HSE

Health and Safety Executive

Attention, awareness and occupational stress

Prepared by **Liverpool John Moores University**
for the Health and Safety Executive 2008

RR644
Research Report

HSE

Health and Safety Executive

Attention, awareness and occupational stress

Stephen Fairclough
Laura Goodwin
School of Psychology
Liverpool John Moores University
Henry Cotton Campus
Webster Street
Liverpool
L2 3ET

Symptoms associated with occupational stress, such as muscular pain and fatigue, are common in the working population. These types of symptoms have been termed idiopathic; in other words, it is difficult to link these symptoms to a definite physical cause. To complicate matters further, idiopathic symptoms are often associated with psychological variables such as anxiety and depression. Despite these difficulties, idiopathic symptoms represent an important index of occupational health and play an significant role in the decision to seek medical consultation. However, the origins of these symptoms are not well understood particularly with respect to the influence of psychological factors.

This project is primarily concerned with the influence of attentional factors on the perception of idiopathic symptoms associated with occupational stress. Attention is fundamentally goal-driven and selective. We attend to a certain category of stimuli to reinforce existing beliefs. If a person has negative beliefs about health, they are inclined to actively monitor bodily signs and symptoms for evidence of illness. A person who is experiencing an uncomfortable or troubling symptom also tends to direct attention internally to the body, at the expense of attending to events in the external world. By directing attention internally, the person experiences a higher level of body consciousness or awareness.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

HSE Books

First published 2008

Glossary of Terms

Attention to the body	Attention is selective and may be divided between the self (and body) and the external environment. Attention to the body describes the selective allocation of attention to the body at the expense of attention to the outside world.
Body consciousness	Body consciousness describes a trait variable that describes how individuals demonstrate higher or lower levels of awareness with respect to bodily signs and symptoms.
Electrocardiogram (ECG)	The electrocardiogram describes the technique of monitoring the electrical activity of the heart. The ECG is used to quantify heart rate and heart rate variability in the current project.
Interoception	The process of interoception describes how the brain receives information about the state of the body from the autonomic nervous system.
Physiological Sensitivity	Sensitivity to bodily events may be assessed by quantifying bodily activity objectively via physiological measurement whilst asking participants to provide a subjective assessment of the same bodily activity, e.g. asking participants to subjectively estimate heart rate whilst monitoring actual heart rate via an ECG trace.
Trait Negative Affectivity	This is a personality trait that is associated with the tendency to experience negative emotions.

Table of Contents

EXECUTIVE SUMMARY 6
1. INTRODUCTION 8
1.1 THE PROBLEM 8
1.2 BACKGROUND 8
1.3 FACTORS INFLUENCING SYMPTOM PERCEPTION 9
1.3.1 Physiological sensitivity *9*
1.3.2 Gender *10*
1.3.3 Trait negative affectivity *10*
1.3.4 Attention to the body *11*
1.4 AIMS OF THE PROJECT 12
2. INTEROCEPTIVE EXPERIMENT 13
2.1 INTRODUCTION 13
2.2 THEORY 13
2.3 EXPERIMENTAL PROCEDURES 13
2.3.1 Participants *13*
2.3.2 Stress and Relaxation Conditions *13*
2.3.3 Apparatus *14*
2.3.4 Heartbeat Detection Task *14*
2.3.5 Experimental Procedure *14*
2.4 RESULTS 14
2.5 DISCUSSION 16
2.6 CONCLUSIONS 17
3. PILOT STUDY 18
3.1 INTRODUCTION 18
3.2 THEORY 18
3.3 EXPERIMENTAL PROCEDURE 19
3.3.1 Participants *19*
3.3.2 Measures *19*
3.3.3 Procedure *20*
3.4 TRAIT MODEL 20
3.5 LONGITUDINAL RESULTS 22
3.6 DISCUSSION 23

3.7 CONCLUSIONS **25**
4. OCCUPATIONAL SURVEY **26**
4.1 INTRODUCTION **26**
4.2 THEORY **26**
4.3 EXPERIMENTAL PROCEDURES **27**
4.3.1 Participants ***27***
4.3.2 Measures ***28***
4.3.3 Procedure ***29***
4.4 ANALYSIS **29**
4.4.1 Factor Analysis ***30***
4.4.2 Path Analysis Model 1 ***31***
4.4.3 Path Analysis Model 2 ***32***
4.4.4 Path Analysis Model 3 ***32***
4.5 DISCUSSION **34**
4.6 CONCLUSIONS **36**
5. GENERAL DISCUSSION AND CONCLUSIONS **37**
5.1 SUMMARY OF FINDINGS **37**
5.2 THEORETICAL ISSUES **37**
5.3 LIMITATIONS **39**
5.4 FURTHER RESEARCH **40**
5.5 RECOMMENDATIONS **40**
6 REFERENCES **42**

EXECUTIVE SUMMARY

Symptoms associated with occupational stress, such as muscular pain and fatigue, are common in the working population. These types of symptoms have been termed idiopathic; in other words, it is difficult to link these symptoms to a definite physical cause. To complicate matters further, idiopathic symptoms are often associated with psychological variables such as anxiety and depression. Despite these difficulties, idiopathic symptoms represent an important index of occupational health and play an significant role in the decision to seek medical consultation. However, the origins of these symptoms are not well understood particularly with respect to the influence of psychological factors.

This project is primarily concerned with the influence of attentional factors on the perception of idiopathic symptoms associated with occupational stress. Attention is fundamentally goal-driven and selective. We attend to a certain category of stimuli to reinforce existing beliefs. If a person has negative beliefs about health, they are inclined to actively monitor bodily signs and symptoms for evidence of illness. A person who is experiencing an uncomfortable or troubling symptom also tends to direct attention internally to the body, at the expense of attending to events in the external world. By directing attention internally, the person experiences a higher level of body consciousness or awareness.

Attention and awareness of the body influences the perception of symptoms. If a person has negative health beliefs that elevate body consciousness, they tend to report a higher frequency of symptoms compared to the general population. Symptoms of occupational stress, being idiopathic and ambiguous with respect to psychological/physical origins, may be particularly susceptible to this kind of psychological inflation. Also, the bodily experience of occupational stress tends to increase autonomic activity at a physiological level. For example, heart rate and blood pressure may be elevated for a stressed person. The registration of bodily symptoms by the brain is achieved via a neurological process called interoception. It has been argued that stress tends to intensify the experience of bodily signs and symptoms via elevated autonomic activity. Therefore, the experience of occupational stress may amplify symptoms at the physiological as well the psychological level.

To summarise, the experience of occupational stress may inflate symptom perceptions in two ways; (a) the psychological route by creating a negative bias and amplifying symptoms by directing attention to the body, and (b) the physiological route whereby awareness of symptoms is magnified and intensified by elevated autonomic activity.

The role of attention and awareness during the perception of stress-related symptoms was studied via an experiment and a number of survey exercises. The first was a laboratory study to investigate the influence of stress on the physiological process of interoception. This process was studied using a standard protocol known as the heartbeat detection task wherein participants must correctly distinguish between live (accurate) and delayed (inaccurate) aural feedback of the heart rate. It was predicted that exposure to stress would increase participants' accuracy on the heartbeat detection task. It was also assumed that participants who exhibited higher levels of interoceptive sensitivity on this task would report a higher frequency of symptoms (because they had a higher level of awareness of bodily activity). Both hypotheses were not supported by the study; exposure to stress actually diminished performance on the heartbeat detection task for females and we found no evidence for any association between performance on the heartbeat detection task and symptom reporting.

Exposure to a stressful event may inflate symptom perception by directing attention to the self, but stressful events could also have the opposite effect, by distracting attention from the body due to the cognitive stimulation provided by the stressor. This question was explored via a longitudinal study on the influence of naturalistic stress on symptom reporting. Self-rated anxiety and symptom reports were collected from 147 participants over a period of five months, which included a stressful event at the fourth month. Symptom frequency tended to decline throughout the study period. Whilst subjective anxiety rose during the fourth month, there was no evidence for any systematic influence on the frequency of self-reported symptoms.

The main hypothesis explored by the project concerned the influence of individual differences in body consciousness on the perception of stress-related symptoms. It was proposed that high body consciousness would be associated with increased frequency of stress-related symptoms, even after known influences (e.g. gender, negative affectivity, life stress) were controlled. This hypothesis was supported by two surveys: a pilot survey (N=505) and an occupational survey (N=707). The latter included a sophisticated index of body consciousness, which incorporated three factors: (1) awareness of bodily activity, (2) awareness of autonomic reactivity, and (3) negative beliefs about health. It was found that body consciousness tended to increase the frequency of stress-related symptoms, however, there was a strong association between body consciousness and negative affectivity (the tendency to experience negative emotion).

The relationship between occupational stress and body consciousness was explored in the occupational survey. As the experience of occupational stress tends to inflate related symptoms, it was anticipated that individuals with higher body consciousness would be more susceptible to this effect. This survey supported a positive link between occupational stress (job demands) and stress-related symptoms. It was also found that all three factors of body consciousness increased the frequency of stress-related symptoms. Therefore, exposure to occupational stress and high body consciousness increased the frequency of stress-related symptoms, but both effects were independent of one another. There was no evidence that exposure to occupational stress had any influence on body consciousness. The data analysis revealed that the trait of body consciousness was inflated by other factors, such as trait negative affectivity and other life experiences, e.g. health history, life stressors.

The project concluded that psychological characteristics associated with body consciousness represent a significant influence on self-reported symptoms of stress and psychological distress. There was no evidence for any link between stress and self-reported symptoms at a physiological level. Body consciousness was associated with other known influences on self-reported health, such as trait negative affectivity, but this factor also made a unique contribution to prediction of stress-related symptoms. On this basis, it is recommended that body consciousness is an important addition to any comprehensive study of self-reported health to be conducted in the future. It is suggested that trait measures of body consciousness may be used as covariates (to control individual differences) or to split samples into high vs. low body consciousness groups in order to assess the impact of a given stressor across a range of the population.

1. INTRODUCTION

1.1 THE PROBLEM

The experience of physical symptoms is widespread in the general population (Rief et al., 2001). Several common symptoms may be labelled "idiopathic" (Kroenke, 2001) because they have no underlying physical cause. This category covers several physical symptoms that are directly related to occupational stress, e.g. headaches, backache, impaired sleep and decreased energy. Idiopathic symptoms present a particular dilemma for the medical professional due to the strong association between these symptoms and psychological distress (de Waal et al., 2005). This dilemma is also apparent for research seeking to identify the impact of occupational stress on employee health. Idiopathic symptoms represent a confound between physical and psychological factors and begs a question about whether distressed individuals tend to report higher number of symptoms.

Miller et al. (1988) proposed a distinction between people who are "monitors" and "blunters." The former tend to report a higher number of symptoms because they are inclined to attend to internal symptoms and demonstrate higher awareness of body activity. Blunters demonstrate the opposite tendency; when symptoms are apparent, they tend to direct attention elsewhere to distract themselves from thinking about the consequences of their symptoms. This categorisation highlights the role of psychological factors, such as attention to the body, pre-existing beliefs and the awareness of internal symptoms.

These psychological factors may significantly increase the frequency of medical consultations, as symptoms may appear to be more salient or threatening for those who tend to be monitors rather than blunters. Body awareness, attention to the self and health beliefs all represent a source of positive or negative bias for studies that rely on self-reported health data to assess the impact of occupational stress.

1.2 BACKGROUND

The Biomedical model assumes a direct cause-and-effect relationship between illness and symptoms, i.e. symptoms represent underlying physical dysfunction or insult, whereas contemporary approaches take account of psychosocial aspects within the process of symptom perception (Schwartz, 1982). (Kroenke, 2001) found that the prevalence of physical symptoms tends to be inflated in self-report data and underestimated in medical records. (Pennebaker, 1982) has argued that subjective inflation represents the contribution of psychological factors to the process of symptom perception , e.g. beliefs, mood, perceptual/attentional factors (Cioffi, 1991; Cecile M T Gijsbers van Wijk & Kolk, 1996; Kolk et al., 2002, 2003; Leventhal & Leventhal, 1993; Robbins & Kirmayer, 1991).

The process of symptom perception is initiated by the experience and recognition of an uncomfortable or unusual internal sensation that provokes the search for some plausible cause. This initial stage is mediated by two processes: interoception and attention. Interoception describes the detection of physiological change inside the body from a variety of sources, e.g. heart, lungs, (Cameron, 2001; Craig, 2002). Attention is inherently selective and the individual must shift focus from the external environment to the internal 'world' of interoceptive stimuli to register the presence of such sensations. Symptoms that arise internally may include changes in temperature or specific sensations such as hunger pangs or the fullness of the bladder. Information from the viscera may be used to detect symptoms of illness (e.g. nausea) and as a cue for feelings such as anxiety (e.g. "butterflies in the stomach"). This interoceptive process is comparable to a process of self-representation (Churchland, 2002)wherein feedback from the muscles, organs, viscera etc. are relayed up the spinal pathways and represented in the brain. The

interoceptive influence on symptom perception inevitably represents a bottom-up flow of sensory signals via the spinal cord to the somatosensory cortex of the brain.

The psychological 'meaning' of a symptom is determined by the top-down influence of cognitive factors such as beliefs and illness representation. These cognitive factors encompass previous experiences, knowledge and context. For instance, illness hypotheses (based on health history) drive a search for further sensations that reinforce these cognitions and may lead to a worsening of the original symptoms (Pennebaker & Skelton, 1981). It has been proposed that people with hyochondria are particularly vulnerable to this kind of symptom amplification (Barsky & Borus, 1999), where selective attention to particular symptoms appear to confirm the presence of pathology by amplifying the frequency and intensity of those symptoms.

Attention is finite and selective and focus on in a particular area or direction tends to be at the expense of another. It has been proposed that attention directed to the self promotes the recognition of internal change compared to those occasions when attention is externally-oriented to the environment (Kolk et al., 2003). This conflict between "internal" and "external" attention was captured by Pennebaker (1982) who proposed the 'Competition of Cues' hypothesis, wherein internal bodily cues and external cues compete for selective attention. Therefore, a stimulating, rich environment will draw attention away from internal symptoms, whereas exposure to a monotonous environment tends to direct attention inwards to the self (Pennebaker, 1982). The symptom perception model encompasses both "bottom-up" and "top-down" psychological influences to explore the interactions between physiological activity, personality traits and transient factors such as mood and environment.

For a fuller discussion of these issues, see section 1 of Appendix A.

1.3 FACTORS INFLUENCING SYMPTOM PERCEPTION

A number of psychological factors influence the process of symptom perception. These factors may be described in two categories: trait variables (i.e. fixed characteristics of the individual such as gender and personality) and state variables (i.e. relatively transient variables such as mood and mental workload). This section will present background literature on both groups of factors.

