidant) became significantly more anxious after the mood induction, suggesting that avoidance may have a causal role.

The theories of physical symptom reporting described in the introduction claim that an attentional bias towards threatening body-relevant information leads to an increase in physical symptom reports (Barsky & Wyshak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997). In the current study, low symptom reporters were found not to display attentional bias towards threatening health-relevant information at baseline. That, taken with the finding that high symptom reporters display attentional avoidance of the same information (Thompson et al., 2014) is supportive of the theory that attentional bias plays a role in physical symptom reporting. It does not however, enable conclusions to be drawn as to whether this relationship is causal.

Based on the theory that attentional bias plays a role in symptom reporting, it was assumed that high symptom reporters would have an attentional bias towards threatening information and as such, low symptom reporters were trained such that this bias would be acquired. However, theories of physical symptom reporting do not state the time-course of
attentional bias (i.e. whether this is at earlier or later stages of cognitive processing). The current study was unsuccessful in creating an attentional bias towards threatening health-relevant information in low symptom reporters. It is a possibility that attentional bias in physical symptom reporting is different to what was expected and consequently, the paradigm may not have been designed to adequately test this theory. Training low symptom reporters to attend to threat with an SOA of 250ms resulted in greater disruption in task performance. If high symptom reporters are characterised by a tendency to pay attention to negative health-relevant information and this results in a disruption in task performance (similar to the low symptom reporters undergoing ABM in the current study), this might lead to strategic attempts to overcome this effect, for example by diverting attention away from it. This is consistent with the finding that high symptom reporters are avoidant of negative health-relevant information at an SOA of 250ms.

Attentional bias has been studied extensively in the anxiety literature and there is evidence of a vigilance-avoidance pattern of responding in the presence of threat (Mogg & Bradley, 1998). This is where increased attention to threat is evident at earlier stages of processing and is followed by avoidance at later stages. Avoidance is considered to occur secondary to facilitated attention and difficulty in disengagement (Koster, De Raedt, Goeleven, Franck, & Crombez, 2005). It is thought that anxiety states may be generated and maintained by the presence of an initial vigilant ‘checking’ mode in order to rapidly detect the presence of threat in the environment (Beck & Clark, 1997). Once a threatening stimulus is detected, there is a strategic attempt to keep attention away from it in order to reduce the unpleasant reaction it produced or to aid disengagement from the threatening stimulus (see Cisler, Bacon, & Williams, 2009 for review).

The finding that high symptom reporters are avoidant of threat at an SOA of 250ms (Thompson et al., 2014), as well as the findings from emotional Stroop studies, is consistent with a similar vigilance-avoidance effect of threat in physical symptom reporters. Previous exogenous cueing studies in this area have used an SOA of 150ms, which may have been too short to capture this avoidance effect. However, it would also be anticipated that these studies would have captured the initial vigilance to threat which only one study successfully demonstrated (Chapman & Martin, 2011). Importantly however, these studies examined attention to health-threat words rather than pictures. Threatening words may have less threat value than pictures and attention to threat may only be captured if the threshold for
threat is exceeded (Mathews & Mackintosh, 1998). Furthermore, bias was measured in individuals with a diagnosed functional somatic syndrome rather than non-clinical high symptom reporters. These differences might be important factors in attentional bias in physical symptom reporting and warrants further exploration. Theoretically, this would suggest that models of physical symptom reporting should include reference to vigilance-avoidance in their accounts of the attentional processes involved in symptom reporting. A vigilance-avoidance effect of tactile stimuli following exposure to threatening information has previously been demonstrated in high symptom reporters (Brown et al., 2010) offering further support for this theory.

If there is a vigilance-avoidance pattern of response to threat involved in physical symptom reporting, facilitated attention to threat at short stimulus durations (e.g. 100ms) might predict later behavioural avoidance. Clinically, this would suggest that modification of the initial vigilance to threat might prevent later avoidance of it and lead to a reduction in symptoms. Similarly, modification of the later avoidance of threat might prevent the maintenance of physical symptoms. If high symptom reporters are vigilant to threat at early stages and avoidant at later stages, ABM could be applied to train high symptom reporters away from threat with a short SOA (e.g. 100ms) or to train attention towards the direction of threat at a later SOA (e.g. 250ms, 300ms) to see whether this decreases their symptom reports. Conversely, in low symptom reporters ABM could be applied to train attention towards threat at a short SOA or to avoid threat at a later SOA (i.e. to train low symptom reporters to respond to threatening health-relevant information more like high symptom reporters) to see whether this causes an increase in symptom reports. In the current study, training low symptom reporters to attend more to threat led to a relative slowing on threat trials but not an attentional bias for threat per se. This would call in to question the notion of training high symptom reporters to attend more to the location of threat to reduce attentional avoidance. However, as discussed previously, this slowing on threat trials observed in low symptom reporters as a result of ABM may be due to a disruption in the habituation to threat as opposed to a strategic attempt to avoid further processing of this information after initial vigilance to it.

If there is an attentional bias to health-threat information in the form of vigilance-avoidance this could have clinical implications in the way that medically unexplained physical symptoms are managed. This would contraindicate techniques such as distraction
and advocate the use of techniques which encourage an attentional focus on the self and the body such as mindfulness and body-scanning in the management and reduction of MUS. In a study exploring the effect of attention and distraction in health-anxious and non-health anxious chronic pain sufferers, attention to sensations of chronic pain resulted in lower anxiety and pain than distraction in health anxious participants (Hadjistavropoulos, Hadjistavropoulos & Quine, 2000). This suggests that more research into attentional bias in physical symptom reporting is required before attention bias modification tasks are developed for clinical purposes. Evidently, the nature of any attentional mechanisms involved in physical symptom reporting needs to be determined before any attempt is made to alter this bias clinically.

In order to further study attentional bias in physical symptom reporting, the specific attentional mechanism being measured should be clear (i.e. engagement, disengagement or avoidance). Further research should also be conducted using different lengths of SOA to determine at what stage of processing attentional bias occurs. If there is a vigilance-avoidance effect of threatening health-relevant information involved in physical symptom reporting, it would be expected that a short SOA (e.g. 100ms) would capture an initial orienting to threatening information and a longer SOA (e.g. 300ms) would reveal a later avoidance of this information. Additionally, a study exploring attentional bias and the effects of ABM would benefit from directly comparing low and high symptom reporters and their response to threat to determine whether these two groups do indeed fundamentally respond differently to this information.

One potential limitation of this study is that the physical symptom and anxiety measures were completed following the ABM task. It is possible that the ABM procedure was a mood induction in its own right and although anxiety scores were comparable across the groups, there could have been baseline differences. Including anxiety/mood measures prior to the attention paradigm would have enabled assessment of baseline anxiety/mood and is recommended for future studies. Another limitation is that an incorrect version of the physical symptoms measure was used. The version administered did not instruct participants to rate the symptoms they were currently experiencing (rather symptoms they had experienced previously) and this was an experimenter error. This may explain why training did not have an effect on physical symptom scores after the health-relevant mood
induction. The mood induction did increase anxiety but this effect was comparable for both
groups and training did not influence anxiety, however.

Future studies would therefore benefit from including a state measure of physical symptom
reporting to determine whether there is such an effect. Furthermore, the threat value of
the threatening images was not rated by participants included in the main study. In order
to ensure that the health-relevant threat information is appropriately threatening, future
studies exploring attentional bias to health-threat information should include stimuli rated
as threatening and neutral by the experimental participants themselves.