1.3.1 Physiological sensitivity

It has been argued that the tendency to report a high number of symptoms reflects sensitivity to interoceptive stimuli at the most fundamental physiological level. In other words, hypersensitivity to symptoms reflects is a product of high interoceptive sensitivity, i.e. people who are highly aware of internal change (Barsky et al., 1988; Pennebaker, 1999). The evidence to support this hypothesis is mixed. A study by Aronson and colleagues (Aronson et al., 2001) found no association between interoceptive accuracy and scores on the somatosensory amplification scale (SSAS) (Barsky et al., 1990), i.e. the SSAS is associated with hypochondriasis and increased symptom reporting. By contrast, a neuropsychological study conducted by Critchley et al (Critchley et al., 2004) reported a positive association between: (a) interoceptive sensitivity and the size of the right anterior insula (i.e. local grey matter volume), and (b) local grey matter volume in the right anterior insula and a subjective measure of body awareness (Porges, 1993).

Physiological reactivity to everyday stress may influence the process of symptom perception by acting directly on levels of activity in the autonomic nervous system. Anxiety and negative affect both have distinct autonomic concomitants (Shapiro et al., 2001), which may raise sensitivity to internal symptoms

and provoke the tendency towards symptom amplification noted by Barsky (Barsky & Borus, 1999) and Pennebaker (Pennebaker, 1999). This causal chain could potentially beget a vicious spiral wherein exposure to stress increases the prominence of internal events, which amplifies the severity and frequency of idiopathic symptoms, and subsequently raises the level of stress experienced by the individual and sensitises the person to symptoms of anxiety.

For a fuller description of physiological mechanisms of interoception, see section 2 of Appendix A.

1.3.2 Gender

Women may be more disposed to focus attention on the symptom and to make judgements about its meaning and the need to take action (e.g. monitors), whereas men are prone to focus attention elsewhere to distract themselves from any bothersome internal symptoms as a means of avoiding to think about the implications of the symptom (e.g. blunters) (Gijsbers van Wijk & Kolk, 1997). There is consistent evidence that women report more symptoms compared to males (Gijsbers van Wijk et al., 1999; Gijsbers van Wijk & Kolk, 1997; Pennebaker, 1982). Roberts and Pennebaker (1995) suggested that women and men use internal (interoceptive) and external (contextual) cues differently during the perception of bodily states (Roberts & Pennebaker, 1995), i.e. women rely more heavily on external cues than men. An alternative explanation concerns the use of different coping strategies by the sexes once a symptom has been detected. The majority of studies that report this gender difference have relied on healthy populations (Gijsbers van Wijk et al., 1999; Popay et al., 1993; Verbrugge, 1989) but this effect has been replicated with patient populations (Kroenke & Spitzer, 1998), even when gynaecologic conditions were excluded from the analysis(Gijsbers van Wijk et al., 1991). There is evidence that the presence of other traits, such as negative affectivity (see below), are implicated in the symptom perception process of females relative to males(Van Diest et al., 2005). Alternatively, gender differences in symptom reporting could represent an artefact of retrospective reporting, i.e. no gender bias was found when symptom frequency was measured prospectively (Kolk et al., 2003). The influence of gender on symptom reporting is discussed in more detail in Appendix A (section 4.1)

1.3.3 Trait negative affectivity

Trait negative affectivity (NA) is a personality trait linked to neuroticism and described as the tendency to perceive negative emotions (see section 4.3 of Appendix A for a fuller definition). It has been found that those with high levels of trait NA are more likely to experience symptoms and to perceive these symptoms as threatening or distressing(Watson & Pennebaker, 1989). There are several reasons why negative emotions tend to inflate symptom perception:

- High trait NA promotes an internal focus of attention as negative emotions have a somatic or physiological component – therefore, symptoms are more likely to be noticed by high NA individuals because attention is internally focused.
- High NA individuals have a tendency to worry about health generally, which prompts an internal focus of attention and a tendency to attribute idiopathic symptoms to a pathological cause (Costa & McCrae, 1985).
- Negative emotions associated with high trait NA may have a detrimental effect on symptom perception via an unhealthy lifestyle (Mayne, 1999), i.e. not eating adequately due to depression and lack of motivation.

Negative affectivity may be measured as a trait variable (representing a stable personality factor) or a state variable (representing transient changes in negative emotion). Kolk et al. (2003) examined the association between both trait and state negative affectivity and symptom reporting. They found that high

trait NA coupled with a low level of mental and social stimulation was significantly associated with negative mood (state NA), and the interaction between trait NA and mood inflated the number of reported symptoms (Kolk et al., 2003).

1.3.4 Attention to the body

Health beliefs provide a context for symptom reporting and direct attention to specific symptoms or particular parts of the body. For example, Pennebaker (1982) conducted an experiment in which half of the participants were told that it was the flu season before a period of exercise. After a period of exercise, those participants in the "flu" group reported more flu symptoms compared to those not provided with this information. Therefore, the manipulation of illness beliefs directly increased symptom reports.

Somatosensory amplification has been defined as "the tendency to experience somatic sensation as intense, noxious and disturbing" (Barsky et al., 1988). Somatosensory amplification involves a heightened focus on relatively weak sensations and a disposition to react to these sensations with negative affect and worry that intensifies the original symptoms (Barsky et al., 1988). Barsky et al. (1988) reported a close association between somatosensory amplification and depression. Two reasons were proposed to explain this relationship: (1) people who are emotionally distressed are more likely to notice and report physical symptoms, and (2) hypersensitivity to physical and psychological symptoms may result in a diagnosis of depression.

Socio-cultural factors and illness beliefs also influence attention to the body and symptom reporting (Barsky & Borus, 1999). Mass psychogenic illness (MPI) occurs when a large group of individuals working in the same environment report the same physical symptoms that have no clear medical basis. It has been suggested that when one person reports symptoms to their colleagues, this report influences the illness beliefs of others who may subsequently experience the same symptoms (Pennebaker, 1994). The phenomenon of MPI demonstrates how proximity to illness may cause a change in illness hypotheses, which may provoke self-directed attention for specific symptoms. A campaign in Leicester requesting the public to be vigilant to pigmented lesions resulted in GP consultations for this condition doubling (Graham-Brown et al., 1990). The opposite effect was found for a public health campaign in Australia advising people on how to deal with back pain, which had the principal message that individuals with back pain should remain active and at work. This resulted in claims for compensation decreasing 15% during the 2-year period when the campaign was running (Bookbinder & Jolly, 2001). These studies can be differentiated in that the first study resulted in a heightened attention to a particular symptom, whereas the second persuaded individuals to be more conservative during the symptom reporting process.

The ability to filter sensory information is necessary because human beings have limited capacity as information processors (Cioffi, 1991) and therefore, only a portion of the available information is consciously processed (Kolk et al., 2002). Miller, Brody et al. (1988) reported that high monitors experienced significantly fewer serious medical problems than low monitors, as quantified by post-visit evaluations to the doctor. However, high monitors reported less improvement in their medical problems (relative to low monitors) indicating that monitors had negative expectations with respect to recovery. The attentional focus of monitors results in the experience of greater symptomatological distress relative to low monitors or blunters, even when medical conditions are rated objectively as equal (S. M. Miller et al., 1988).

A number of scales have been developed to gauge the disposition to focus on internal bodily sensations. The Somatosensory Amplification Scale (SSAS) is a self-report questionnaire that was developed to

measure the amplifying somatic style (Barsky et al., 1990). A potential drawback of the SSAS scale is that scores are correlated with scores on depression scales (Barsky et al., 1990), and a measure of negative emotionality from the Multidimensional Personality Questionnaire Negative Emotionality Subscale (NEM) (Aronson et al., 2001). The Body Consciousness Questionnaire was designed to measure sensitivity to the body and selective attention to internal symptoms, whilst avoiding overlap with hypochondriasis (L. C. Miller et al., 1981). Miller et al. (1981) conducted an experiment in which half of the participants were given caffeine and the control group were given a placebo; those who were high in private body consciousness reported more changes in bodily state than those who were low. The results suggest that individuals who are high in private body consciousness are more aware of their internal state and implying that the Body Consciousness Questionnaire has validity (L. C. Miller et al., 1981). This scale is similar to the Body Perception Questionnaire (Porges, 1993) which includes several factors, including: awareness (to bodily processes), perception of the stress response and autonomic reactivity and stress styles. The awareness factor was correlated with the size of the right anterior insula (Critchley et al, 2004), a structure associated with interoceptive activity.

Attention to the body has a tendency to increase the number of symptoms reported by individuals. The tendency to inflate symptom reports may be due to heightened attention to the body as a response to anxiety that us driven by health beliefs. There is also evidence that personality traits play a role and certain individuals may be predisposed to attend to bodily sensations at the expense of external events. These topics are described in more detail in section 3 of Appendix A.

1.4 AIMS OF THE PROJECT

The aim of the current project is to investigate the influence of body awareness and attention to the body on the perception of health within the context of occupational stress. It is known that symptoms of occupational stress fall into the category of idiopathic symptoms, which are particularly susceptible to the influence of psychological factors such as gender, negative affectivity and attention to the body. In order to investigate this topic, the project will adopt a number of questions or hypotheses to be explored via laboratory experimentation and survey exercises. These hypotheses are as follows:

Can attention to the body be measured in terms of a physiological index? Does this physiological index underpin those psychological factors involved in body awareness and symptom perception? This hypothesis was explored via a laboratory study (section 2).

Do trait measures of body awareness make a significant contribution to the prediction of stress-related symptoms within an occupational context? If so, which aspects of body awareness are important and how can they be measured? This hypothesis was studied via two survey exercises (sections 3 and 4).

How does stress in everyday life influence the perception of stress-related symptoms? When people are exposed to stress, do they tend to over-report the frequency of symptoms? This hypothesis was explored in a longitudinal study (section 3).

2. INTEROCEPTIVE EXPERIMENT

2.1 INTRODUCTION

Interoception describes the perception of symptoms and sensations that originate within the body (Cameron, 2001; Craig, 2002). Interoceptive perception of internal change functions as the first stage in the process of symptom detection (Cacioppo et al., 1989; Cioffi, 1991). If a person is able to accurately assess physiological activity, they are said to possess a high level of interoceptive accuracy. Laboratory-based assessment of interoceptive accuracy typically involves the subjective appraisal of ongoing physiological activity, e.g. sensitivity to temporal characteristics of heart rate (Whitehead et al., 1977). A number of standard protocols have been developed and refined for the measurement of heartbeat detection accuracy (Eichler & Katkin, 1994; Eichler et al., 1987; Katkin et al., 1981); for example, the Whitehead procedure (Whitehead et al., 1977) which requires participants to discriminate between synchronous ('true') and asynchronous ('false') feedback of the heartbeat, presented aurally as a series of tones (Wiens & Palmer, 2001; Yates et al., 1985).

2.2 THEORY

The purpose of this study is to explore whether a physiological mechanism exists to explain individual differences in symptom perception. For instance, if certain individuals possess very accurate perceptions of internal events (i.e. high interoceptive accuracy), do these individuals tend to report higher or lower symptom frequencies on average? It has been argued that high interoceptive accuracy (IA) is associated with hypersensitivity to bodily sensations and a tendency to over-report physical symptoms (Barsky et al., 1988; Pennebaker, 1999), but evidence to support this hypothesis is mixed (Aronson et al., 2001; Critchley et al., 2004). Increased sympathetic activation due to psychological variable, such as stress, may moderate IA by acting directly on the autonomic system.

The goal of the current study is to test this hypothesis by prospectively manipulating levels of stress in a laboratory environment and assessing any subsequent effects on heartbeat detection accuracy. The study will also investigate any possible correlational relationships between heartbeat detection accuracy, individual traits and symptom reporting.

2.3 EXPERIMENTAL PROCEDURES

2.3.1 Participants

Forty participants completed the experiment: 20 males (mean age = 25.3, s.d. = 6.3) and 20 females (mean age = 25.8, s.d. = 4.9). Participants were excluded from the study if they were taking any medication at the time of the experiment or if there was any evidence for: (a) stress-related illness (e.g. peptic ulcer, hypertension), (b) psychological illness (e.g. depression, high anxiety), or (c) cardiovascular illness (e.g. cardiac arrhythmia). All participants received a financial reward for taking part in the study.

2.3.2 Stress and Relaxation Conditions

A laboratory stressor based upon the mental arithmetic task used by Brod (Brod, 1963) was used during the stress condition. Initially, participants received a three-digit number presented on a computer screen (e.g. 517), which they were instructed to summate (e.g. 5+1+7=13) and then add this sum to the original number (e.g. 13+517=530) and verbally report the answer when the "Answer Now" screen appeared six seconds later. The three digits of the new total must then be added together (e.g. 5+3+0=8) and added to the total (e.g. 530+8=538). This cycle was repeated for three minutes' duration. For the relaxation

condition, participants were taught a simple Yogic breathing technique. Participants were instructed to mentally count during inhalation and exhalation, and to progressively extend the duration of inhalation and exhalation over the three-minute duration of the task, i.e. from a count of three during the first minute to a count of five during the final minute.

2.3.3 Apparatus

The ECG was monitored via three electrodes connected to a MP150 BIOPAC system running AcKnowledge 3.8 (BIOPAC Systems Inc) at a sample rate of 1000Hz, with high and low bandpass filters were set at 0.5-35Hz, respectively. Vinyl electrodes were positioned on the seventh intercostal space on the right and left side of the body to measure heart activity. A common ground electrode was placed on the hip on the right side of the body. Participants received aural feedback of each R-peak in the ECG trace via a triggering algorithm in the AcKnowledge software, which produced a tone that was presented binaurally via headphones

2.3.4 Heartbeat Detection Task

Participants listened to ten consecutive tones (i.e. heart beats) during each heartbeat detection trial. At the end of each series of ten tones, they were prompted to indicate in writing whether they believed the series represented their actual heart rate or not. Half of the series were presented as synchronous tones (200ms delay) and the other half were presented as asynchronous tones (500ms delay) (Wiens & Palmer, 2001), providing a 1:1 ratio of 'targets' and 'non-targets.'

2.3.5 Experimental Procedure

Participants attended two counterbalanced sessions (stressor and relaxation) separated by a seven-day interval. At the initial session, the participants signed a consent form and completed the trait questionnaires. The ECG electrodes were attached to each participant who was seated in a comfortable chair, which was physically separated from the experimenter via a screen. The participant was instructed to place their hands on the arms of the chair and to maintain this position when performing the heartbeat detection trials, i.e. to prevent the participant checking his or her own pulse. Each participant received a training session of 12 heartbeat detection trials where no data were collected. Half of the trials contained synchronous tone series and this ratio was maintained throughout all subsequent conditions. The training trials were followed by 24 baseline trials before exposure to the 'experimental trials' where heartbeat detection trials were interspersed with the psychological stressor or relaxation exercise. These experimental trials began with exposure to the stressor/relaxation exercise for three minutes, followed by six heartbeat detection trials (which took approximately two minutes to complete). This sequence was repeated over four cycles, yielding 24 heartbeat trials per experimental condition. Post-test mood scales were completed following the final set of heartbeat detection trials. This procedure was duplicated during the second session.

2.4 RESULTS

The frequency of 'hits' (correct identification of 200ms series as own heart rate) and 'false alarms' (incorrect identification of 500ms series as own heart rate) were calculated for each of the four experimental conditions (baseline_stressor, stressor, baseline_relaxation, relaxation) using the parametric formula: $d'=z(HITS)-z(FA)$ (MacMillan & Creelman, 1991). This formula was used to represent the accuracy of participants' responses, i.e. number of correct responses relative to the number of incorrect responses.

These data were subjected to statistical analysis using an Analysis-Of-Variance procedure (ANOVA). An ANOVA is a test used to discern whether the differences between two or more experimental treatments is

statistically significant. For example, if participants were exposed to three types of safety information (risk of infection, risk of injury, risk of exposure to dangerous chemicals) and subsequently asked to provide subjective ratings of risk to each category, an ANOVA would be used to assess whether subjective risk was higher for one type of safety hazard relative to the other two.

A 2 x 4 repeated-measures ANOVA procedure was performed on accuracy of participants' responses(Gender x Experimental Condition). The analysis of sensitivity (*d'*) revealed no significant main effects between baseline (stressor), stressor, baseline (relaxation) and relaxation manipulation; however, there was an interaction effect between gender and experimental condition [$F(3,36) = 2.87$, $p < 0.05$]. Post-hoc t-tests revealed that interoceptive accuracy was reduced during the stressor condition for female participants compared to baseline_stress ($t = 2.50$, df = 19, $p = 0.02$), baseline_relaxation ($t = 2.15$, df = 19, $p = 0.04$) and relaxation conditions ($t = 2.10$, df = 19, $p = 0.05$); in addition, interoceptive sensitivity was lower for female participants compared to males during the stressor condition ($t = 1.99$, df = 38, $p = 0.05$). Mean values for this analysis are shown in Table 1.

Table 1. Sensitivity (d′) of heartbeat detection performance across all four experimental conditions for: all participants (N=40), males only (N=20), and females only (N=20). Note: higher score = greater accuracy of response to heartbeat detection

	Base_stress	Stress	Base_relax	Relax
All participants	0.48	0.25	0.50	0.51
Males only	0.45	0.50	0.70	0.65
Females only	0.50	-0.05	0.38	0.43

A baseline value of *d'* was calculated using data obtained from both baseline sessions only (i.e. 48 trials in total) and this baseline *d'* was used as a dependent variable. A number of trait variables were selected as possible predictors of heartbeat sensitivity (*d'*); these were: (i) age, (ii) body mass index (BMI) calculated on the basis of height and weight (i.e. there is some evidence that high BMI impairs interoceptive accuracy (Jones, 1995)), (iii) mean inter-beat interval (IBI) from the ECG data (averaged across both baseline conditions also) , (iv) average heart rate variability (HRV) also averaged across both baseline sessions, (v) negative affectivity from the PANAS, (vi) Body Awareness subscale from the BPQ, (vii) the Autonomic Nervous System Reactivity (ANS-R) sub-scale from the BPQ, (viii) Trait Anxiety (TA) from the STAI, (viv) total number of reported physical symptoms from the PILL, and (x) social desirability from the Marlowe-Crowne scale.

These data were subjected to a statistical procedure called multiple regression analysis. This technique has been developed to estimate the predictive value of several independent variables with reference to a specific outcome known as a dependent variable. For example, we have the accident history of a hundred employees of a company, we could collect characteristics from that person as potential predictors of accident involvement, e.g. age, work experience, training, personality. Using multiple regression, we would then use these variables to predict accident involvement and construct a mathematical model of this relationship, e.g. accident involvement = x * *age* + y * experience + etc. The size of the contribution to the predicted outcome is expressed as a standard Beta weighting, i.e. the higher the Beta weighting, the greater the influence of each predictor over the dependent variable.

A multiple regression analysis was conducted on these data to explore associations between interoceptive accuracy (baseline *d'*) and subjective variables. The regression equation was significant [$F(8,31) = 3.09$, $p < 0.01$] and achieved a R^2 of 0.45 (adjusted $R^2 = 0.28$). Three independent variables achieved statistical significance: Body Awareness, Autonomic Reactivity and mean inter-beat interval (IBI). Standard beta weights, t-values and significance levels for all independent variables are shown in Table 1. Autonomic Reactivity and mean inter-beat interval from the ECG both had a positive association with interoceptive accuracy; however, Body Awareness exhibited a negative association with interoceptive accuracy.

Table 2. Results of the multiple regression analysis (N=40)

Independent Variable	Standard Beta	Sig
BMI	0.176	0.26
Body Awareness	-0.369	0.04
Autonomic Reactivity	0.622	<0.01
Marlowe-Crowne	0.050	0.78
Trait NA	-0.216	0.18
Trait Anxiety	-0.273	0.11
Mean Inter-Beat Interval (IBI)	0.352	0.03
Heart Rate Variability	-0.003	0.99
Symptom Frequency (PILL)	-0.016	0.93

2.5 DISCUSSION

The stressor condition failed to significantly improve interoceptive accuracy (IA); in fact, heartbeat detection performance significantly declined for female participants (Table 1). It is possible that reduced IA for female participants was caused by fatigue due to the intense cognitive demand during the previous period, i.e. the Whitehead task requires concentration and exposure to the mathematical stressor may have diminished participants' ability to focus on the heartbeat detection task. However, it is not clear why this factor would specifically degrade the performance of females. There is some evidence in the heartbeat detection literature that males tend to perform at a superior level to females for laboratory tests of IA (Jones, 1995), which raises the possibility that females' heartbeat perception performance may have been more susceptible to cognitive demand/fatigue, but this explanation is pure conjecture. An alternative explanation is suggested by the 'Competition of Cues' hypothesis (Pennebaker, 1999) where the decline of IA observed for females represented an attentional strategy, i.e. to focus on the external environment at the expense of internal cues during a period of stress. This explanation is speculative, but there is

evidence for this type of gender bias with respect to attentional strategies and interoception (Roberts & Pennebaker, 1995).

The multiple regression analysis used a range of dependent variables to predict IA using an aggregated data set based on both baseline sessions (i.e. 48 trials in total). The absence of any statistically significant relationship between IA and symptom frequency (as measured by the PILL in Table 1) failed to directly support the hypersensitivity hypothesis (i.e. high levels of IA are associated with increased frequency of self-reported symptoms) (Barsky et al., 1988; Pennebaker, 1999). This finding weakens the relevance of the hypothesis underlying the stress/relaxation manipulation used in the study, i.e. if IA has no relationship to symptom-reporting, then any variation of interoceptive sensitivity due to stress/anxiety is irrelevant in this respect. Two traits from the Body Perception Questionnaire (BPQ) (Porges, 1993) achieved significance as predictors of IA during the multiple regression: Autonomic Nervous System Reactivity (ANS-R) and Body Awareness (BA) (Table 1). The positive relationship between interoceptive sensitivity and ANS-R was expected, but the negative association between Body Awareness and IA was counterintuitive. Regardless of this issue, the precise relationship of autonomic reactivity to IA is difficult to discern as the ANS-R scale mixed symptoms of ill health (e.g. vomiting, diahorrea, constipation, chest pains) with awareness of non-clinical signs of autonomic reactivity. Therefore, the significant links between IA and traits associated with body perception reported in the current experiment are inconclusive, but merit further investigation

2.6 CONCLUSIONS

The following conclusions may be drawn from this study:

- There was evidence that transient states of stress may degrade interoceptive accuracy for female participants during laboratory testing, which contradicts the main hypothesis of this study (that stress would improve interoceptive sensitivity)
- There was no evidence from this study for a link between interoceptive sensitivity and retrospective symptom-reporting in the laboratory.
- Interoceptive sensitivity seems to have limited relevance for the process of symptom reporting.

3. PILOT STUDY

3.1 INTRODUCTION

A number of individual traits have been associated with increased frequency of idiopathic symptoms. Trait negative affectivity (NA) (see section 1.3.3) and attention to the body (see section 1.3.4) both tend to inflate the frequency of symptom reports. The Private Body Consciousness (PBC) scale (L. C. Miller et al., 1981) was designed to assess the tendency to attend to internal sensations. High scores on the PBC scale were associated with increased symptom reports in both clinical and non-clinical samples (Ahles et al., 1987; Martin et al., 1991), accurate perception of physical changes due to caffeine (L. C. Miller et al., 1981) and illness anxiety in a non-clinical sample (Vervaeke et al., 1999). Whilst high-PBC individuals tend to register internal symptoms, there is no relationship between PBC scores and hypochondriasis (L. C. Miller et al., 1981); the latter is associated with a negative emotional response to internal change, which is captured by the somatosensory amplification scale (SSAS) (Barsky et al., 1988; Barsky et al., 1990).

A number of demographic factors are also associated with increased symptom frequency. It is well-known that females tend to report a higher number of symptoms relative to males (C M T Gijsbers van Wijk & Kolk, 1999; Kolk et al., 2003; Pennebaker, 1999; Van Diest et al., 2005; Watson & Pennebaker, 1989) (see section 1.3.2). In addition, physical symptoms are often reported within the context of a person's health history; hence, chronic disease and medical conditions tend to inflate symptom reports (Epstein et al., 1999).

Psychological distress due to major or minor stressors represents a transient influence on symptom perception. In general terms, life stress or life events (Cropley & Steptoe, 2005) and daily hassles (Stone et al., 1987) tend to increase the frequency of reported symptoms. Stress may exert an influence on symptom reporting via an influence on symptom attribution or by increasing levels of anxiety or depression (Barsky & Borus, 1999); elevated anxiety and depression are known to increase the reporting of somatic symptoms (Haug et al., 2004). The purpose of the pilot study was to assess the relative contributions of trait (i.e. fixed) and state (i.e. transient) variables to the assessment of stress-related symptoms. In addition, participants were asked to report the number of symptoms on a prospective basis over a period of six months, which included at least one period of naturally occurring stress, e.g. examinations. If stress tends to inflate symptom perception, it is anticipated that the frequency of stress-related symptoms will peak during the examination period.

3.2 THEORY

Attention has three characteristics: direction, selectivity and flexibility. When attention is focused inwards on the internal bodily state or feelings, the perception of symptoms is particularly acute. This shift from attention that is focused outwards to the external world to self-focused attention may represent a response to an external event, e.g. failure, a breakdown of a personal relationship, bereavement. Similarly, attention to the self may be minimal when a person is busy or placed within a stimulating environment. Attention is finite and inherently selective, therefore attention will favour internal stimuli at the expense of external stimuli and vice versa. It has been argued that this competition between external environmental stimuli and internal bodily signals exerts a considerable influence on symptom reporting (Cecile M T Gijsbers van Wijk & Kolk, 1996; Pennebaker, 1999; Roberts & Pennebaker, 1995). There is some evidence to support this position, with respect to short-term attentional strategies (Haenen et al., 1996) and the quantity of external information and degree of stimulation offered by the environment

(Cecile M T Gijsbers van Wijk & Kolk, 1996; Kolk et al., 2003), i.e. a stimulating, busy environment tends to shift attention from internal to external stimuli.

Attention may also be modulated by emotional bias. It has been speculated that trait NA may lower the threshold for symptom detection by proactively directing attention inwards leading to somatic hypersensitivity (Deary et al., 1997; Stegen et al., 2001). Alternatively, a negative reporting bias (also associated with trait NA) may exert a retrospective influence on symptom reporting, i.e. many symptom reports are collected on a post-hoc basis and retrospective biases can artificially inflate symptom frequency. A recent study contrasted both explanations (somatic hypersensitivity vs. retrospective bias) and tended to favour the latter hypothesis(Aronson et al., 2006).

3.3 EXPERIMENTAL PROCEDURE

3.3.1 Participants

Participants were recruited from the undergraduate and postgraduate population at a UK University via email. 716 participants responded to an initial invitation to take part in the survey, of whom 505 completed full data sets for analysis. The mean age of the final participant population was 22.63 years old (s.d. = 5.93yrs. range = 18-47yrs.) and participants were predominantly female, i.e. 25.2% of the sample were male. The majority of the sample were single (i.e. 8.3% were married) and represented full-time undergraduates.

3.3.2 Measures.

A list of sixty-six common symptoms was taken from (Gijsbers van Wijk & Kolk, 1996) who originally derived their checklist from the Pennebaker Inventory of Limbic Languidness (PILL) (Pennebaker, 1982) (see Appendix B) and a number of stress-related symptoms were extracted from this list based on previous research and discussions with project officers at HSE. These symptoms are listed in Table 3 below.

Table 3. List of stress-related symptoms

Lump in throat	Upset stomach
Out of breath	Indigestion
Chest pain	Diarrhoea
Racing heart	Constipation
Palpitations	Headaches
Cold sweat	Pressure in the head
Insomnia	Back pain
Fatigue	Twitching eyelid
Dry mouth	Trembling hands
Loss of appetite	

- Symptom frequency was assessed by asking participants to indicate whether they had experienced any of symptoms listed during the previous 14-day period.
- The health history of each participant was assessed by asking each person to indicate any previous incidence of serious illness (i.e. arthritis, hypertension, heart disease, diabetes, epilepsy, cancer, stroke, ulcers, pneumonia), psychiatric illness (i.e. clinical depression, post-partum depression, bulimia, anorexia), and current medical conditions (i.e. migraines, asthma, eczema, back pain, gastric problems, endocrine problems).
- Trait Negative Affectivity (NA) for each participant was assessed using the negative affectivity component of the Positive and Negative Affect Scales (PANAS) (Watson et al., 1988).
- The level of life stress experienced by the participant in previous year was assessed using the Social Readjustment Rating Scale (SRRS) (Holmes & Rahe, 1967).
- The Students Hassles scale was devised by Sarafino & Ewing (1999) and represents the frequency and unpleasantness associated with minor stressors associated with student life.
- The level of psychological distress experienced by each participant was measured using a state version of the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983).
- Attention to the body was assessed by the Private Body Consciousness (PBC) (L. C. Miller et al., 1981). This 5-item scale was designed to measure the tendency to focus on internal bodily sensations. The PBC scale has adequate internal consistency and test-retest validity(L. C. Miller et al., 1981).
- The Somatosensory Amplification Scale (SSAS) (Barsky et al., 1990) was used to measure a tendency towards somatisation and hypochondriasis. The SSAS has good internal consistency and test-retest reliability (Barsky et al., 1990). One of the ten items ('I am quick to sense the hunger contractions in my stomach') was removed from the SSAS for purposes of the current study because this item also appeared on the PBC scale.
- The participants also completed a reduced version of the Autonomic Nervous System Reactivity (ANS-R) sub-scale from the Body Perception Questionnaire (Porges, 1993), i.e. all somatic symptoms were removed from the version used in this study to prevent redundancy with the symptom frequency checklist. The ANS-R scale is concerned with participants' awareness of symptoms of sympathetic activation, e.g. excessive salivation, difficulty coordinating breathing and eating.

3.3.3 Procedure

Participants were recruited by an email that was circulated to the undergraduate population of the University. Once consent was obtained, participants were directed to a website containing all questionnaire materials. Participants were informed that all information would be held securely and anonymously, and cookies would not be used when collecting their data. Participants were asked to complete the questionnaire pack during the first two weeks of each month in February, March, April, May and June in 2006. All undergraduates took their examinations in the first three weeks of May. This protocol for data collection had been approved by the University Ethical Committee.