Although there does seem to be evidence of a relationship between attentional bias and
physical symptom reporting, it is evident that further research is required to establish the
precise nature of this relationship. The failure to induce an attentional bias in low symptom
reporters in the current study could implicate the involvement of additional factors in this
process. It remains a possibility that a third variable (such as illness beliefs and previous
illness experience) mediates attentional bias and physical symptom reporting which is
referred to in Brown’s integrative model (2004) and warrants further consideration in
studies in this area.
References


Section 3: Critical appraisal

Word count (excluding references): 5,396
Introduction

Despite the confusion and debate regarding the classification of medically unexplained symptoms (MUS; see Brown, 2007), it is now widely recognised that sufferers can be significantly debilitated and distressed by their condition. Medically unexplained symptoms have been shown to cost the NHS in England alone £3 billion every year (Department of Health [DoH], 2011). These human and societal costs have been recognised by the Government and in their mental health outcomes strategy ‘No health without mental health’ (DoH, 2011), the improved treatment of medically unexplained symptoms was placed as a priority and the resulting ‘Improving Access to Psychological Therapies for Long Term Conditions and Medically Unexplained Symptoms’ (IAPT LTC/MUS) is now in the first phase of its development. Advancements and investments such as these may mark the beginning of an improved understanding of a highly complex phenomenon.

The professional and academic confusion regarding the categorisation of symptoms with no identifiable organic cause most certainly transfers to the individuals who experience them. In qualitative research with individuals with MUS, themes of having to live with uncertainty and feeling fraudulent emerged (Nettleton, 2006). Even in the more ‘medical’ medically unexplained conditions such as chronic fatigue syndrome and irritable bowel syndrome, individuals have been found to feel stigmatised by their condition compared to those with organic conditions (Looper & Kirmayer, 2004) and frustrated that their condition is not validated by others (Asbring & Narvanen, 2002). Issues such as these highlight the contribution of psychosocial factors in the maintenance of MUS as postulated in most contemporary psychological models.

Although attentional processes have long been implicated in the development and maintenance of MUS (Barsky & Whyshak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997), however a causal relationship has yet to be established. The current thesis aimed to explore some of the evidence of an attentional bias in medically unexplained symptoms and to provide a first test of whether attentional bias causes increased physical symptom reporting. In an acknowledgement of the debate regarding the ‘psychiatric’ versus ‘medical’ approaches to classifying unexplained symptoms, the systematic review paper (Paper 1) of this thesis provides a review of the experimental manipulations and empirical evidence of attentional bias in functional somatic syndromes (FSS), that is, the medical approach to classifying conditions defined by MUS. A review of the evidence of attentional
bias from a psychiatric perspective was undertaken by another trainee. A review of the evidence separately might enable readers to see where the similarities and differences in these conditions are. The empirical paper (Paper 2) is one of the first known experimental investigations of attentional bias modification (ABM) in physical symptom reporting. Here, we attempted to generate an attentional bias towards threatening body-relevant stimuli in low symptom reporters and to test whether this leads to increased symptom reports following a health-relevant mood induction. Within the context of the recent Government agenda to improve services and treatments for individuals with MUS, this thesis is considered timely and relevant.

The critical reflections section of this thesis will be used to further elaborate on the theoretical underpinnings of attentional bias in physical symptom reporting to contextualise the rationale of the thesis. Methodological considerations of the systematic review and empirical study will be explored, along with reflections on the wider topic area throughout.

**Theoretical background**

As has been discussed in previous papers in this thesis, attentional bias to threatening body-relevant information is considered to play a central role in the development and maintenance of physical symptoms. A brief overview of the attentional mechanisms involved in physical symptom reporting has been discussed, however a detailed description of the precise mechanisms involved in this process were beyond the scope of the previous papers. Further information is provided about this in the current section in order to contextualise the work in this thesis.

It is only with reference to the theoretical underpinnings of attentional bias that the precise attentional mechanisms measured by experimental paradigms become clear. The different experimental paradigms measure distinct aspects of attention; cognitive interference in the emotional Stroop; spatial attention in dot-probe and exogenous cueing paradigms; and hypervigilance in paradigms exposing individuals to bodily sensations. Evidence of attentional bias is frequently accepted and compared without due consideration of the different attentional mechanisms measured by the particular paradigm.
‘Attention’ is a term that is frequently used without consideration of its multifaceted nature. Psychological models of MUS posit that selective attention to bodily sensations is a central component in their development and maintenance (Barsky & Wyshak, 1990; Brown, 2004; Kirmayer & Taillefer, 1997); however, they differ with regards the way in which this ‘attentional bias’ manifests.

Selective attention to threat is considered to consist of a preferential narrowing of attention onto threat stimuli relative to neutral stimuli. This attentional bias can manifest as facilitated engagement with threat (also referred to as vigilance for threat) or delayed disengagement from threat (also referred to as attentional maintenance on threat). Mogg and Bradley (1998) also refer to attentional avoidance which is characterised by the initial allocation of attention to threat followed by avoidance. Attention is directed towards locations opposite the location of the threat cue. This is considered to be a strategic process reflecting an attempt to reduce the negative affect associated with the threat.

The terms ‘selective attention’ and ‘hypervigilance’ for threat have frequently been used interchangeably. In a recent review of these processes in anxiety, Richards, Benson, Donnelly and Hadwin (2014) highlight that they are distinct attentional biases. While selective attention is considered to be associated with the orienting network, the alerting network is implicated in hypervigilance (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Posner, 2012; Posner & Rothbart, 2007). The orienting network is involved the selective allocation of attention to relevant objects or locations in order to enable further processing in these areas of foveal vision (Fan et al., 2005; Posner, 2012; Posner & Rothbart, 2007). This includes: disengaging from the currently attended to location in order to align attention with relevant stimuli, and shifting attention and re-engaging at a new location (Posner & Peterson, 1990). This enables attentional resources to be prioritised for the processing of relevant information. It is also considered that this reduces the degree of cognitive interference of competing, less relevant stimuli as they are not within the attended to region (Raz & Buhle, 2006). In contrast, the alerting network acts to ensure that information of high priority is noticed by creating a state of alertness and sustaining cognitive activation over prolonged periods of time (Posner & Peterson, 1990). In sum, then, selective attention consists of a selective narrowing of attention onto threat in preference of neutral stimuli; hypervigilance for threat consists of enhanced threat detection and altered attentional processes may be evident in the absence of threat.
Shiffrin and Schneider (1977) postulated two stages of information processing: automatic and strategic. Automatic processing is considered to be unconscious, effortless and capacity-free, whilst strategic processing is considered to be conscious, effortful and capacity-limited. Empirical evidence has demonstrated that attentional biases can present under both automatic, subliminal conditions and strategic, supraliminal conditions. Models of attentional bias in anxiety have differed with regards to the specific stage of information processing in which attentional biases occur, with some suggesting that they reflect automatic processes (e.g. Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1988), others strategic processes (e.g. Wells & Mathews, 1994) and some citing both processes as critical (e.g. Beck & Clarke, 1997; Ohman, 1996). While there is little consensus as to the phenomenological characteristics and the precise mechanisms of attentional bias towards threat, a review has concluded that all of the above characteristics are involved in attentional biases (Cisler, Bacon, & Williams, 2009).

Kirmayer and Taillefer (1997) extended the concept of somatosensory amplification proposed by Barsky and Whysak (1990) by integrating social and forensic factors. It is hypothesised that physical sensations are selectively attended to and interpreted as signs of illness. This leads to illness behaviours such as help-seeking, where the physician’s response can increase the distress associated with the symptoms. This model also includes the social responses of others (including agencies such as insurance and compensation systems), which can increase emotional arousal and physiological disturbance, which lead to an increase in symptoms and attention to these. This model incorporates many of the factors that serve to perpetuate MUS and thus takes a personalised, wholistic account of an MUS sufferers’ experience.