3.4 TRAIT MODEL

Participants completed a number of trait scales and a checklist of stress-related symptoms during the initial data collection period in February. The mean number of stress-related symptoms reported by participants was 4.44 (s.d. = 3.21) from a maximum of 19 (Table 2). These data were the basis of a cross-sectional analysis to explore the contribution of individual traits to the prediction of stress-related symptoms.

A hierarchical multiple regression was performed on these data. This technique is identical to multiple regression with one important difference; multiple regression creates an equation to describe the relationship between independent variables (predictors) and dependent variables (outcomes) in one stage. Using the hierarchical multiple regression, sub-groups of independent variables are entered in sequential stages and an equation describing their relationship to the dependent variables (outcome) is generated at each stage. This technique is particularly useful for assessing and comparing the predictive values of specific groups of variables. For example, if we wish to predict employee accident rates based on several clusters of predictors such as demographics (age, gender), work experience (years served, level of expertise) and personality traits (extraversion, neuroticism, conscientiousness); we could construct a hierarchical regression to enter demographics as stage one, experience as stage two, and personality traits as the final stage. This analysis allows us to assess and compare the relative contribution of each cluster to the prediction of accident rates.

A hierarchical multiple regression was performed using SPSS v12 to examine the relative influence of several groups of variables on the total number of symptoms reported. The variables were entered in the following order:

Step 1: Gender, Age

Step 2: Health history (frequency of serious illness, medical condition and psychiatric illness)

Step 3: Trait NA

Step 4: Life stress, frequency of student hassles

Step 5: Private Body Consciousness, Somatosensory Amplification, Autonomic Reactivity

The results of the regression analysis are shown below in Table 4. The model successfully explained 28% of the variance associated with stress-related symptoms (adjusted R Square = 0.27). As shown in Table 3, each stage of the model significantly improved the amount of variance explained; health history accounted for 10.4% of the variance alone and trait NA accounted for 7.1% whereas the body awareness factors at step 5 accounted for 3.2%.

Table 4 also includes information regarding the size of the contribution from each indepedent variable or predictor. Both medical condition and psychiatric illness categories of the health history made the most significant contributions at step 2, as did trait NA at step 3. The score for life stress made a greater impact than student hassles during the fourth step of the regression, but both sources of stress were statistically significant. During the final stage of the model, private body consciousness and somatosensory amplification significantly predicted the frequency of stress-related symptoms. In all cases of statistical significance, the weighting factors were positive, i.e. all variables increased the frequency of symptoms.

Table 4. Predictors of stress-related symptoms in the final step in the multiple regression model

Independent Variables	Std Beta	Sig.	R^2 change	Model R^2
Gender	0.06	0.15		
Age	0.07	0.08	.019	.019
Serious Illness	-0.01	0.84		
Medical Condition	0.16	<0.01		
Psychiatric Illness	0.16	<0.01	0.104	0.123
Trait NA	0.17	<0.01	.071	.195
Life Events	0.18	<0.01		
Student Hassles	0.09	0.05	0.05	0.244
PBC	0.11	<0.01		
ANS-R	0.03	0.46		
SSA	0.11	0.02	0.032	0.276

3.5 LONGITUDINAL RESULTS

A sub-group of the original participant population (N=147) completed the stress symptom report checklist and the HADS during the first two weeks of the five months from February to June 2006. This period is significant in the academic calendar as all undergraduate students undergo examinations in May. The purpose of this data collection was to investigate how exposure to a naturalistic stressor influenced the perception of stress-related symptoms. Repeated-measures ANOVA was performed on the symptom frequency data collected between February and June. It was anticipated that stress-related symptoms would peak during the examination period in May. The ANOVA revealed a significant effect of month [$F(4,143) = 36.36$, $p < 0.01$]. Post-hoc Bonferroni tests revealed that symptom frequency was highest during February compared to all other months ($p < 0.05$).

It was also found that symptom frequency during June was significantly lower than February, March and April ($p < 0.05$). The same ANOVA analysis was also conducted on the Anxiety component of the HADS over the same period. The purpose of this analysis was to assess whether participants' level of anxiety was significantly influenced by the presence of examinations in May. This ANOVA model was also significant [$F(4,143) = 46.43$, $p < 0.01$]. Post-hoc testing revealed that HADS anxiety was significantly reduced in the month of June compared to all other months. Mean values for both symptom frequency and HADS anxiety are illustrated in Figure 1.

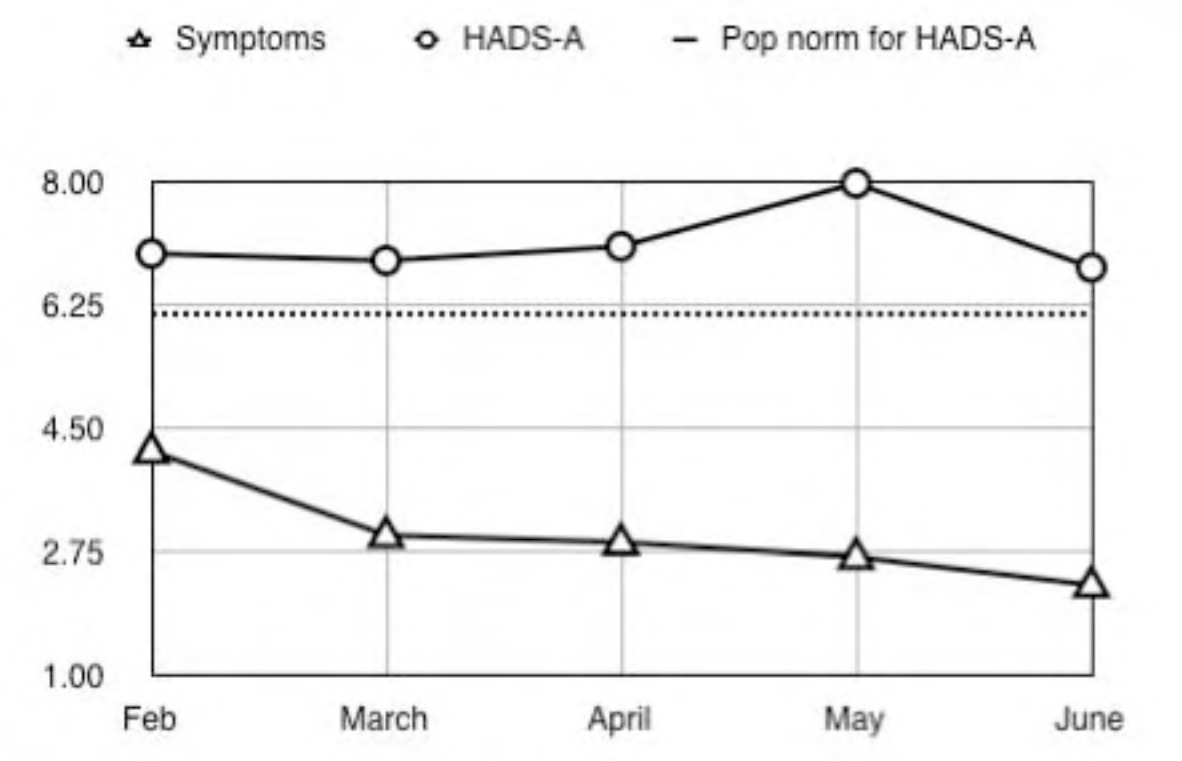


Figure 1. Mean frequency of stress-related symptoms and mean HADS Anxiety score over five consecutive months including the May examinations for undergraduate students (N=147). This chart contains the mean value for HADS-A from a large (N=1792) non-clinical sample for illustrative purposes (Crawford et al., 2001).

3.6 DISCUSSION

The trait analysis (section 3.4) was performed to assess the relative contribution of body awareness traits and naturalistic stress on the perception of stress-related symptoms. According to this analysis, previous experience of psychiatric illness and medical conditions explained the greatest proportion of the variance (Table 4). The most common sub-category of the former was clinical depression whereas migraine headaches were the most frequently cited category of medical condition. This finding was not surprising as depression has a somatic component and symptoms of migraine headaches overlapped with specific stress-related symptoms, e.g. pressure in head, headaches (Table 2).

Trait NA accounted for 7% of the variance and the experience of stress (both life events and hassles) predicted 5% of the variance. These findings underscore the significance of negative affectivity, particularly for retrospective questionnaires where a negative memory bias may be in operation (Aronson et al., 2006). The two measures of body awareness that significantly contributed to the prediction of symptoms (Private Body Consciousness and Somatosensory Amplification) only explained just over 3% of the variance. The influence of health history and life stress were expected given the nature of the symptoms (Table 2), however the trait model demonstrates that trait NA and body awareness both significantly increase the frequency of stress-related symptoms.

One purpose of the pilot trial was to demonstrate the relevance of body awareness traits before proceeding to a survey using an occupational sample. However, the range of variables used in the pilot trial may require expansion as (a) only 28% of the variance associated with stress-related symptoms was explained by the trait model, and (b) both Private Body Consciousness and Somatonsensory Amplification focus on sensitivity to somatic sensations and did not include any cognitive variables that influence body awareness such as health beliefs. The pilot study also demonstrated a degree of overlap between trait NA and measures of body awareness, which is important to address in the occupational survey.

The longitudinal analysis (section 3.5) was performed to explore competing hypotheses regarding how naturalistic stress may influence stress-related symptoms. The somatic hypersensitivity hypothesis (Deary et al., 1997; Stegen et al., 2001) predicts that stress-related symptoms would peak with the psychological experience of anxiety. In this case, the experience of examination stress would increase sympathetic activation at an autonomic level, rendering symptoms more salient and conspicuous relative to less stressful periods. The competition of cues hypothesis (Cecile M T Gijsbers van Wijk & Kolk, 1996; Pennebaker, 1999; Roberts & Pennebaker, 1995) argues that attention is selective and finite, and therefore, a stimulating environment would distract attention from the self – resulting in lower levels of body awareness and reduced symptom reports.

The analysis of anxiety from the HADS (Figure 1) showed the predicted trend over the period of five months, e.g. anxiety peaks during May (the examination period) and declines in June (the post-examination period). However, the experience of stress-related symptoms bore no relationship to this trend (Figure 2); participants reported the highest frequency of symptoms during the initial data collection in February, which steadily declined through the remaining months and reached a nadir in June. This pattern cannot be explained by either somatic hypersensitivity or competition of cues hypotheses. There is no evidence for any significant peak or decline of symptom frequency during the examination period. Furthermore, the frequency of stress-related symptoms continues to decline in the post-examination month of June. The trend of symptom frequency suggests a methodological problem with repeated health surveys over a relatively short period. For example, participants respond enthusiastically and liberally during the initial period of data collection and become either more reluctant or more conservative during each successive administration.

3.7 CONCLUSIONS

The following conclusions may be drawn from this pilot study:

- Trait measures of body awareness inflate the reporting of stress-related symptoms even when known influences (e.g. trait NA, life stress, experience of illness) have been controlled.
- Exposure to naturalistic stress had no discernible influence on the frequency of stress-reported symptoms during the longitudinal study.

4. OCCUPATIONAL SURVEY

4.1 INTRODUCTION

Many symptoms of stress-related illness fall into the "idiopathic" zone between physical causes and psychological distress (de Waal et al., 2005). Characteristic symptoms of stress-related illness, such as headaches, fatigue and back pain, are common in the general population (Rief et al., 2001) and may be attributed to multiple causes. These symptoms will be tolerated by the majority of people, but as their base rate in the population is so high, idiopathic symptoms account for a substantial proportion of medical consultations (Kirmayer et al., 2004) with an associated cost for the health care service (Shaw & Creed, 1991).

Attention to the body is important in two respects for the perception of idiopathic symptoms. The division of attention between the self and the outside world determines the salience of these symptoms, i.e. whether the symptom enters conscious awareness. This 'splitting' of attention is captured by Miller's (1988) dichotomy between 'monitors' and 'blunters.' On an anecdotal level, one would equate a 'monitoring' style with hypochondria, however true hypochondriacs combine the self-focused attention with negative health beliefs and a negative emotional response (Barsky et al., 1990). This type of person is extremely susceptible to idiopathic symptoms, which may often be attributed to potentially serious illnesses and often contain an element of psychological distress.

The influence of stress on idiopathic symptoms represents an additional complication to this picture. Exposure to stress may impact on symptom perception in several ways: (1) amplifying physiological events to make internal symptoms more salient, (2) creating a negative bias in beliefs and expectations, which translates into a style of self-focus, where symptoms are presumed to be detrimental for long-term health, and (3) the practical demands associated with a stressor (such as increased mental workload) may act as an external source of distraction promoting a 'blunting' style of reduced self-focus.

The first study on this project (section 2) found no evidence to support the first hypothesis, e.g. laboratory-induced stress actually hinders the perception of internal bodily activity for female participants. The pilot study (section 3) painted a mixed picture. On one hand, examination stress had no discernible influence on the frequency of stress-related symptoms on a longitudinal basis. However, exposure to stressful life events and everyday hassles, resulted in an increased frequency of stress-related symptoms on a cross-sectional basis. One goal of the occupational survey is to investigate how body awareness contributes to the perception of stress-related symptoms within the context of occupational stress

The primary purpose of the occupational survey is to quantify the contribution of body awareness traits to the reporting of stress-related symptoms. If body awareness biases people in terms of over- or under-reporting symptoms of stress, it would be useful to determine the size of this bias - relative to known amplifiers of poor health such as negative affectivity and illness history.

4.2 THEORY

The occupational survey represents several advancements over the pilot survey reported in the previous section. The pilot survey used three measures of body awareness (Private Body Consciousness, Somatosensory Amplification, Autonomic Reactivity) whereas the occupational survey will introduce two additional measures: (1) Body Awareness – this questionnaire is the main companion to the Autonomic Reactivity scale; it is derived from Porges' (1988) Body Perception Questionnaire, and is describes sensitivity to specific bodily signs and internal symptoms, and (2) the Health Anxiety scale to index

negative beliefs about health and the likelihood of serious illness (Salkovskis et al., 2002). The pilot survey revealed significant correlations between the three body awareness scales, and therefore, a factor analysis will be performed on the five questionnaires used in the current survey in order to achieve orthogonal factors and to reduce the number of scales.

The pilot survey quantified stress using the life events checklist and a measure of everyday hassles. This survey is concerned with occupational health and includes a validated measure of occupational stress – the Job Content Questionnaire (JCQ) (Karasek et al., 1998). The Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983) was used in the pilot survey to index psychological distress through a longitudinal data collection period. We propose to use measures of body awareness to predict the total HADS score (i.e. psychological distress) in addition to symptom frequency in the current survey. This decision was prompted by the large overlap between stress-related symptoms and psychological distress.

4.3 EXPERIMENTAL PROCEDURES

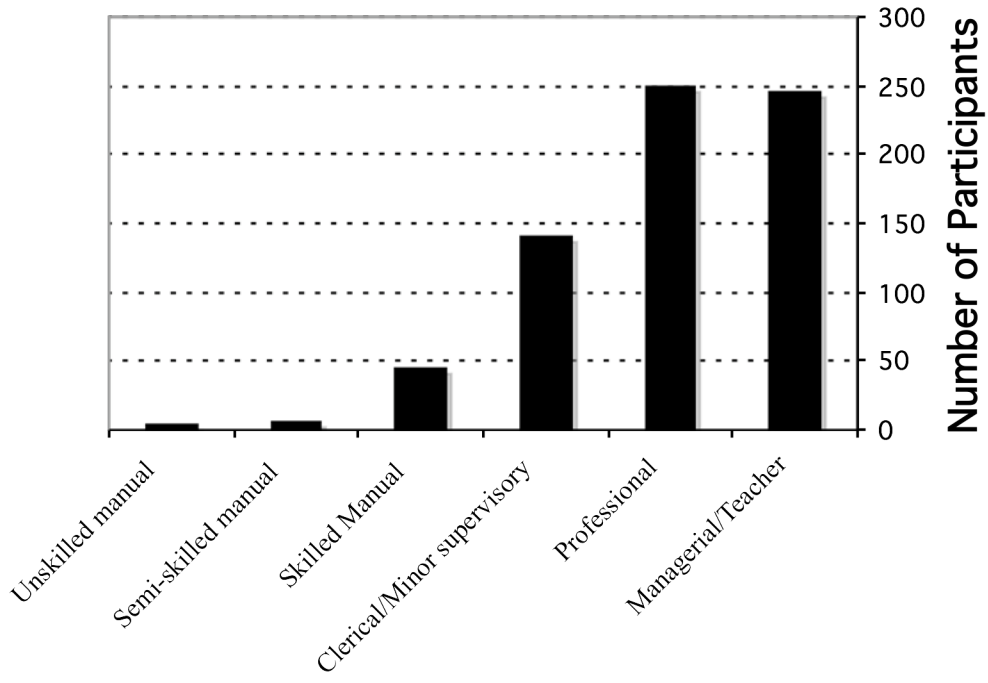
4.3.1 Participants

707 participants completed the survey. Multivariate outliers were excluded before analysis, which reduced the final number of participants to 689. The mean age of the participant population was 42 years old (s.d. = 10.86 yrs., range = 21 – 66 yrs.) and participants were predominantly female, i.e. 34.5% of the sample was male. In terms of ethnic origin, 92% of the sample was White British and a further 4.6% of the sample described themselves as "White – other background." 56.3% of the sample was married and a further 18.1% were living with their partner; the remaining participants lived alone. 48% had dependents (either children or adults) and 34.3% were currently taking medication (a full listing of medications and frequency is provided in Appendix C).

Respondents were asked to categorise their occupation into one of six categories: managerial/teacher, professional, clerical/minor supervisory, skilled manual, semi-skilled manual, and unskilled manual. The frequencies of responses falling into each category are represented in Figure 2.

The majority of the sample categorised themselves as either 'Professional' or 'Managerial/Teacher.' This was unsurprising as a number of teachers' trade union representatives had circulated details of the survey amongst their members. On average, respondents were full-time employed, working an average of 36.7 hours per week (s.d. = 10.42 hrs., range = 5-96 hrs.) and a minority were shift workers (12.2%).

Figure 2. Distribution of participants through six occupational categories (N=689).



4.3.2 Measures

- Symptom frequency was assessed by asking participants to indicate whether they had experienced any stress-related symptom (Table 2) *at the moment*, e.g. a non-retrospective assessment.
- The level of psychological distress experienced by each participant was measured using a state version of the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983).
- The health history of each participant was assessed by asking each person to indicate any previous incidence of serious illness (e.g. cancer, heart disease), current medical conditions (e.g. eczema, migraine headaches), and chronic medical conditions (e.g. arthritis, hypertension). A full listing of all health history items, their categorisation and frequency is provided in Appendix D.
- Trait Negative Affectivity (NA) for each participant was assessed using the negative affectivity component of the Positive and Negative Affect Scales (PANAS) (Watson et al., 1988).
- The level of life stress experienced by the participant in previous year was assessed using the Social Readjustment Rating Scale (SRRS) (Holmes & Rahe, 1967).
- Attention to the body was assessed by the Private Body Consciousness (PBC) (L. C. Miller et al., 1981). The Somatosensory Amplification Scale (SSAS) (Barsky et al., 1990) was used to measure a tendency towards somatisation and hypochondriasis. One of the ten items ('I am quick to sense the hunger contractions in my stomach') was removed from the SSAS for purposes of the

current study because this item also appeared on the PBC scale. The participants also completed reduced versions of the Body Awareness (BA) and Autonomic Nervous System Reactivity (ANS-R) sub-scale from the Body Perception Questionnaire (Porges, 1993), i.e. all items pertaining to stress-related symptoms were removed to avoid any redundancy.

- Beliefs about health were captured via the Health Anxiety Inventory(Salkovskis et al., 2002).
- Occupational stress was measured using the Job Content Questionnaire (JCQ) (Karasek et al., 1998); four components of occupational stress were measured in this version of the JCQ: job demands (i.e. level of mental workload), decision latitude (i.e. level of skill discretion and autonomy), supervisor support (i.e. practical and emotional support from line manager) and co-worker support (i.e. practical and emotional support from peers).

4.3.3 Procedure

Participants were largely recruited by email and magazine advertisements with the assistance of Health and Safety representatives from major trade union bodies. Once consent was obtained, participants were directed to a website containing all questionnaire materials. Participants were informed that all information would be held securely and anonymously, and cookies would not be used when collecting their data. Participants were asked to complete the questionnaire pack during January and June 2007. This protocol for data collection had been approved by the University Ethical Committee.

4.4 ANALYSIS

The purpose of this analysis was to quantify the relationship between job-related stress, body awareness and occupational illness, e.g. stress-related symptoms, psychological distress. It is assumed that body awareness will act as a moderator of health-related outcomes, i.e. body awareness influences the strength of the relationship between job-related stress and occupational illness.

The analysis was conducted via two stages. In the first instance, all body awareness variables were subjected to factor analysis. This statistical technique has been developed to identify redundancy between related measures and to reduce these data by developing higher-level factors. For example, imagine one wished to reduce the number of measures associated with employee health and safety (perceived health, absenteeism, body mass index, alcohol intake per week, accident record, perceived adherence to safe practices, perceived importance of protective clothing). A factor analysis may produce two orthogonal (i.e. independent) factors; a health factor composed of perceived health, absenteeism, body mass index, alcohol intake, and a safety factor calculated on the basis of the remaining variables. It is also possible to ascribe a score on each factor to each participant using this technique. Hence, seven original variables have been reduced to two measures.

The second phase of the analysis was a path analysis. This technique is based upon linear modelling methods used for multiple regression. A path analysis allows the researcher to construct a spatial model of relations between key variables and then to test 'the goodness of fit' between this spatial model and actual data. For example, we may assume that both work-related stress and family-related stress both contribute to negative emotion and sickness-related absence. We could construct a model wherein work-related stress contributes to negative emotion and absenteeism, and family stress predicts both work-related stress and negative emotion. A path analysis would allow us to test how accurately the relationships described within this model match the pattern of relations within the actual data.

The path analysis model was designed to predict two outcomes: stress-related symptoms and psychological distress (as measured by the total HADS score, which combined anxiety and depression). The path analyses were conducted in three stages. The rationale for this analysis was to begin with a 'minimal' model containing the smallest number of predictors for both outcomes, and to subsequently add additional predictors through the following two stages to reach a final 'complex' model. The predictors included in each phase of the path analysis were as follows:

1. Job Demands, Decision Latitude, Supervisor Support, Co-Worker Support
2. Body Awareness factors
3. Gender, Age, Trait Negative Affectivity, Health History, Life Events

The rationale behind this approach was to begin with a simple model describing the relationship between occupational stress and both outcomes, and then to explore the additional predictive value of adding all subsequent variables.

4.4.1 Factor Analysis

Five trait variables associated with body awareness were entered into a factor analysis, these were: Private Body Consciousness, Somatosensory Amplification, Health Anxiety, Body Awareness and Autonomic Nervous System Reactivity (see section 3.3.2). The factor analysis revealed a four-factor solution. The full-rotated component matrix is shown in Appendix E and summarised in Table 5. A number of points should be noted: (a) the four-factor solution accounts for 40% of the variance associated with all available data, (b) Factor 1 is associated with specific bodily sensations from the Body Awareness scale, (c) Factor 2 is loaded with items from the Health Anxiety scale reflecting health concerns and worries about serious illness, (d) items from the Autonomic Nervous System Reactivity scale loaded on Factor 3, and (e) Factor 4 represents 'general' statements about body awareness from the Private Body Consciousness and Somatonsensory Amplification scales.

Table 5. Summary of the Factor Analysis

	Items with Highest Weighting Scores	% Variance
Factor 1	- Urge to defecate - Urge to urinate - Fullness of bladder	10.57
Factor 2	- Afraid of serious illness - Difficulty taking mind off health-related thoughts - Difficult to think of anything else in presence of unexplained bodily sensation	4.59
Factor 3	- I have difficulty coordinating breathing and eating - When I eat, I am difficulty coordinating swallowing/chewing with breathing - I have trouble focusing when I go into dim or brightly illuminated places	3.15
Factor 4	- I am sensitive to internal bodily sensations - I'm very aware of changes in my body temperature - I am often aware of various things happening within my body	2.54

4.4.2 Path Analysis Model 1

The purpose of the path analyses was to predict two outcomes (stress-related symptoms and psychological distress) based on a number of predictors. Participants in the occupational survey reported an average of 5.25 symptoms (s.d. = 3.23) and the mean HADS score was 14.03 (s.d. = 7.25).

The first model used four factors from the JCQ (psychological job demands, decision latitude, supervisor support, co-worker support) to predict the frequency of stress-related symptoms (Table 2) and psychological distress (total score from both HADS components, representing both anxiety and depression). This path model produced an adequate fit to the data, using both the discrepancy measure [$|^2$ = 7.11, df = 5, $\underline{p}$ = 0.21] and other indicators of model fit: Tucker-Lewis Index = 0.986, Goodness-Of-Fit = 0.996, Adjusted Goodness-Of-Fit = 0.984. The first model is illustrated in Appendix F; note a criterion of $p<0.01$ was used to assess statistical significance and only paths with a weighting factor of 0.10 or above are included in the diagram.

The four components of the JCQ successfully predicted 26% of the variance associated with stress-related symptoms and 16% of the variance associated with HADS. However, there was a considerable amount of overlap between HADS and stress-related symptoms, i.e. a path weight of 0.47 represents approximately 20% overlapping variance. In terms of prediction, a low level of supervisor support predicted the frequency of stress-related symptoms, whilst the HADS component was positively predicted by the level of psychological job demands and negatively predicted by decision latitude and co-worker support, i.e.

low levels of decision latitude and co-worker support are associated with increased psychological distress. The model also revealed a degree of inter-dependence between the JCQ components.

4.4.3 Path Analysis Model 2

The second version of the model supplemented the first by adding the four body awareness/attention (Table 5) to the JCQ components as potential predictors. This path model provided an adequate fit to the data, using both the discrepancy measure [$|^2$ = 25.31, df = 19, $\underline{p}$ = 0.15] and other indicators of model fit: Tucker-Lewis Index = 0.980, Goodness-Of-Fit = 0.992, Adjusted Goodness-Of-Fit = 0.977. This second version of the model is illustrated in Appendix F; once again, only paths with a weighting factor of 0.10 or above are included in the diagram.

In the second version of the path model, the amount of variance associated with psychological distress has increased dramatically, i.e. from 16% in the first model to 40%. This increase is due to the influence of Factor 2 (negative beliefs about health) in combination with Factor 3 (autonomic reactivity) and Factor 4 (general body awareness). The amount of variance associated with stress-related symptoms does not increase to the same extent, but all four body awareness factors make significant contributions to this outcome, and the link between HADS and symptoms has been substantially reduced relative to the first model.

In the second version of the model, psychological job demands from the JCQ contributes to both stress symptoms and total HADS score, i.e. this variable only contributed to the latter in the first version. These interactions indicate that both decision latitude and supervisor support had influences on frequency of stress symptoms, which were mediated by the attentional variables. Therefore, those individuals reporting the above aspects of their job positively had reduced body awareness and reported a lower frequency of stress symptoms.

4.4.4 Path Analysis Model 3

The final version of the model added several ‘general’ trait factors believed to influence both the perception of health and body awareness: gender, age, trait negative affectivity and health history (i.e. frequency of medical conditions and serious illnesses), as well as life events (to index non-occupational sources of stress). This path model provided an adequate fit to the data using the discrepancy measure [$|^2$ = 58.8, df = 57, $\underline{p}$ = 0.14]. Other indicators of model fit were also lower than those reported for previous versions of the model: Tucker-Lewis Index = 0.985, Goodness-Of-Fit = 0.986, Adjusted Goodness-Of-Fit = 0.970. This model is illustrated in Figure 3.

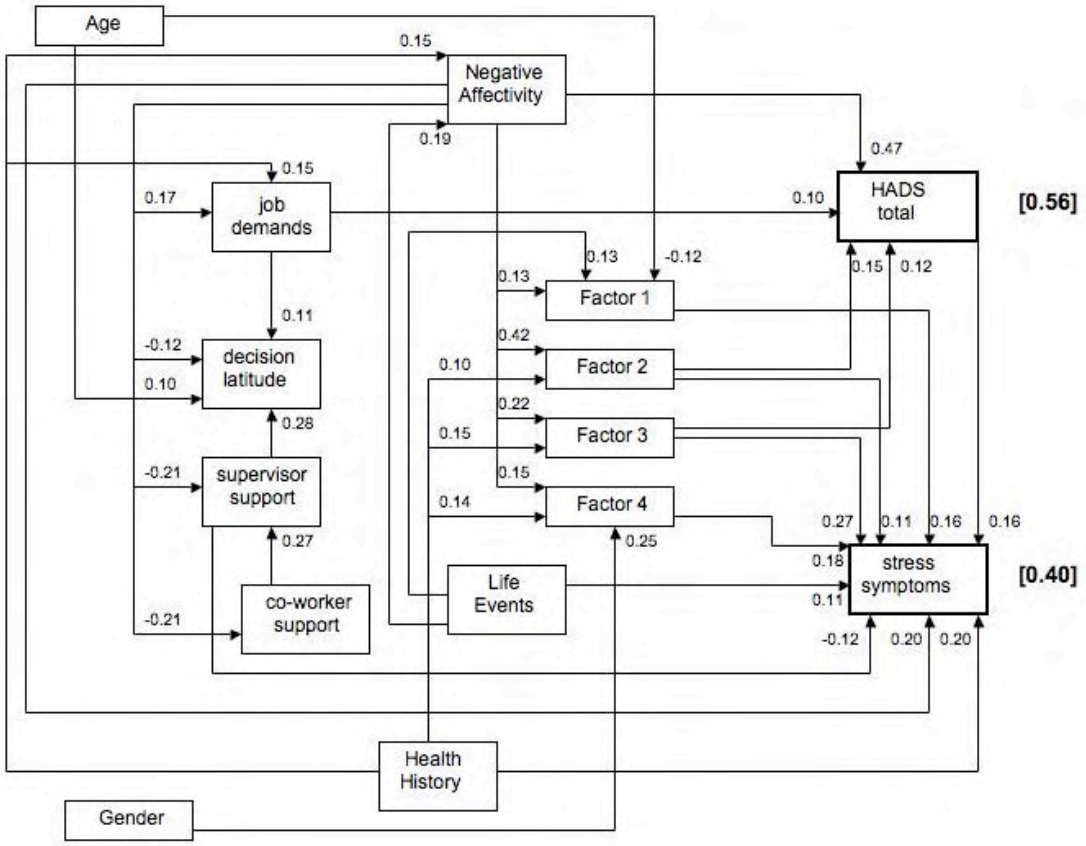


Figure 3. Final version of the path model using JCQ components in combination with body awareness factors and trait negative affectivity and health history to predict stress-related symptoms and psychological distress (N=689)

This final version of the model clearly illustrates the pervasive influence of both trait negative affectivity and health history on almost every other variable. Trait negative affectivity has a significant influence on all four body awareness factors (particularly Factor 2 - negative beliefs about health) and all components of the JCQ. Health history is similarly associated with all body awareness factors, with the exception of Factor 1 (awareness of specific bodily sensations), as well as trait negative affectivity and job demands. In addition, trait negative affectivity had a direct influence on both psychological distress and stress-related symptoms, whilst health history provided a direct path to stress-related symptoms.