With regards to the attentional processes involved in MUS, this model postulates that if threatening information engages attention, it will have a facilitating effect resulting in accelerated response times to detect such stimuli (Fox, Russo, Bowles, & Dutton, 2001; Ohman, Flykt, & Esteves, 2001). Conversely, if selective attention consists of difficulty disengaging attention away from threat this will manifest as increased response times to detect a stimulus if attention has previously been captured by threatening information relative to neutral information (Amir, Elias, Klumpp, & Przeworski, 2003; Fox et al, 2001). The processes involved in selective attention are considered to be associated with attentional orienting.
Influenced by the cognitive-psychological theory of attentional control by Norman and Shallice (1986), Brown (2004) offered an extension of Kirmayer and Taillefer’s model, which sought to define the precise attentional processes involved in the development and maintenance of MUS. This model distinguishes between two attentional control systems: the primary attentional system (PAS), which operates prior to conscious awareness and the secondary attentional system (SAS), which operates following PAS selection processes and represents higher level thinking and attentional processes, thus distinguishing between automatic and strategic processes.

According to this model, unexplained symptoms represent an alteration in the body image generated by information acquired through numerous sources such as exposure to physical states in the self or others, socio-cultural transmission or verbal suggestion. These create memory traces of symptoms that are functionally similar to those generated when the symptom is experienced in the self. This information provides the basis for “rogue representations” of illness (Brown, 2004), which are automatically selected by the PAS and lead to the subjective experience of symptoms. Subsequent processes in the SAS such as the repeated allocation of high-level attention to symptoms lead to the maintenance of this experience, and thereby chronic MUS. In addition, the SAS makes active attempts to respond to the illness representations selected by the PAS, which leads to reactivation of rogue representations and reduction in the threshold for their selection by the PAS.

The perseverative nature of these attentional processes indicates that individuals with MUS may be hypervigilant to detect bodily sensations and then have difficulties disengaging attention away from these once it has been engaged. According to this model, individuals with MUS also have difficulties filtering out threatening physical sensations, associated with a failure to inhibit attention towards such stimuli. This would manifest as greater response times to complete a task when threatening task-irrelevant stimuli are present (Mogg & Bradley, 1998; Williams, Mathews, & MacLeod, 1996).

**Systematic review (Paper 1)**

The literature in functional somatic syndromes (FSS) can be confusing and somewhat contradictory. The different FSS such as irritable bowel syndrome, fibromyalgia and chronic fatigue syndrome are referred to as medical diagnoses and were classified on Axis III of the
Diagnostic Statistical Manual as medical conditions (DSM IV; APA, 1994). However, these are conditions in which the underlying pathology for the observed symptoms is, as yet, unknown. By this definition, these are ‘medically unexplained’ conditions, as there is no clear medical explanation for their existence. The distinguishing feature seems to be that the symptoms in these conditions are most notable in one specific bodily system. Although organic factors such as a virus have been associated with the development of some conditions (such as CFS, see Strauss, 1991), the evidence has been far from conclusive.

An anecdotal observation of the literature is that there appears to be a hierarchy of FSS with irritable bowel syndrome, chronic fatigue syndrome and fibromyalgia being considered as the most ‘medical’ and maybe most accepted of the FSS. Fibromyalgia has been said to have become more widely accepted as a medical health condition over time (Kirmayer, 1999) and irritable bowel syndrome is thought to be considered as an organic illness by many of the general population (Looper & Kirmayer, 2004). The timeline of FSS highlights the somewhat socially constructed nature of illness. To use an example from a review by Barsky and Borus (1999), the FSS ‘Gulf War Syndrome’ can be traced back to battle fatigue, shell shock and soldier’s heart/Da Costa syndrome. This demonstrates that conditions such as these are subject to change, which no doubt increases the professional and general confusion regarding their classification.

**Reviewing the literature**

Identifying mechanisms underlying the development and maintenance of MUS is seen as essential to developing more effective therapeutic interventions for these phenomena (Brown, 2007). Although theories of MUS postulate attentional bias towards symptoms as a central feature in their development and maintenance, there have been no comprehensive reviews of the evidence for this. The decision to review medical rather than psychiatric MUS was largely driven by the separate literatures in these areas. A separate review of FSS serves to increase the understanding of attentional processes involved in FSS specifically, and will inform the debate as to whether FSS and somatoform disorders (and other “psychiatric” approaches to MUS) share fundamental similarities or differences. A review of attentional bias to body-relevant information across the range of MUS (somatoform disorders, FSS and habitual symptom reporters) would be useful to further elucidate whether these conditions are in fact fundamentally different conditions or whether they share in common core developmental processes, so long as the evidence in the different
MUS is separated. It is recommended that the current review and the separate review of attentional bias in psychiatric classifications are combined for the purposes of publication.

When embarking on the initial scoping exercise, it was evident that search terms would have to be selective in order to balance the sensitivity and specificity of the search. Due to the vast amount of research in the area of attention, search terms needed to be checked independently in order to identify the terms that yielded the most relevant literature. Although this is required when conducting a systematic review in a large topic area in order to navigate the literature, this parsimonious approach may result in some of the relevant literature not being identified. Employing strategies such as cross referencing (as was employed in the systematic review) helps to reduce this issue, although this may only help to identify the most frequently cited studies. The process was regarded as a balance between identifying the relevant literature and being a manageable undertaking.

There is some debate as to whether systematic reviews and meta-analyses should attempt to include ‘grey literature’. A lack of peer review and the potentially questionable validity of these studies has led to the exclusion of such literature in many reviews (Sacks, Reitman, Pagano, & Kupelnick, 1996). It is argued however, that reviews excluding grey literature are likely to over-represent studies with positive findings (Conn, Valentine, Cooper, & Rantz, 2003). Although the Cochrane Collaboration recommends that reviews include grey literature, there is acknowledgement that this is a time consuming exercise and can itself be a source of bias (Hopewell, McDonald, Clarke, & Egger, 2007). The systematic review in the current thesis excluded unpublished studies, conference abstracts and poster presentations. The inclusion of such literature would have widened the scope of the review and potentially altered the findings. However, the exclusion of studies that had not been peer reviewed was justified on the grounds of common practice and time constraints. The equivocal findings yielded by the review indicate that the studies in this area were not subject to positive publication bias.

The decision to develop a bespoke quality assessment tool was driven by a difficulty in finding an existing tool which covered the most pertinent factors to scientific integrity in this particular research area. This ensured that the most important factors, such as diagnostic ascertainment and the validity of the experimental paradigm, were weighted equally. There are some quality assessment tools which enable an overall study quality
score to be calculated, however this can result in biased ratings and may not adequately reflect the specific areas of strengths and weaknesses in studies’ design and methodology (Green et al., 2008).

**Presenting the findings**

In order to review studies in attentional bias in FSS, it was necessary to contextualise this within theories of both attention and medically unexplained symptoms. There is a wealth of literature in both of these areas and it was a challenge achieving a balance between presenting adequate theoretical and empirical context, and maintaining the accessibility and focus of the review aims.

The systematic review highlighted that although there is some evidence of attentional bias towards threatening information in individuals with FSS, this is far from unequivocal. It is hoped that this review will highlight that more research is needed in this field in order to be able to draw conclusions with regards to the role of attentional bias in FSS. The description of the different experimental paradigms within the context of attentional theory was intended to highlight the different attentional mechanisms potentially involved in attentional bias. This may guide future attentional bias research to employ appropriate paradigms in order to explore the specific attentional mechanism of interest.

**Empirical paper (Paper 2)**

The systematic review demonstrated that evidence of attentional bias in FSS is equivocal. However, those studies that did demonstrate the presence of attentional bias and the compelling theoretical literature suggesting a role for attention in MUS provided the rationale for this study. Similar attentional processes are considered to underlie anxiety disorders and physical symptom reporting. Therefore, the establishment of the causal role of attentional bias in the anxiety disorders through ABM, marks an exciting avenue of exploration in physical symptom reporting.

**The experimental paradigm**

ABM has not been explored in physical symptom reporting other than a study exploring the pain reducing effect of ABM in fibromyalgia (Carleton, Richter, & Asmundson, 2011). That study did not provide response time data on the ABM task, making it impossible to draw
conclusions regarding the effectiveness of attentional bias training. As such, the experimental paradigm used in our study was largely exploratory, in that there was no specific empirical evidence within the area of ABM in physical symptom reporting from which to draw when designing the task. Although studies using ABM in the anxiety disorders have typically utilised a modified version of the dot-probe task (one study has used a visual search task; Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007), the current study adopted an ABM paradigm based on exogenous attentional cueing. The tasks are similar, such that they both measure spatial attention and enable facilitated attention, difficulty in disengaging attention and attentional avoidance, to be observed. The decision to use this task, rather than the more typical dot-probe task, was informed by the potential confounds introduced by presenting threatening and neutral stimuli simultaneously within the same field of vision. Response times to detect either stimulus may unavoidably be influenced by the presence of the other, meaning that it is difficult to interpret which stimulus caused the effect. Exogenous cueing tasks in which stimuli are presented individually, remove this possibility and make interpretation easier.

In order to train attentional bias towards a cued location, it is essential that there is a cue validity effect, such that response times to detect valid cues are faster than invalid cues. Studies using spatial cueing paradigms have demonstrated a cue validity effect using different stimulus onset asynchronies (SOAs; i.e. the duration between the start of one stimulus and the start of another). Mogg, Holmes, Garner and Bradley (2008) found a cue validity effect at 250ms, whereas Amir et al. (2003) found it at 600ms. Longer SOAs have been found to result in slower response times on cue valid trials than invalid trials; a phenomenon referred to as ‘inhibition of return’. This is thought to reflect an evolved mechanism whereby previously attended to locations are inhibited to facilitate subsequent searching (Posner, Rafal, Choate, & Vaughan, 1985). In order to determine the SOA to be adopted in the empirical study, three pilot trials were conducted with varying SOA’s (175 ms, 250 ms and 300 ms) with 10 participants completing each pilot. The SOA of 250 ms produced the most consistent cueing effect. Although cue validity did not interact with threat as had been expected, analysis demonstrated a consistent main effect of cue validity demonstrating that the desired effect was evident.

The ABM training trials used a ratio of 75% valid trials and 25% invalid trials, such that threatening stimuli appeared in the cued location on 75% of trials. Spatial cueing tasks have
traditionally employed a ratio of 80% valid and 20% invalid to create a cue validity effect (Posner, 1980). Due to the design of the empirical study, however, the combination of stimulus type, cue validity and target type would not have been fully counterbalanced at 80% cue validity. The counter balancing of experimental trials was considered to be the more important factor to the scientific integrity of the study, thus a cue validity of 75% was employed. ABM studies have previously employed a cue validity of 100% (Dandeneau et al., 2007), however it was considered that this might make the purpose of the task too predictable and potentially have an impact on response times that was unrelated to attentional bias. It would be beneficial to explore whether the ratio of valid and invalid cues results in differential responding to threatening valid trials. It is possible that response times to detect threatening valid cues in the experimental paradigm would have been different using a cue validity of 100%. However, the experimental paradigm demonstrated a consistent cue validity effect in both the experimental and control group; moreover, different response times on threat versus neutral trials were observed following training. This indicates that a cue validity of 75% was sufficient to result in differential responses to threat.

Analysis

Although attentional bias scores are widely used as a measure of attentional bias (e.g. Asmundsen & Hadjistacvropoulos, 2007; Hou et al., 2014), and are useful in exploring the distinct mechanisms of selective attention (facilitated, difficulty disengaging and avoidance) there is the possibility that important information regarding differential processing of threatening and neutral stimuli, regardless of congruency, will be missed resulting in an increased risk of Type II error. In the experimental study, it was initially hypothesised that there would be a significant four way interaction between threat, group, validity and time such that the experimental group would be significantly faster to respond to threat when this has been validly cued following training. However, the analysis revealed that there was a significant three way interaction that was not contingent upon validity. Therefore, attentional bias scores would not have reflected this significant difference.

Mogg and Bradley (2008) highlighted that the calculation of attentional bias scores is confounded by a response slowing effect of threatening information. If there is an overall slowing to respond in the presence of threatening stimuli (cue or uncued) then this may implicate the validity of interpretations of attentional bias scores. For example, what could
have been interpreted as a difficulty disengaging attention away from threat may actually be an artefact of an overall slowing in the presence of threat. Indeed, in a study examining attentional bias towards body relevant stimuli, children with functional abdominal pain were found to be slower than healthy children to respond on all trials on which gut-relevant stimuli were presented, regardless of whether this validly or invalidly cued (van der Veek et al., 2014). As the authors calculated attentional bias scores, this was interpreted as a null finding for an attentional bias towards body relevant stimuli in children with functional abdominal pain. However, this finding suggests that the presence of threatening stimuli led to differential processing of this information that was not dependent upon the validity of the probe, which suggests attentional bias in the form of an overall slowing effect of threat.

**Recruitment**

Recruitment for the study was conducted in conjunction with a parallel study exploring attentional bias modification in high symptom reporters. Although evidence suggest that approximately one third of the population fall within the ‘low symptom reporting’ range, recruitment of low symptom reporters required ‘active’ recruitment strategies, such as wider advertising. An *a priori* calculation indicated that a sample size of 56 participants in total would be required to achieve adequate power, and active attempts were made to achieve this target. A larger number of high symptom reporters completed the screening phase than low symptom reporters, possibly because the study topic was of more interest to those experiencing a high number of physical symptoms.

As the study recruited from a university, all the participants were undergraduate or postgraduate students, and so may not be representative of the wider population of low symptom reporters. Also, it was a largely female sample with an under-representation of male participants. A more representative sample recruited from wider sources would have resulted in greater generalisability of the findings. Due to the relatively large sample required and the time constraints for recruitment, a student sample was considered appropriate. Furthermore, the inclusion of only university students resulted in greater homogeneity of the sample and greater confidence in the comparability of the experimental groups in this study, whilst also enabling comparison with the groups in the parallel high symptom reporting study.
The findings of the empirical study, together with the parallel study in high symptom reporters, provide the first evidence of the effects of ABM on physical symptom reporting. The author of the parallel study was included as second author of the empirical paper due to the shared recruitment process and the intention to jointly publish the findings of the two studies in one paper.

*Measures*

The measures used in the study were chosen due to their validity and accessibility.

The Patient Health Questionnaire 15 (PHQ-15) is considered to have high internal reliability (Chronbach’s alpha = 0.80; Kroenke, Spitzer, & Williams, 2002; van Ravesteijn et al., 2009). Test-retest reliability is also adequate (Pearson’s r = .80; van Ravesteijn et al, 2009). This proved to be an effective measure for screening purposes and appeared effective in distinguishing high and low symptom reporters. The difference between the low and high symptom reporters on the same experimental paradigm suggests that they were in fact distinct groups with regards their response threatening information.

The Health Anxiety Short Form (SHAI) has been demonstrated to have good internal consistency (Chronbach’s alpha = 0.89). Although test-retest reliability was not conducted on the shortened version of the HAI, the longer version HAI has good test-retest reliability (Pearson’s r = 0.90) at one week retest (Salkovskis, Rimes, Warwick, & Clark, 2002).

The Pennebaker Inventory of Limbic Languidness (PILL) is considered to have high internal consistency (Chronbach alpha = 0.88) and adequate test-retest reliability (Pennebaker, 1982).