It was noted that life stress contributed positively to trait NA and Factor 1 (awareness of specific bodily symptoms) as well as stress-related symptoms. The predictive validity of the model benefited from the inclusion of the additional trait variables, particularly in the case of HADS. Age has a positive influence on decision latitude from the JCQ and a negative influence on Factor 1, i.e. older members of the sample were less aware of specific bodily sensations compared to younger participants.

The only influence of gender was on Factor 4 (general awareness), i.e. females reported higher values for Factor 4. In terms of the influence of occupational stress, the significant path between job demands and

stress-related symptoms found in the second model has disappeared in this final version, leaving the influence of supervisor support on stress-related symptoms as the only significant path.

A comparison between all three versions of the path model is summarised in Table 6 below. It should be noted that the addition of variables at each stage improved the predictive validity of each model, i.e. R^2 values showed an incremental increase with each version of the model. Therefore, the final model predicted approximately 40% of the variance associated with symptoms and 56% of the variance associated with psychological distress, as represented by the total HADS score.

Table 6. Summary of the Path Analysis Models

	Stress Symptoms		Total HADS	
	R^2	top predictor	R^2	top predictor
model 1	0.26	supervisor support	0.16	job demands
model 2	0.32	F3 (autonomic reactivity)	0.40	F2 (negative health beliefs)
model 3	0.40	F3 (autonomic reactivity)	0.56	Negative Affectivity

4.5 DISCUSSION

The factor analysis demonstrated the reliability of the original questionnaires; Body Awareness, Health Anxiety and Autonomic Reactivity loaded primarily on Factors 1, 2 and 3 respectively, whereas Factor 4 represented a merging of Private Body Consciousness with Somatosensory Amplification (see Appendix E). Factor 1,3 and 4 were concerned with awareness of the body or attention to bodily sensations whilst Factor 2 represented negative beliefs about health and the probability of serious illness. In essence, Factor 2 provides a motivation for the three body awareness factors, i.e. negative beliefs about health tend to direct attention to internal bodily sensations and amplify body awareness. Factor 1 was concerned with awareness of non-pathological bodily events (e.g. fullness of bladder, urge to urinate) whereas Factor 4 merged the neutral character of the Private Body Consciousness Scale (e.g. I am sensitive to internal bodily sensations) with more neurotic aspects of self-monitoring represented by the Somatosensory Amplification Scale (e.g. I hate to be too hot or too cold). For the purpose of the current report, it would be accurate to say that Factor 1 provided an index of body awareness via specific bodily sensations whereas Factor 4 captured awareness of the body by the use of relatively general statements.

The three path models (Table 6, Figure 3 & Appendix F) are best discussed in terms of the transitions between each version of the model. It was noted that the prediction of both outcomes (stress-related symptoms and psychological distress) was substantially improved by the addition of the four 'body awareness' factors. All four body awareness factors significantly increased the frequency of stress-related symptoms, and three of the four factors significantly increased the total HADS score (Factor 1 being the

exception in this case). The contrast between model 1 and model 2 demonstrated that people with higher levels of body awareness and negative beliefs about health reported increased symptom frequency and higher level of psychological distress. This effect was achieved in addition to the expected influence of occupational stress on outcome measures, i.e. the influence of JCQ components on symptoms and distress.

The final model represented an attempt to place the influence of the four body awareness factors into a broader context that included known influences, such as trait NA, health history and life stress. This path model (Figure 3) demonstrated the pervasive influence of trait Negative Affectivity (NA) on both outcome variables as well as the four body awareness factors and the JCQ components. A bias towards negative emotion represents a powerful influence on all self-reported variables related to job stress, health and body awareness. This was particularly apparent for the HADS score, i.e. the level of overlapping variance between trait NA and HADS was over 30% (Figure 3). The health history of the individual tended to inflate the number of reported symptoms as expected. Previous experience of illness also increased three of the four body awareness factors (negative beliefs, autonomic reactivity, general body awareness). This finding supports the commonsense hypothesis that attention to the body and negative health beliefs may represent a learned response to previous experience of illness, i.e. individuals who suffer from a number of health complaints are highly sensitive to the presence of symptoms. As expected, life stress (i.e. number of stressful life events in the past year) increased the frequency of symptoms and scores on the trait NA scale (Figure 3). Previous exposure to life stress also had a positive influence on Factor 1 (awareness of specific bodily sensations); this finding suggests that life stress may amplify sensitivity to bodily sensations, which in turn, increases the number of stress-related symptoms reported by an individual.

The inclusion of trait NA, health history and life stress tended to sharpen the influence of the four body awareness factors on both outcome variables. Factor 1 (specific bodily awareness) and Factor 3 (general bodily awareness) had a positive influence on the frequency of stress-related symptoms, but not on psychological distress. Factors 2 (health beliefs) and 4 (autonomic reactivity) had positive paths to both psychological distress and stress-related symptoms, although this link was notably stronger in the case of Factor 4 (Figure 3). These findings support the view that body awareness traits increase the frequency of stress-related symptoms, whereas the negative health beliefs influence both symptoms and distress, even in the presence of other known influences.

The transition from model 1 to model 3 saw a waning of influence for the JCQ components that represent occupational stress. In the final model, psychological job demands increased the HADS score whilst a high level of supervisor support reduced the frequency of stress-related symptoms. There was no evidence of any interaction between occupational stress and body awareness in the final model (Figure 3), which suggests that those paths that were significant in the second model (Appendix F) represented the pervasive influence of trait NA. Therefore, body awareness traits are not amplified or reduced in the presence of occupational stress, although both fall under the common influence of trait NA, and to a lesser extent, health history (which had a positive effect on job demands as well as body awareness factors).

It should also be noted that the high overlap between psychological distress and stress-related symptoms that was apparent in the first model had largely dissipated by the final model (Figure 6). This trend indicated that the addition of the body awareness factors, trait NA, life stress and health history provided the final model with greater discriminative power – to separate the different influences on stress-related symptoms and psychological distress.

4.6 CONCLUSIONS

The conclusions of the occupational survey are as follows:

- Body awareness factors appear to make a significant contribution to the prediction of both stress-related symptoms and psychological distress and all weighting factors were positive. Therefore, increased body awareness inflates both symptom frequency and distress.
- The factor analysis indicates that body awareness is measured as a combination of attention to the body and negative beliefs about health.
- Trait negative affectivity represents a negative reporting style that was associated with increased body awareness and higher estimates of occupational stress.
- Body awareness does not interact with occupational stress when trait negative affectivity is included in the model. There was some evidence that experience of life stress tended to increase body awareness.

5. GENERAL DISCUSSION AND CONCLUSIONS

5.1 SUMMARY OF FINDINGS

The project focused on three central hypotheses to explain how awareness and attention to the body influenced stress-related symptom perception.

The first hypothesis was physiologically-based and concerned whether the perception of bodily activity in a laboratory had any bearing on the topic of investigation. The laboratory study described in section 2 found no evidence that people who were objectively sensitive to 'normal' physiological activity reported more symptoms than those less sensitive. Therefore, psychological factors appear to dominate the process symptom perception, and that interoceptive accuracy (i.e. objective physiological accuracy of normal bodily activity) has limited relevance for this process.

The second hypothesis was based upon an assumption that people with higher body awareness reported a higher frequency of stress-related symptoms. This hypothesis was supported by the pilot survey (section 3) and occupational survey (section 4). Data from the occupational survey demonstrated that body awareness factors boosted the prediction of stress-related symptoms by approx. 6% and psychological distress by approx. 24% once all other variables had been controlled.

The aim of the longitudinal study (section 3) was to explore the third hypothesis – does exposure to stress inflate attention to the body, which in turn, increases the reported frequency of stress-related symptoms. The longitudinal study found no evidence for either increase or decrease of stress-related symptoms during a period of naturalistic stress despite elevated levels of subjective anxiety during the same period. The absence of any interaction between body awareness and occupational stress was confirmed in section 4, which found no evidence that the effects of occupational stress on health were enhanced for those individuals with high body awareness (when trait negative affectivity was included in the model).

5.2 THEORETICAL ISSUES

The conceptualisation of body awareness passed through several stages of development during the project. The four-factor analysis used in the occupational survey produced the most sophisticated conception of attention and awareness to the body. Two of the four factors were concerned with body awareness either in a general sense or with respect to specific bodily sensations (Table 5). Both body awareness factors had positive links to the number of self-reported stress symptoms but did not contribute to psychological distress (Figure 3); hence, the influence of body awareness was specific to symptom perception. The third factor measured awareness of non-clinical symptoms of autonomic reactivity, e.g. excessive salivation. This factor contributed to both psychological distress and the number of stress-related symptoms, which was not surprising as the autonomic reactivity scale incorporated excessive sympathetic activation and the experience of anxiety. The health beliefs factor lay outside of a strict concept of body awareness; this factor was included to acknowledge an implicit hypothesis that attention is goal-directed. In other words, negative beliefs about health promote attention to the body as part of a broader search for illness-related symptoms.

The final conceptualisation of body attention/awareness used in the occupational survey is based three contributory factors: attention to the body, autonomic reactivity, and negative beliefs about health. This survey revealed that all factors were influenced by trait negative affectivity (NA). This path of influence was expected with respect to negative beliefs about health and autonomic reactivity, as both are related to the experience of anxiety. The link between trait NA and body awareness was not entirely unexpected (Gendolla et al., 2005) but is difficult to explain. This finding suggests that the somatic component of negative emotional experiences may promote body awareness in a general sense (Damasio, 1999). The health history variable used in the occupational survey (Figure 3) represented individuals' experience of illness and existing medical conditions. This experience informed negative health beliefs, autonomic reactivity and general awareness, as well as negative affectivity. By contrast, the body awareness factor (Factor 1 - awareness of specific bodily signs) was not influenced by the experience of illness, but increased in response to life stress and declined with age. The amplification of body awareness (Factor 1) by life stress was interesting but we found no evidence for any similar relationship between occupational stress and body awareness. Finally, it was apparent that females had higher ratings for general body awareness factor (Factor 4); this link may reflect greater body awareness in a general sense for women due to exposure to physiological variability introduced by the menstrual cycle (Pennebaker, 1982; Roberts & Pennebaker, 1995).

The broad concept of body awareness was associated with negative emotional responses, experience of illness, exposure to life stress and gender. The inclusive character of body awareness begs a question of circularity, i.e. are we simply measuring the same concept in several different ways? The hierarchical character of the analyses performed in sections 3 and 4 suggests not. In both cases, body awareness contributed a unique and statistically significant proportion of the variance to the prediction of stress-related symptoms. The pervasive influence of trait negative affectivity on symptom reporting has been attributed to a negative retrospective reporting bias (Aronson et al., 2006), but in the case of the occupational survey, participants were asked only to report symptoms that were present at that moment. Trait negative affectivity seemed to reflect a ubiquitous negative reporting style, which influenced the assessment of occupational stress as well as health outcomes (Figure 6), but could not account for all individual variation.

It was anticipated that exposure to occupational stress would promote body awareness by amplifying those idiopathic symptoms associated with stress, i.e. the hypersensitivity hypothesis. The links between occupational stress and body awareness were present during the modelling exercise (Figure 5), but disappeared from the final model (Figure 3). It would appear that the interaction between occupational stress and body awareness was due to a common source of variance – trait negative affectivity and the tendency towards a negative reporting style . It was also significant that the experience of life stress in the past twelve months had no influence on estimates of occupational stress, suggesting that participants perceived both sources of stress from home and the office as separate and distinct from one another.

Both survey exercises confirmed that high awareness of bodily sensations inflated the frequency of stress-related symptoms. This begs a question concerning the authenticity of these symptoms; do monitors and blunters respectively over- and under-report the presence of symptoms during medical consultations and survey exercises? To answer this question, it is necessary to draw a satisfactory distinction between "real" and "reported" symptoms – therefore, we may say that sensitive individuals report a higher number of symptoms relative to those that were actually present. This distinction between "real" and "reported" symptoms is feasible for symptoms that may be verified objectively; for example, an ECG trace may be taken to diagnose a fast, irregular heartbeat, feelings of breathlessness may be confirmed by a pulse oximeter reading. However, many stress-related symptoms fall into a category that is resistant to this kind of objective quantification. The idiopathic character of stress symptoms is problematic from the

biomedical perspective. According to this view, there are "real" symptoms representing physical insult or pathology, which are "distorted" by psychological beliefs and attentional biases underpinning the perception of the body. These idiopathic symptoms fall into a nebulous area within this framework and the problem for stress researchers (as well as sufferers) is that the influence of those psychological factors central to the current project (e.g. mood, beliefs, attention, awareness) is typically dismissed as illusory and detrimental to the "objective" process of diagnosis. This perspective is particularly unhelpful when considering stress-related symptoms, which may legitimately originate from psychological distress or physiological dysfunction or some combination of both. The association between the psychologically based variables and stress symptom reporting in the models supports these links between negative mood, stress and the perception of stress symptoms, but does not undermine the symptom experience for the individual. Therefore, the distinction between "real" and "reported" symptoms within the context of stress-related illness is difficult to resolve; it is suggested that understanding the causal paths of influence (as attempted via the modelling exercise in Section 4) is more meaningful than attempting an objective validation of idiopathic symptoms.