Visual analogue scales, although highly subjective, are considered to be a valuable, time efficient tool for measuring change within individuals (for clinical and research purposes), rather than measuring differences across groups at one time point (Crichton, 2001). This was used to measure change in self-reported anxiety following the mood induction. This proved to be a useful tool for the purposes of measuring change in anxiety, and demonstrated that all participants reported an increase in anxiety following the induction.
As the effect of the mood induction on physical symptoms and anxiety were of interest, the PILL and visual analogue scale were administered following the experimental task and again following the mood inductor. It is possible that the experimental task itself created an increase in physical symptoms and anxiety and so may not have reflected baseline levels. The study was designed to explore whether ABM would create a vulnerability to experience an increase in physical symptoms and anxiety following a body-relevant mood inductor which formed the rationale of the order of measurement administration. It would have been useful to also measure anxiety and symptoms before the ABM procedure to assess whether this also had an impact.

**Implications and further research**

The clinical and theoretical implications from this thesis have been referred to throughout the thesis and recommendations for future research have been made on the basis of the findings. These are summarised below.

**Theoretical and clinical implications**

The systematic review demonstrates that the role of attentional bias in functional somatic syndromes is far from established empirically. As has been previously described, the different empirical paradigms employed measure different aspects of attentional bias. It may be that individuals with FSS demonstrate attentional bias in a specific area of attention such as cognitive interference, spatial attention or hypervigilance, which may manifest as facilitated attention to threat, delayed disengagement from threat or attentional avoidance from threat but the range of paradigms employed across the different syndromes has not reflected this.

Prior to embarking on the empirical study, it was considered that physical symptom reporting was associated with an attentional bias towards threatening body-relevant information. The findings suggested that low symptom reporters do not have a specific attentional bias towards threatening body-relevant information (as would be expected) but can be trained to be more distracted or less tolerant of such information. The corresponding study demonstrates that high symptom reporters demonstrate an attentional avoidance of threatening body-relevant information (Thompson, Poliakoff, & Brown, 2014).
The experimental paradigm demonstrated that ABM is able to generate a differential response to threatening stimuli in low symptom reporters, such that they became more distracted or less tolerant to threat. The question arises as to whether the ABM procedure made low symptom reporters respond more like highs, since the bias assessment post-training for experimental lows was not the same as the baseline attention assessment for the high symptom reporters. The findings suggested that high symptom reporters might have a vigilance-avoidance pattern of responding (Mogg & Bradley, 1998) to threatening health-relevant information. Low symptom reporters were found to demonstrate greater cognitive interference in the presence of threat after training. It may be that with repetition, these individuals will display responses more in line with high symptom reporters. By becoming less tolerant or more observant of threat, low symptom reporters may, over time, develop an attentional avoidance of threat and thereby behave more like high symptom reporters in this respect. In light of this evidence, models of symptom reporting may need to make reference to vigilance-avoidance in their conceptualisations to accommodate this. If high symptom reporters demonstrate an avoidance of threatening body-relevant information, it may be that this avoidance is maintaining the symptoms. This would suggest that interventions such as distraction are contraindicated in the treatment of MUS, and conscious, body-focussed attention strategies such as body-scanning and mindfulness may be more appropriate.

Attending to sensations of pain has been observed to result in greater reduction of anxiety and pain than distraction in health-anxious chronic pain sufferers. In non-health anxious chronic pain sufferers, attention to pain sensations resulted in increased worry about health than distraction (Hadjistavropoulos, Hadjistavropoulos & Quine, 2000). This seems counter-intuitive and opposed to some current theory. However, this is consistent with the Brown (2004) model because the problem is focusing on symptom representations rather than what is actually coming from the body, meaning that focusing on the latter might make perception more accurate.

Further research
The current thesis has demonstrated that there is a need for further research in attentional bias in functional somatic syndromes specifically and physical symptom reporting more generally. It is recommended that future research in functional somatic syndromes is
conducted using experimental paradigms which enable the distinct attentional processes involved in FSS to be assessed, and that this is conducted with large, well-defined samples.

The experimental paper suggests that low and high symptom reporters have different responses to threat and low symptom reporters response to threat can be altered using ABM. In order to explore this further it is recommended that future research in ABM in physical symptom reporting attempts to train high symptom reporters towards threat and low symptom reporters away from threat. If high symptom reporters avoid threat, then training bias towards threat might result in a reduction in symptoms. Similarly, training low symptom reporters to avoid threat might result in an increase in symptoms. Further research is needed to explore further the exact attentional processes involved in physical symptom reporting prior to exploring the utility of ABM in determining causality of attentional bias and as a potentially effective therapeutic intervention.
References


Appendices
Appendix A: Quality assessment tool
### Participant characteristics

A high (+++) rating is awarded to a study that meets the following criteria:

1. Age and gender are provided for all participants (mean age is acceptable)
2. All participants’ diagnoses are operationalised by including the specific diagnosis by specialist practitioner and diagnostic criteria eg. Rome to make the diagnosis
3. Full inclusion and exclusion criteria included
4. Recruited to minimise bias

An acceptable rating (+) quality rating is awarded to a study that meets the following criteria:

1. Age and gender are provided for all participants (mean age is acceptable)
2. All participants’ diagnoses are operationalised by definition of behaviours and symptoms of participants rather than a formal diagnosis
3. Full inclusion and exclusion criteria included

An unacceptable (-) quality rating is awarded to a study that does not meet each of the + rating criteria 1, 2 and 3.

### Control group

A ++ rating is awarded to a study that meets the following criteria:

1. Clearly describes the characteristics of the control group
2. Control group is age and sex matched to the experimental group
3. Attempts have been made to make control and experimental groups homogenous other than the presence or absence of a functional syndrome
4. Includes an illness control group

A + rating is awarded to a study that meets the following criteria:

1. Provides basic description of the characteristics of the control group
2. Age and sex of control group and experimental group are not significantly different
3. Control participants were recruited from the general population

An unacceptable (-) quality rating is awarded to a study that does not meet each of the + rating criteria 1, 2 and 3.

### Confounding factors

A ++ rating is awarded to a study that meets the following criteria:

- Potentially relevant variables are accounted for and measured (e.g. anxiety, depression, medication use)

A + rating is awarded to a study that meets the following criteria:

- Some variables are accounted for

A - rating is awarded to a study that does acknowledge any potentially confounding factors
### Independent variable (IV)

**A ++ rating** is awarded to a study that meets the following criteria:

1. Defines the independent variables with replicable precision (i.e. One could reproduce the intervention given the description provided).
2. Measures attention to the body using a validated method or some attempt to demonstrate the validity of the method has been made within the study.
3. 

**A + rating** is awarded to a study that meets the following criteria:

1. Defines many elements of the IV’s but omits specific details.
2. Measures attention to the body using a method with face validity.

**A - rating** is awarded to a study that does not sufficiently define the IV’s and/or does not use an appropriate method to manipulate attention.

### Dependent variable (DV)

**A ++ rating** is awarded to a study that meets the following criteria:

1. The variables are defined with operational precision.
2. The paper cites or presents evidence that the measure has been validated as a measure of attention.
3. Measured in such a way to minimise bias.

**A + rating** is awarded to a study that meets the following criteria:

1. Defines many elements of the DV’s but omits specific details.
2. The paper cites or presents evidence that the measure has been validated as a measure of attention.

**A - rating** is awarded to a study that does not meet the above criteria.

### Statistical analysis

**A ++ rating** is awarded to a study that meets the following criteria:

1. Analysed to demonstrate differences in attentional bias.
2. Appropriate statistical analyses were conducted given the power of the test i.e. Was sample size large enough to conduct a parametric test, were data normally distributed, did data meet the assumptions of the test.
3. 2 tailed analyses.

**A + rating** is awarded to a study that meets the following criteria:

1. Analysed to demonstrate differences in attentional bias.
2. Appropriate statistical analyses were conducted on 75% of DV’s or in which proper statistical analyses were conducted on 100% of DV’s but with inadequate power or a small sample size.
3. 2 tailed analyses.

**A - rating** is awarded to a study in which statistical analyses were not appropriate or the sample size was too small.
Effect Sizes

A ++ rating is awarded to a study that meets the following criteria:

- Effect sizes are reported for all tests
A + rating is awarded to a study that meets the following criteria:

- Effect sizes are given or provides enough information in order to calculate effect sizes (means and SD’s) for main hypotheses only
A - rating is awarded to a study that does not provide the information necessary to calculate effect sizes for the main hypotheses

Note:
++ High quality
+ Acceptable quality
- Unacceptable quality
Appendix B: Participant Information Sheet and Consent Form: Screening phase
Title: Attentional Bias Modification and Physical Symptom Reporting

Participant Information Sheet
Screening Phase

You are being invited to take part in research that is being carried out as part of a Clinical Psychology doctoral thesis. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?

Sarah Scott and James Thompson, who are both trainee clinical psychologists working under the supervision of Dr Richard J. Brown, will be conducting the research. Please see below for contact details.

What is the aim of the research?

It is known that the more physical symptoms someone reports, the more distress and disability they experience. Research suggests that various factors can affect how many symptoms we experience, many of which are unrelated to physical factors such as injury or disease. For example, it is thought that people who are always “on the lookout” for signs of illness (perhaps because they are worried about becoming ill) are more like to notice and report symptoms than other people. The purpose of the present research study is to test this idea.

By understanding more about what is involved in symptom reporting, we hope to develop treatments to reduce the number of distressing physical symptoms that people experience.

Why have I been chosen?

We are approaching all students and staff at the University of Manchester to see if they are eligible to take part in the research. We are hoping to recruit people who fall in the appropriate range on the screening measure. One hundred and twelve participants will be involved in total.

What would I be asked to do if I took part?

You will be asked to complete a brief, 15 item screening questionnaire about your experience of common physical symptoms such as headaches
or dizziness and a brief, 18 item questionnaire about your thoughts about physical symptoms. This will take approximately 15 minutes. If your score is in the appropriate range then you agree to be invited to take part in the next stage which consists of a 60 minute testing session at the University, at a time that is convenient for you. We will give you a separate information sheet about the testing session if you are eligible to take part.

If your score does not fall in the appropriate range, you will not be invited to take part in a testing session and we thank you for your time.

**What happens to the data collected?**
The data collected from this will be analysed by the researchers and the findings written up as part of a doctoral thesis.

**How is confidentiality maintained?**
The data will be stored in the University and will be kept confidential. Electronic data will be password protected to maintain confidentiality. Only the researchers and their supervisor will have access to this data. Personal details will be kept separate from the data so you will not be identifiable. This will be stored securely at the University for a period of ten years after which time it will be destroyed.

**What happens if I do not want to take part or if I change my mind?**
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without having to give a reason and without detriment to yourself.

**Will I be paid for participating in the research?**
You will be entered into a prize draw for taking part in the screening phase even if you are not eligible to take part in the experimental phase. If you complete the experimental session you will receive either four experimental credits (for Psychology undergraduates) or £5 for your inconvenience.

**Where will the research be conducted?**
School of Psychological Sciences, University of Manchester

Room S20, 2nd Floor Zochonis Building,

Brunswick Street

Manchester, M13 9PL
Will the outcomes of the research be published?
The researchers intend to publish the findings in peer reviewed academic journals.

Who has reviewed the research project?
The project has been reviewed by the University of Manchester Research Ethics Committee 1.

What if something goes wrong?
In the unlikely event that something goes wrong and you required assistance or advice, you should contact the researchers using the above details in the first instance. It is hoped that taking part in the screening phase would not cause you any distress. However, if you do feel distressed then the researchers will provide you with the contact details of sources of support.

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to 'The Research Practice and Governance Co-ordinator, Research Office, Christie Building, The University of Manchester, Oxford Road, Manchester M13 9PL', by emailing: Research-Governance@manchester.ac.uk, or by telephoning 0161 275 7583 or 275 8093.

Contact for further information
Sarah Scott and/or James Thompson
School of Psychological Sciences, University of Manchester
2nd Floor Zochonis Building,
Brunswick Street
Manchester, M13 9PL
Study Consent Form

Screening Phase

Title: Attentional Bias Modification and Physical Symptom Reporting

Please read the following statements and initial each box

1. I confirm that I have read and understood the information sheet dated 22.05.2013 (version 3) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected.

3. I give my permission for my data to be retained by the research team and used confidentially in connection with the study if I withdraw.

4. I give my permission to be contacted about the experimental session if I am eligible to take part.

5. I agree to take part in the screening phase of the above study

Participant _________________________    ______________________________

Researcher _________________________    ______________________________

Name                      Signature                      Date
Appendix C: Participant Information Sheet and Consent Form: Experimental phase
Title: Attentional Bias Modification and Physical Symptom Reporting
Participant Information Sheet
Experimental Phase

You are being invited to take part in research that is being carried out as part of a Clinical Psychology doctoral thesis. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?
Sarah Scott and James Thompson, who are both trainee clinical psychologists working under the supervision of Dr Richard J. Brown, will be conducting the research. Please see below for contact details.

What is the aim of the research?
It is known that the more physical symptoms someone reports, the more distress and disability they experience. Research suggests that various factors can affect how many symptoms we experience, many of which are unrelated to physical factors such as injury or disease. For example, it is thought that people who are always “on the lookout” for signs of illness (perhaps because they are worried about becoming ill) are more likely to notice and report symptoms than other people. The purpose of the present research study is to test this idea.

By understanding more about what is involved in symptom reporting, we hope to develop treatments to reduce the number of distressing physical symptoms that people experience.

Why have I been chosen?
You have been chosen to take part as your score on the screening questionnaire was below the required score. Fifty six participants scoring within a similar range will be involved in total.

What would I be asked to do if I took part?
You will be invited to take part in a 60 minute testing session at the University, at a time that is convenient for you.

During the session, you will be shown a series of pictures on a computer screen which will be followed by a shape (a triangle or circle). You will be asked to indicate which shape it was using a computer key. Some of the pictures in this task are quite unpleasant (e.g., pictures of physical injury), but no worse than what would be routinely seen on medical dramas and documentaries. An example of the kinds of pictures used in the task has been provided with this information sheet.
We will then show you a short video consisting of clips from the television drama *Casualty*. The purpose of this video is to induce a temporary, mildly negative mood so that we can study its effects. If you would like to see a brief clip designed to give you some idea of what the video is like then please visit http://youtu.be/3i4uAkihgEY

We anticipate that this negative mood will be tolerable and short-lived. However, if you think that you would be very highly distressed during or after seeing the video then please do not take part. In the unlikely event that you do become very distressed we have procedures in place to manage this, and give a list of possible sources of support to all participants. If you do become very distressed by any aspect of the study then please let the researcher know.

After the video you will be asked to complete two short questionnaires. The whole process should take around 60 minutes. The purpose of the study is to try and train people to focus more on unpleasant pictures and increase physical symptom reporting. As a result of this, you may be more likely to notice physical threat. Although this is unlikely to be a lasting effect, you will be given the option to undergo further training to reverse this effect if you wish.

**What happens to the data collected?**
The data collected from this will be analysed by the researchers and the findings written up as part of a doctoral thesis.

**How is confidentiality maintained?**
The data will be stored in the University and will be kept confidential. Electronic data will be password protected to maintain confidentiality. Only the researchers and their supervisor will have access to this data. Personal details will be kept separate from the data so you will not be identifiable. This will be stored securely at the University for a period of ten years after which time it will be destroyed.