5.3 LIMITATIONS

There are a number of limitations and caveats on the research presented in the current report, which provide an important context for the interpretation of data. With the exception of the laboratory experiment, data collection was based exclusively on subjective self-reported variables. This factor may have inflated the role of trait negative affectivity, which reflects a negative reporting style. In addition, reliance on self-report is a limitation on some of symptoms reported by our participants and it would have been preferable to have measures of health that had at least been verified by behaviour (e.g. seeking medical consultation) or by a medically-qualified person. The other important limitation of the survey work was that participants were self-selected for inclusion. Therefore, we have reason to suspect some bias in the participant sampling. Evidence for this bias was provided by a number of atypical findings. For example, males exhibited higher levels of HADS-Depression compared to females in the pilot survey (section 3). This finding contradicts previous research and suggests that our male participants in the pilot survey were uncharacteristic of the male population. Similarly, the average for the total HADS score obtained during our occupational survey was 14.03; this score is almost one standard deviation higher than the population norm of 9.82 for this score (Crawford et al., 2001). Therefore, we are forced to conclude that a self-selection bias was in operation, whereby those workers who currently experienced higher levels of psychological distress were inclined to take part in the survey.

The analysis of both survey exercises was designed to predict health-related outcomes based on a number of psychological variables and related demographics. The final path model for the occupational survey (Figure 3) predicted approx. 56% of psychological distress and 40% of stress-related symptoms. This level of prediction is highly significant from a statistical perspective but it also an inevitable question about which variables *were not* included that could have explained the remaining 44% of distress and 60% of symptoms. In the progression from a pilot survey to the occupational survey, several variables were considered and not included that may have been important. A short list is provided below:

Social support (a high quality of social support should reduce symptom frequency and psychological distress)

Home-work interface (this factor falls between stressors from the home and from the workplace; it may function as an independent stressor in its own right).

Effort-Reward Imbalance (it was decided to use the JCQ to represent occupational stress, but this questionnaire does not capture this important facet of stress in the workplace)

5.4 FURTHER RESEARCH

A number of possibilities for future research based upon the current project are listed below:

Verifiable outcomes: the current project was limited to self-report variables as health outcomes, e.g. symptoms, distress. To understand how body attention/negative health beliefs impact on health in more substantive terms, it is necessary to assess these variables with reference to objective outcomes such as number of medical consultations and absenteeism. It would be especially useful to assess the impact of body awareness on medically verified symptoms vs. self-reported symptoms.

Longitudinal research: the cross-sectional survey work on the project demonstrated how stressful life events in the previous year and experience of illness had a substantial influence on body awareness as well as increasing self-reported symptoms and trait negative affectivity. This hypothesis should be explored on a longitudinal basis over a period of years. It is important to understand how the origin of stress-related symptoms and psychological distress with respect to life stress, illness and occupational stress. This study did not reveal the anticipated links between stressful life events and occupational stress reports but a cumulative effect may increase the association.

Symptom attribution: clear symptoms of illness are easy to detect and attribute, e.g. runny nose and sore throat = common cold, whereas idiopathic symptoms are difficult to accurately attribute to a known source. This uncertainty inflates the significance of these symptoms as they may be attributed to serious illness, particularly for people with a history of such illnesses. It would be useful to investigate the relationship between symptom attribution and attention to the body in order to understand the process of 'learned sensitivity' works.

Body awareness and suggestibility: information about health and illness is available from a range of public media and it may be argued that people with high body attention and negative health beliefs may be more susceptible to the influence of media. This hypothesis could be explored by understanding how suggestibility interacts with body awareness and investigating the size of this potential bias in the general population.

Body awareness and occupational stress: This study provided limited support for an interaction between occupational variables and body awareness, however, a longitudinal study may reveal levels of body awareness to vary as work related stress increases. Decision latitude at work and supervisor support were identified as outcomes to be targeted.

5.5 RECOMMENDATIONS

The conclusions from this project carry a number of recommendations for future studies that rely on self-reported survey data in this field. The project has demonstrated that: (a) body awareness and negative beliefs increase the frequency of stress symptoms and psychological distress, and (b) this relationship was independent of the relationship between occupational stress and symptoms of stress/psychological distress. On this basis, researchers may adopt two broad strategies in future studies.

- To regard body awareness as an undesirable confound and 'extract' the influence of this variable using a covariate analysis.
- Measure body awareness and use it in order to gauge the impact of a stressor or intervention across the range of the population.

The problem of separating "real" from "reported" symptoms of occupational stress is entrenched because stress-related illness has not been medicalised with sufficient clarity. This problem is aggravated by a methodological emphasis on self-report data and the degree of convergence associated with these types of data. The path analyses in Section 4 represent an attempt to express this convergence whilst considering the unique influence of each variable. A more crude and relatively artificial approach would be to treat

certain variables as covariates and use regression analysis to partition out the influence of these variables. Hence, a multiple regression analysis could be run using trait NA and body awareness as dependent variables to predict the frequency of stress-related symptoms; the residual scores from this analysis would provide a measure of "real" stress-related symptoms from which the influence of trait NA and body awareness has been subtracted.

The body awareness factors and negative beliefs about health may also be used to measure the degree of 'vulnerability' to over-reporting within a given population. Hence, the presence of a stressor, such as the threat of redundancy, may have its greatest impact on the health of 'monitors' relative to 'blunters'. The researcher could use individual differences with respect to body awareness to dichotomise the population, and therefore, to represent the impact of a stressor on health as a range rather than an averaged score, i.e. to demonstrate 'best case' and 'worst case' scenarios. In order to do so, the researcher would use a body awareness score to partition his population into high vs. low groups and assess the size of the experimental effect for each sub-population. The same approach may be used to assess the impact of a stress intervention. In this case, we would expect the benefits of an intervention to be more prominent for 'monitors' relative to 'blunters.'

In practical terms, if one wished to replicate the four body awareness factors from the occupational sample in future studies, the factor analysis (summarised in Table 5 and listed in Appendix E) provides guidance regarding those influential items that represent each factor. These items may be incorporated into future surveys to provide abbreviated versions of the body awareness factors used in the occupational survey.

REFERENCES

Ahles, T. A., Cassens, H. L., & Stalling, R. B. (1987). Private body consciousness, anxiety and the perception of pain. Journal of Behavioural Therapy & Experimental Psychiatry, 18(3), 215-222.

Aronson, K. R., Feldman Barrett, L., & Quigley, K. S. (2001). Feeling your body or feeling badly: Evidence for the limited validity of the somatosensory amplification scale as an index of somatic sensitivity. Journal of Psychosomatic Research, 51(1), 387-394.

Aronson, K. R., Feldman Barrett, L., & Quigley, K. S. (2006). Emotional reactivity and the over-report of somatic symptoms: Somatic sensitivity or negative reporting style? Journal of Psychosomatic Research, 60, 521-530.

Barsky, A. J., & Borus, J. F. (1999). Functional somatic syndromes. Annals of Internal Medicine, 130, 910-921.

Barsky, A. J., Goodson, J. D., Lane, R. S., & Cleary, P. D. (1988). The amplification of somatic symptoms. Psychosomatic Medicine, 50, 510-519.

Barsky, A. J., Wyshak, G., & Klerman, G. L. (1990). The somatosensory amplification scale and its relationship to hypochondriasis. Journal of Psychiatric Research, 24(4), 323-334.

Bookbinder, R., & Jolly, D. (2001). Population based interventions to change back pain and disability: Three part evaluation. BMJ, 322, 1516-1520.

Brod, J. (1963). Hemodynamic basis of acute pressor reactions and hypertension. British Heart Journal, 25, 227-245.

Cacioppo, J. T., Andersen, B. L., Turnquist, D. C., & Tassinary, L. G. (1989). Psychophysiological comparison theory: On the experience, description, and assessment of signs and symptoms. Patient Education and Counseling, 13, 257-270.

Cameron, O. G. (2001). Interoception: The inside story - a model for psychosomatic processes. Psychosomatic Medicine, 63, 697-710.

Churchland, P. S. (2002). Self-representation in nervous systems. Science, 296, 308-310.

Cioffi, D. (1991). Beyond attentional strategies: A cognitive-perceptual model of somatic interpretation. Psychological Bulletin, 109(1), 25-41.

Costa, P. T., & McCrae, R. R. (1985). Hypochondriasis, neuroticism, and ageing: When are somatic complaints unfounded? American Psychologist, 40, 19-28.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. Nature Reviews: Neuroscience, 3, 655-666.

Crawford, J. R., Henry, J. D., Crombie, C., & Taylor, E. P. (2001). Normative data for the hads from a large non-clinical sample. British Journal of Clinical Psychology, 40, 429-434.

Critchley, H. D., Wiens, S., Rotshtein, P., Ohman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. Nature Neuroscience, 7, 189-195.

Cropley, M., & Steptoe, A. (2005). Social support, life events and physical symptoms: A prospective study of chronic and recent life stress in men and women. Psychology, Health and Medicine, 10(4), 317-325.

Damasio, A. R. (1999). The feeling of what happens: Body and emotion in the making of consciousness. New York: Harcourt Brace.

de Waal, M. W. M., Arnold, I. A., Spinhoven, P., Eekhof, J. A. H., & van Hemert, A. M. (2005). The reporting of specific physical symptoms for mental distress in general practice. Journal of Psychosomatic Research, 59, 89-95.

Deary, I. J., Scott, S., & Wilson, J. A. (1997). Neuroticism, alexithymia and medically unexplained symptoms. Personality and Individual Differences, 22, 551-564.

Eichler, S., & Katkin, E. S. (1994). The relationship between cardiovascular reactivity and heartbeat detection. Psychophysiology, 31, 229-234.

Eichler, S., Katkin, E. S., Blascovich, J., & Kelsey, R. M. (1987). Cardiodynamic factors in heartbeat detection and the experience of emotion. Psychophysiology, 24, 587.

Epstein, R. M., Quill, T. E., & McWhinney, I. R. (1999). Somatization reconsidered: Incorporating the patient's experience of illness. Archives of Internal Medicine, 159(3), 215-222.

Gendolla, G. H. E., Abele, A. E., Andrei, A., Spurk, D., & Richter, M. (2005). Negative mood, self-focused attention and the experience of physical symptoms: The joint impact hypothesis. Emotion, 5(2), 131-144.

Gijsbers van Wijk, C. M. T., & Kolk, A. M. (1996). Psychometric evaluation of symptom perception related measures. Personality and Individual Differences, 20(1), 55-70.

Gijsbers van Wijk, C. M. T., & Kolk, A. M. (1999). Gender differences in physical symptoms and illness behaviour. A health diary study. Social Science and Medicine, 49, 1061-1074.

Gijsbers van Wijk, C. M. T., & Kolk, A. M. (1997). Sex differences in physical symptoms: The contribution of symptom perception theory. Social Science & Medicine, 45(2), 231-246.

Gijsbers van Wijk, C. M. T., Kolk, A. M., & Everaerd, W. T. A. M. (1991). Symptom sensitivity and sex differences in physical morbidity: A review of health surveys in the u.S.A. And the netherlands. Women and Health, 12, 103-145.

Graham-Brown, R. A. C., Osborne, J. O., London, S. P., Fletcher, A. P., Shaw, D., Williams, D., et al. (1990). The initial effects of workload and outcome of a public education campaign on early diagnosis and treatment of malignant melanoma in Leicestershire. British Journal of Rheumatology, 122, 53-59.

Haenen, M. A., Schmidt, A. J. M., Kroeze, S., & van den Hout, M. A. (1996). Hypochondriasis and symptom reporting - the effect of attention and distraction. Psychotherapy and Psychosomatics, 65, 43-48.

Haug, T. T., Mykletun, A., & Dahl, A. A. (2004). The association between anxiety, depression and somatic symptoms in a large population: The hunt-ii study. Psychosomatic Medicine, 66, 845-851.

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. Journal of Psychosomatic Research, 11, 213-218.

Jones, G. E. (1995). Constitutional and physiological factors in heartbeat perception. In D. Vaitl & R. Schandry (Eds.), From the heart to the brain: The psychophysiology of circulation-brain interaction (pp. 173-192). Frankfurt: Peter Lang.

Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P., & Amick, B. (1998). The job content questionnaire (jcq): An instrument for internationally comparative assessments of psychosocial job characteristics. Journal of Occupational Health Psychology, 3(4), 322-355.

Katkin, E. S., Blascovich, J., & Goldband, S. (1981). Empirical assessment of visceral self-perception: Individual and sex differences in the acquisition of heartbeat discrimination. Journal of Personality and Social Psychology, 40(6), 1095-1101.

Kirmayer, L. J., Groleau, D., Looper, K. J., & Dao, M. (2004). Explaining medically unexplained symptoms. Canadian Journal of Psychiatry, 49, 663-672.

Kolk, A. M., Hanewald, G. J. F. P., Schagen, S., & Gijsbers van Wijk, C. M. T. (2002). Predicting medically unexplained physical symptoms and health care utilization. A symptom-perception approach. Journal of Psychosomatic Research, 52, 35-44.

Kolk, A. M., Hanewald, G. J. F. P., Schagen, S., & Gijsbers van Wijk, C. M. T. (2003). A symptom perception approach to common physical symptoms. Social Science & Medicine, 57, 2343-2354.

Kroenke, K. (2001). Studying symptoms: Sampling and measurement issues. Annals of Internal Medicine, 134, 844-853.

Leventhal, H., & Leventhal, E. A. (1993). Affect, cognition and symptom perception. In C. R. Chapman & K. M. Foley (Eds.), Current and emerging issues in cancer pain: Research and practice (pp. 153-173). New York: Raven Press.

MacMillan, N. A., & Creelman, C. D. (1991). Detection theory: A user's guide. New York: Cambridge University Press.

Martin, J. B., Ahles, T. A., & Jeffrey, R. (1991). The role of private body consciousness and anxiety in the report of somatic symptoms during magnetic resonance imaging. Journal of Behavioural Therapy & Experimental Psychiatry, 22(1), 3-7.

Mayne, T. J. (1999). Negative affect and health: The importance of being earnest. Cognition and Emotion, 13(5), 601-635.

Miller, L. C., Murphy, R., & Buss, A. H. (1981). Consciousness of the body: Private and public. Journal of Personality and Social Psychology, 41(2), 397-406.

Miller, S. M., Brody, D. S., & Summerton, J. (1988). Styles of coping with threat: Implications for health. Journal of Personality and Social Psychology, 52, 345-353.

Pennebaker, J. W., & Skelton, J. A. (1981). Selective monitoring of physical sensations. Journal of Personality and Social Psychology, 41(2), 213-223.

Pennebaker, J. W. (1982). The psychology of physical symptoms. New York: Springer-Verlag.

Pennebaker, J. W. (1999). Psychological factors influencing the reporting of physical symptoms. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. S. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), The science of self-report: Implications for research and practice (pp. 299-316). Mahwah, NJ: Erlbaum.

Popay, J., Bartley, M., & Owen, C. (1993). Gender inequalities in health: Social position, affective disorders and minor physical morbidity. Social Science & Medicine, 1, 21-32.

Porges, S. W. (1993). Body perception questionnaire: Laboratory of Developmental Assessment

University of Maryland.

Rief, W., Hessel, A., & Braehler, E. (2001). Somatization symptoms and hypochondriacal features in the general population. Psychosomatic Medicine, 63, 595-602.

Robbins, J. M., & Kirmayer, L. J. (1991). Attributions of common somatic symptoms. Psychological Medicine, 21, 1029-1045.