**What happens if I do not want to take part or if I change my mind?**
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without having to give a reason and without detriment to yourself.

**Will I be paid for participating in the research?**
If you complete the experimental session you will receive either four experimental credits (for Psychology undergraduates) or £5 for your inconvenience.

**Where will the research be conducted?**
School of Psychological Sciences, University of Manchester
Room S20, 2nd Floor Zochonis Building,
Brunswick Street
Manchester, M13 9PL
Will the outcomes of the research be published?
The researchers intend to publish the findings in peer reviewed academic journals.

Who has reviewed the research project?
The project has been reviewed by the University of Manchester Research Ethics Committee 1.

What if something goes wrong?
In the unlikely event that something goes wrong and you required assistance or advice, you should contact the researchers using the above details in the first instance.

It is hoped that taking part in this study would not cause undue distress. However, if you do feel distressed then you can contact any of the sources of support provided with this information sheet.

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to ‘The Research Practice and Governance Co-ordinator, Research Office, Christie Building, The University of Manchester, Oxford Road, Manchester M13 9PL’, by emailing: Research-Governance@manchester.ac.uk, or by telephoning 0161 275 7583 or 275 8093.

Contact for further information
Sarah Scott and/or James Thompson
School of Psychological Sciences, University of Manchester
2nd Floor Zochonis Building,
Brunswick Street
Manchester, M13 9PL

Email: sarah.scott-2@postgrad.manchester.ac.uk and james.thompson-7@postgrad.manchester.ac.uk
Telephone: 0161 306 0400
Study Consent Form

Experimental Phase

Title: Attentional Bias Modification and Physical Symptom Reporting

Please read the following statements and initial each box

6. I confirm that I have read and understood the information sheet dated 22.05.2013 (version 3 - SS) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

7. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected.

8. I give my permission for my data to be retained by the research team and used confidentially in connection with the study if I withdraw.

9. I give my permission to be contacted about future studies

10. I would like to receive a summary of the findings from the study.

11. I agree to take part in the above study

Participant _________________________ __________________________

Researcher _________________________ __________________________

Name                      Signature                      Date
Appendix D: Measures
<table>
<thead>
<tr>
<th>Problem</th>
<th>Not bothered at all</th>
<th>Bothered a little</th>
<th>Bothered a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain in your arms or legs or other joints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menstrual cramps or other problems with your periods (women only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headaches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fainting spells</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling your heart pound or race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortness of breath</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain or problems during sexual intercourse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constipation, loose bowels, or diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea, gas, or indigestion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling tired, or having low energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble sleeping</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**ii: Health Anxiety Inventory**

Each question in this section consists of a group of four statements. Please read each group of statements carefully and then select the one which best describes your feelings, over the past month. Identify the statement by ringing the letter next to it, i.e. if you think that statement a.) is correct, ring statement a.). It may be that more than one statement applies, in which case, please ring any that are applicable.

1. a.) I do not worry about my health.  
   b.) I occasionally worry about my health.  
   c.) I spend much of my time worrying about my health.  
   d.) I spend most of my time worrying about my health.

2. a.) I notice aches/pains less than most other people (of my age).  
   b.) I notice aches/pains as much as most other people (of my age).  
   c.) I notice aches/pains more than most other people (of my age).  
   d.) I am aware of aches/pains in my body all the time.

3. a.) as a rule I am not aware of bodily sensations or changes.  
   b.) sometimes I am aware of bodily sensations or changes.  
   c.) I am often aware of bodily sensations or changes.  
   d.) I am constantly aware of bodily sensations or changes.

4. a.) resisting thoughts of illness is never a problem.  
   b.) most of the time I can resist thoughts of illness.  
   c.) I try to resist thoughts of illness but am often unable to do so.  
   d.) thoughts of illness are so strong that I no longer even try to resist them.

5. a.) as a rule I am not afraid that I have a serious illness.  
   b.) I am sometimes afraid that I have a serious illness.  
   c.) I am often afraid that I have a serious illness.  
   d.) I am always afraid that I have a serious illness.

6. a.) I do not have images (mental pictures) of myself being ill.  
   b.) I occasionally have images of myself being ill.  
   c.) I frequently have images of myself being ill.  
   d.) I constantly have images of myself being ill.

7. a.) I do not have any difficulty taking my mind off thoughts about my health.  
   b.) I sometimes have difficulty taking my mind off thoughts about my health.  
   c.) I often have difficulty in taking my mind off thoughts about my health.  
   d.) Nothing can take my mind off thoughts about my health.

8. a.) I am lastingly relieved if my doctor tells me there is nothing wrong.  
   b.) I am initially relieved but the worries sometimes return later.  
   c.) I am initially relieved but the worries always return later.  
   d.) I am not relieved if my doctor tells me there is nothing wrong.
9.  
   a.) if I hear about an illness I never think I have it myself.  
   b.) if I hear about an illness I sometimes think I have it myself.  
   c.) if I hear about an illness I often think I have it myself.  
   d.) if I hear about an illness I always think I have it myself.  

10.  
   a.) if I have a bodily sensation or change I rarely wonder what it means.  
   b.) if I have a bodily sensation or change I often wonder what it means.  
   c.) if I have a bodily sensation or change I always wonder what it means.  
   d.) if I have a bodily sensation or change I must know what it means.  

11.  
   a.) I usually feel at very low risk for developing a serious illness.  
   b.) I usually feel at fairly low risk for developing a serious illness.  
   c.) I usually feel at moderate risk for developing a serious illness.  
   d.) I usually feel at high risk for developing a serious illness.  

12.  
   a.) I never think I have a serious illness.  
   b.) I sometimes think I have a serious illness.  
   c.) I often think I have a serious illness.  
   d.) I usually think that I am seriously ill.  

13.  
   a.) if I notice an unexplained bodily sensation I don’t find it difficult to think about other things.  
   b.) if I notice an unexplained bodily sensation I sometimes find it difficult to think about other things.  
   c.) if I notice an unexplained bodily sensation I often find it difficult to think about other things.  
   d.) if I notice an unexplained bodily sensation I always find it difficult to think about other things.  

14.  
   a.) my family/friends would say I do not worry enough about my health.  
   b.) my family/friends would say I have a normal attitude to my health.  
   c.) my family/friends would say I worry too much about my health.  
   d.) my family/friends would say I am a hypochondriac.  

For the following questions, please think about what it might be like if you had a serious illness of a type which particularly concerns you (e.g. heart disease, cancer, multiple sclerosis & so on). Obviously you cannot know for definite what it would be like; please give your best estimate of what you think might happen, basing your estimate on what you know about yourself and serious illness in general.  

15.  
   a.) if I had a serious illness I would still be able to enjoy things in my life quite a lot.  
   b.) if I had a serious illness I would still be able to enjoy things in my life a little.  
   c.) if I had a serious illness I would be almost completely unable to enjoy things in my life.  
   d.) if I had a serious illness I would be completely unable to enjoy life at all.
16.  

a.) if I developed a serious illness there is a good chance that modern medicine would be able to cure me.  
b.) if I developed a serious illness there is a moderate chance that modern medicine would be able to cure me.  
c.) if I developed a serious illness there is a very small chance that modern medicine would be able to cure me.  
d.) if I developed a serious illness there is no chance that modern medicine would be able to cure me.  

17.  

a.) a serious illness would ruin some aspects of my life.  
b.) a serious illness would ruin many aspects of my life.  
c.) a serious illness would ruin almost every aspect of my life.  
d.) a serious illness would ruin every aspect of my life.  

18.  

a.) if I had a serious illness I would not feel that I had lost my dignity.  
b.) if I had a serious illness I would feel that I had lost a little of my dignity.  
c.) if I had a serious illness I would feel that I had lost quite a lot of my dignity.  
d.) if I had a serious illness I would feel that I had totally lost my dignity.  

_all groups are scored 0, 1, 2 or 3 depending on the statement selected; if more than statement is selected, use the highest-scoring statement of those chosen._

**total score =**
iii: The Pennebaker Inventory of Limbic Languidness

Several common symptoms or bodily sensations are listed below. Most people have experienced most of them at one time or another. On the page below, write how frequently you experience each symptom. For all items, use the following scale:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have never</td>
<td>Less than</td>
<td>Every month</td>
<td>Every week</td>
<td>More than</td>
</tr>
<tr>
<td>or almost</td>
<td>3 or 4 times</td>
<td>or so</td>
<td>or so</td>
<td>once every week</td>
</tr>
<tr>
<td>never</td>
<td>per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>never experienced</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the symptom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For example, if your eyes tend to water once every week or two, you would answer "D" next to question #1.

1. Eyes water
2. Itchy eyes or skin
3. Ringing in ears
4. Temporary deafness or hard of hearing
5. Lump in throat
6. Choking sensations
7. Sneezing spells
8. Running nose
9. Congested nose
10. Bleeding nose
11. Asthma or wheezing
12. Coughing
13. Out of breath
14. Swollen ankles
15. Chest pains
16. Racing heart
17. Cold hands or feet even in hot weather
18. Leg cramps
19. Insomnia or difficulty sleeping
20. Toothaches
21. Upset stomach
22. Indigestion
23. Heartburn or gas
24. Abdominal pain
25. Diarrhoea
26. Constipation
27. Haemorrhoids
28. Swollen joints
29. Stiff or sore muscles
30. Back pains
31. Sensitive or tender skin
32. Face flushes
33. Tightness in chest
34. Skin breaks out in rash
35. Acne or pimples on face
36. Acne/pimples other than face
37. Boils
38. Sweat even in cold weather
39. Strong reactions to insect bites
40. Headaches
41. Feeling pressure in head
42. Hot flashes
43. Chills
44. Dizziness
45. Feel faint
46. Numbness or tingling in any part of body
47. Twitching of eyelid
48. Twitching other than eyelid
49. Hands tremble or shake
50. Stiff joints
51. Sore muscles
52. Sore throat
53. Sunburn
54. Nausea
iv: Visual Analogue Scale

**How anxious are you feeling right now?**

Please place a cross on the line below that best shows how you are feeling.

---

No anxiety at all

---

Extremely anxious - The worst it has ever been
Appendix E: Ethical Approval
Dear Mr Thompson & Ms Scott

Research Ethics Committee 1
Attentional Bias Modification and Physical Symptom Reporting (ref 13169)

I write to confirm that the amendments to the ethics application form, participant information sheet and advert, and the provision of a correctly formatted version of the photograph comparison document satisfy the concerns of the Committee and that the above project therefore has ethical approval. The committee does require you to include details of who has reviewed the study in your PIS form. Once added, please send a copy to Katy Boyle (katy.boyle@manchester.ac.uk).

The general conditions remain as stated in the letter of 20th September 2013. Finally, I would be grateful if you could complete and return the attached form at the end of the project or by September 2014, whichever is earlier. When completing this form, please reference your project as:

Attentional Bias Modification and Physical Symptom Reporting (ref 13169)

Yours sincerely,

Katy Boyle
Secretary to University Research Ethics Committee
Appendix F: Distress Protocol and Sources of Support
Distress Management Protocol

**For all participants**

Participants will be briefed about the mood induction and reminded of their right to withdraw.

Throughout the research appointment the experimenter will monitor, and be alert to, participants’ responses. The experimenter will debrief all participants at the end of the appointment, and check that participants are ok to leave.

**For participants who appear mildly distressed**

If participants appear to be mildly distressed while viewing the pictures in the mood induction (e.g. turning away from the screen, covering their eyes, orally communicating distress/disgust or other similar responses) the experimenter will ask them ‘are you ok to continue or would you like to stop taking part? It’s completely up to you’.

If the participant replies that they are ok to continue, the experimenter will monitor their distress throughout the remainder of the mood induction and appointment. If their distress increases see section below ‘For participants who appear moderately – extremely distressed’.

If they continue with the study, the experimenter will check that their levels of emotional distress are returning to normal by the end of the appointment.

**If the participant withdraws their consent, the experimenter will:**

- Stop the computer programme immediately
- Manage their emotional distress in a calm and sensitive way
- Apologise that the study has made them feel upset/anxious/distressed
- Normalise the participants’ experience by explaining that the slides are designed to make them feel anxious and uncomfortable and reassure them that other people respond in a similar way
- Ask the participant to wait for five minutes or until they feel their emotional state has returned to normal (if before five minutes is up)
• If the experimenter is then not confident that participants are ok to leave they will follow guidelines below ‘For participants who remain distressed after debriefing and five minute period’

**For participants who appear moderately – extremely distressed but do not withdraw consent**

If participants become overtly distressed (obviously quite agitated, crying or some other adverse emotional reaction that indicates that the participant is extremely distressed) the experimenter will deem that they are too distressed to continue and automatically stop the study. At the same time they will explain that they are stopping the study but will not wait for the participant to withdraw their consent.

If the participant gets up out of their chair and leaves the room, with or without prior indication that they are emotionally distressed, the experimenter will follow them and ask them to wait for five minutes. The experimenter will:

• Manage their emotional distress in a calm and sensitive way
• Reassure them that it is completely within their rights to stop
• Apologise that the mood induction has made them feel upset/anxious/distressed
• Normalise the participants’ experience by explaining that the slides are designed to make them feel anxious and uncomfortable and reassure them that other people respond in a similar way
• Ask the participant to wait for five minutes to ensure emotional state returns to normal
• If the experimenter is then not confident that participant is ok to leave they will follow guidelines below ‘for participants who remain distressed after debriefing and five minute period’

**For participants who do not appear distressed during the mood induction but disclose distress at the end of the study:**

The experimenter will:

• Manage their emotional distress in a calm and sensitive way
• Apologise that the mood induction has made them feel upset/anxious/distressed
• Normalise the participants’ experience by explaining that the slides are designed to make them feel anxious and uncomfortable and reassure them that other people respond in a similar way
• Ask the participant to wait for five minutes to ensure emotional state returns to normal
• If the experimenter is then not confident that participant is ok to leave they will follow guidelines below ‘for participants who remain distressed after debriefing and five minute period’
For participants who remain distressed:
The experimenter will:

- Ask the participant to stay longer until they are feeling better (for up to 10 mins)
- Provide participants with information about how to contact the University Counselling Services.
- Provide participants with the Sources of Support

Any participant who does not complete the mood manipulation:

- Will be followed up one week after their participation in the study.
- Their level of distress and the impact of the mood induction will be assessed.
- This information will be reported back to the supervisory team, who will assess causation of distress and further action.

Payment

The experimenter will offer to pay participants who withdraw their consent to testing during the mood induction the normal sum for participating
POSSIBLE SOURCES OF SUPPORT

Friends and family are often a good source of support so it might be worth approaching them in the first instance.

If you do not feel able to talk to your friends or family, or feel you need additional support, then you might consider contacting:

Your GP, who will be happy to speak to you if you have any concerns about your physical or mental health.

The Samaritans, who have a 24 hour telephone support line (08457 90 90 90). Further information can be found on their website http://www.samaritans.org.uk/

If you feel that the situation is more serious then you can access Crisis Point, a support centre offering a range of services to people in mental health crisis. They can be contacted on 0161 225 9500 or visited at 24 Albert Road, Levenshulme, Manchester, M19 2FP.

In an emergency you can always visit Accident and Emergency or dial 999.