Roberts, T. A., & Pennebaker, J. W. (1995). Gender differences in perceiving internal state: Towards a his-and-hers model of perceptual cue use. In M. Zanna (Ed.), Advances in experimental social psychology (Vol. 27, pp. 143-176). New York: Academic Press.

Salkovskis, P. M., Rimes, K. A., Warwick, H. M., & Clark, D. M. (2002). The health anxiety inventory: Development and validation of scales for the measurement of health anxiety and hypochondriasis. Psychological Medicine, 32(5), 843-853.

Sarafino, E. P., & Ewing, M. (1999). The hassles assessment scale for students in college: Measuring the frequency and unpleasantness of and dwelling on stressful events. Journal of American College Health, 48(2), 758-753.

Schwartz, G. (1982). Testing the biopsychosocial model: The ultimate challenge facing behavioural medicine. Journal of Consulting and Clinical Psychology, 50, 1040-1053.

Shapiro, D. A., Jamner, L. D., Goldstein, I. B., & Delfino, R. J. (2001). Striking a chord: Moods, blood pressure and heart rate in everyday life. Psychophysiology, 38, 197-204.

Shaw, J., & Creed, F. (1991). The cost of somatization. Journal of Psychosomatic Research, 35, 307-312.

Stegen, K., Van Diest, I., Van de Woestijne, K. P., & Van den Bergh, O. (2001). Do persons with negative affect have an attentional bias to bodily sensations? Cognition and Emotion, 15(6), 813-829.

Stone, A. A., Reed, B. R., & Neale, J. M. (1987). Chnages in daily event frequency precede episodes of physical symptoms. Journal of Human Stress, 13(2), 70-74.

Van Diest, I., De Peuter, S., Ertmans, A., Bogaerts, K., Victoir, A., & Van den Bergh, O. (2005). Negative affectivity and enhanced symptom reports: Differentiating between symptoms in men and women. Social Science & Medicine, 61, 1835-1845.

Vervaeke, G. A. C., Bouman, T. K., & Valmaggia, L. R. (1999). Attentional correlates of illness anxiety in a non-clinical sample. Psychotherapy and Psychosomatics, 68(1), 22-25.

Verbrugge, L. M. (1989). The twain meet: Empirical explanations of sex differences in health and mortality. Journal of Health and Social Behaviour, 30, 282-304.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The panas scales. Journal of Personality and Social Psychology, 54(6), 1063-1070.

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress and disease: Exploring the central role of negative affectivity. Psychological Review, 234-254.

Whitehead, W. E., Drescher, V. M., Heiman, P., & Blackwell, B. (1977). Relation of heart rate control to heartbeat perception. Biofeedback and Self-Regulation, 2, 371-392.

Wiens, S., & Palmer, S. N. (2001). Quadratic trend analysis and hearbeat detection. Biological Psychology, 58, 159-175.

Yates, A. J., Jones, K. E., Marie, G., & Hogben, J. (1985). Detection of the heartbeat and events in the cardiac cycle. Psychophysiology, 22, 561-567.

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. Acta Psychiatr Scand, 67, 361-3.

APPENDIX A

Literature Review on Attention, Awareness and Occupational Stress

Laura Goodwin & Stephen Fairclough

School of Psychology

Liverpool John Moores University

Deliverable for Workpackage 1

1. SYMPTOM PERCEPTION

The process of symptom perception represents a bridge between physiological activity and psychological appraisal. Physical symptoms often associated with illness (e.g. headache, muscle pain, nausea, congestion) originate from physiological variation and these changes are perceived, labelled and acted upon in the psychological domain. The process of symptom perception is influenced by many factors, such as the perception of physiological activity (interoception), attention (selective bias) and existing beliefs about health and illness. The interaction between physiological activity and psychological appraisal introduces an element of ambiguity to data interpretation; it is difficult to ascertain whether self-reported symptoms accurately represent physiological feedback or merely reflect awareness and attention to physiological activity. The key question for research is: do symptom reports present an accurate index of physiological disturbance or merely reflect a distorted perception of normal physiological activity?

1.1 BIOMEDICAL MODEL VS. COGNITIVE-PERCEPTUAL MODEL

The Biomedical model assumes that a direct cause-and-effect relationship exists between illness and symptoms, whilst contemporary approaches take full account of psychosocial aspects of illness and the fact that symptom reporting is a subjective process (Schwartz, 1982). The biomedical model assumes that each illness has a specific group of identifiable symptoms that may be used to distinguish one condition from another. It has been argued that this model provides a poor explanation for many health problems because it undervalues psychosocial issues (Schwartz, 1982). The Cognitive-Perceptual model represents an example of a modern theory that encompasses both medical and psychosocial perspectives (Cioffi, 1991). This model emphasises the role of perception and attentional processing on symptom assessment, and the fact that perceived somatic change may not always indicate actual change.

The process of symptom perception will determine not only the interpretation of symptoms but attributions and future coping strategies, e.g. talking to friends about symptoms, visiting the doctor, or ignoring symptoms. Individual reactions to the same symptom can vary and common symptoms, such as headache and fatigue, which are not generally indicative of specific illness, can be interpreted as pathological if one is hypervigilant to internal signs of illness. Therefore, the process of symptom reporting can represent an accurate perception of physiological disturbance, or a distorted perception of normal physiological functioning.

According to Cioffi (1991), once an internal sensation is recognised, the search for a cause begins. If the change in physical state (e.g. cold hands) can be interpreted as an appropriate physiological response to the environment, e.g. cold hands in the snow, then interpretation and formulation of an appropriate behavioural response (e.g. put on gloves) is straightforward. However, where no feasible explanation for the physiological change exists, then a physiological signal may be assumed to be symptomatological (Cioffi, 1991). This process of symptom awareness is mediated by the direction of attention and the process of interoception. Intense, rapid-onset symptoms, such as those sensations associated with sudden pain, will force themselves onto consciousness, whereas the detection of subtle, low-intensity symptoms is dependent on selective attention. Attention is inherently selective and the individual must shift their focus from the external environment to the internal 'world' of sensory stimuli to register the existence of certain physical stimuli. Interoception was originally derived to describe awareness of visceral sensations, but recent conceptions have broadened the concept to include the detection of physiological change inside the body from a variety of sources, e.g. heart, lungs, viscera.

The biomedical model assumes a one-way flow of information, wherein bottom-up sensory information is relayed to the brain for symptom awareness/interpretation. This approach omits the influence of external

influences such as the environment and beliefs (Martin et al., 2001). The cognitive-perceptual model presents a mixture of bottom-up processes, as sensory information is relayed to cognitive activity, and top-down processes such as attention, goals, beliefs, and intentions compliment the bottom-up flow of sensory information. These top-down processes are inherently hypothesis-driven and reflect the attribution process that provides a context for symptom interpretation (Cioffi, 1991). According to this model, the meaning that is assigned to a perceived sensation, as well as perceptual attention, influence the awareness and interpretation of a physical sensation as much as sensory information.

1.2 THE CONTENT OF ATTENTION

The salience of a symptom is determined by beliefs and health-related cognition. Illness hypotheses drive a search for further sensations to reinforce these cognitions and can lead to a worsening of the original symptoms (Pennebaker & Skelton, 1981). Illness representations are also closely linked to the situation in which they occur (Cioffi, 1991). If a physical sensation occurs at a specific time, such as when a person has completed an exercise session, then the aching muscles will generally be attributed to the occurrence of this activity. If the same sensation occurs outside of this context, it may be attributed to illness or tissue damage. The cognitive interpretation of a symptom will determine how the individual selects a coping strategy for dealing with the symptom (Cioffi, 1991).

The Health Belief Model (Rosenstock, 1966) was developed in order to identify the effect of demographic and psychological variables on health beliefs, health behaviours and the likelihood that an individual will adopt certain health promoting behaviours. The model proposes that whether a person performs a particular health behaviour depends on the degree to which the person perceives a personal health threat (threat perception,) and the perception that a particular health practice will be effective in reducing that threat (behavioural evaluation) (Rosenstock, 1966). The influence of beliefs represents a top-down cognitive process that determines the content of attention, i.e. the salience of certain symptoms relative to others.

Somatic disorders are generally characterised by suffering and disability that is not life threatening, as opposed to the bodily dysfunction that occurs in other illness (Barsky & Borus, 1999). Somatic disorders represent an internal focus on key symptoms that is driven by beliefs and these patients are likely to hold many more illness cognitions and hypotheses than healthy individuals. Somatic syndromes, such as chronic fatigue syndrome and irritable bowel syndrome, are characterised by the existence of symptoms that are common in healthy individuals (Manu et al., 1989). It has been proposed that somatization patients are particularly vulnerable to symptom amplification (Barsky & Borus, 1999), i.e. these individuals selectively attend to key symptoms that are determined by their beliefs, which confirms the presence of pathology by amplifying the frequency and intensity of those symptoms.

1.3 THE DIRECTION OF ATTENTION

Attention is finite and selective and focus in one area direction tends to be at the expense of attention to another area. It has been proposed that if attention is self-directed then internal change will be perceived more readily than when attention is externally-oriented (Kolk et al., 2003). Pennebaker (1982) proposed the 'Competition of Cues' hypothesis, which posits a competition between internal bodily cues and external cues. Therefore, a stimulating, rich environment will draw attention from internal sources, whereas monotonous environments tend to focus attention to the self and somatic symptoms (Pennebaker, 1982). This hypothesis is supported by a study in which participants jogging on a track were compared with those running a cross-country route. Participants running on the monotonous track reported more symptoms associated with physical fatigue and effort than those running in the countryside where the scenery was more stimulating (Pennebaker & Lightner, 1980).

Hypochondriasis is a somatoform disorder that is related to the process of somatic amplification and a maladaptive attentional process. Hypochondriasis has been defined as "a preoccupation with fears of having, or the idea that one has a serious disease based on a misinterpretation of one or more bodily signs or symptoms" (American Psychiatric Association, 1994). It has been suggested that hypochondriasis lies on a continuum and represents a trait or tendency exhibited in everyone to a greater or lesser extent (Costa & McCrae, 1985). The attentional focus of hypochondriacs is predominantly internal; Pennebaker (1982) proposed that the hypochondriac filters somatic perceptions, and attends selectively to symptoms that confirm their illness hypothesis whilst ignoring those symptoms that do not. An investigation of college students revealed that those high in hypochondriasis were more likely to interpret ambiguous body sensations as an indicator of a catastrophic illness, (Hitchcock & Mathews, 1992).

1.4 SUMMARY

The cognitive-perceptual model proposes that symptom perception is a complex blend of top-down and bottom-up processes between the body and the brain, which may converge or diverge from actual physiological activity (Cioffi, 1991). Beliefs related to illness are important determinants of the salience of any physical sensation, i.e. if a symptom fits with a hypothesis concerning a particular illness then it becomes increasingly salient. Somatization patients represent one extreme where an attentional focus on illness cognitions tends to bias interpretation of normal functioning as being pathological. The direction of attention refers to the distinction between an internal focus on the body and an external focus to situational and environmental factors. Hypochondriacs are proposed to focus attention internally and interpret the sensations negatively, as well as focusing on those sensations that confirm their disease hypotheses.

This review will describe three main areas of research literature that are relevant to the process of symptom perception:

- Laboratory tests of the interoceptive process.
- Attentional processes and their influence on symptom reporting.
- The influence of psychological traits on symptom reporting.
- The influence of transient states on symptom reporting

2. INTEROCEPTION

2.1 INTEROCEPTIVE PATHWAYS

Feelings and symptoms perceived from within the body are distinct from information received via the senses. Stimuli that arise internally may include changes in temperature or specific sensations such as muscular pain and tickling or itching. Similarly, hunger and thirst have a predictable relationship with several physical symptoms. Information from the viscera may be used to detect symptoms of illness (e.g. nausea) and as a cue for emotional feelings such as anxiety (e.g. "butterflies in the stomach"). The feelings, sensations and symptoms of the body are recognised by a process know as interoception. This term was traditionally used to represent the perception of visceral activity; however, the concept has recently been extended to include "all sensations related to the ongoing physiological condition of all organs of the body – muscles, joints, teeth and skin as well as the viscera" (Craig, 2004). The broad scope advocated by contemporary theorists (Cameron, 2001; Craig, 2002) encompasses exteroception (proprioception) from the skin and muscuoskeletal system, including pain, with viscероception (Vaitl, 1996), e.g. feedback from the viscera and internal organs.

The interoceptive process is analogous to a process of self-representation (Churchland, 2002) wherein afferent feedback from the muscles, organs, viscera etc. are relayed up the spinal pathways and represented in the brain. The conventional neurophysiological view separates this process into two distinct pathways: one for pain and another to convey visceroceptive information. Both pathways ascend from the spinal cord to the somatosensory cortex and gustatory cortex respectively, and were viewed as simple relays for sensory information. This view has been challenged in recent times (Craig, 2002). In the first instance, both pathways convey more than simply sensory information. Pain is a multidimensional experience, comprising sensory-discriminative, affective-motivational and emotional qualities (Wall & Melzack, 1999). According to the somatic marker hypothesis (Damasio, 1999), symptoms from visceroception, which represent sympathetic and parasympathetic activity in the Autonomic Nervous System (ANS), provide the foundation for the perception of emotions. These contemporary theories emphasise the multifaceted nature of the interoceptive process, specifically how feelings and symptoms arising from the body have affective and motivational aspects as well as representing sensory phenomena.

Existing descriptions of pain and visceroceptive pathways have been supplemented by a description of the lamina I spinothalamocortical system (Craig, 2002, 2003, 2004). It has been proposed that this system represents afferent information concerning the internal homeostatic state of the body and may define a sense of the physiological condition of the entire body (Craig, 2002; Critchley, 2004).

The importance of the right anterior cingulate for interoception is supported by a series of functional magnetic resonance studies (Critchley, 2004; Critchley et al., 2002; Critchley et al., 2004). These authors performed a study where participants were asked to perform a biofeedback relaxation exercise using electrodermal activity (Critchley et al., 2002); one crucial manipulation disrupted the accuracy and sensitivity of biofeedback information by introducing random noise or making scalar adjustments of the feedback display. This manipulation had the effect of increasing demand on processing interoceptive information, which modulated activity in the amygdala, the anterior cingulate and the anterior insula. A later study confirmed and supplemented these findings (Critchley et al., 2004). Participants in this study were asked to perform either a heartbeat detection task (i.e. presented with a series of tones which were either synchronous or asynchronous with the QRS wave from the heart, see Section 2.2 of the current review for full explanation) or a perceptual detection task (i.e. an oddball task where participants must a

tone which differed in pitch from others). When participants performed heartbeat detection, the authors noted increased activation in the right anterior insula (rAI); in addition, activation of the rAI was correlated with performance accuracy on the heartbeat detection task and a morphometry analysis revealed that rAI was the only cortical site where the physical size of the site was associated with interoceptive accuracy.

Further support for the significance of the rAI for interoception came from a study where participants were injected with isoproterenol, a substance known to produce β-adrenergic stimulation, e.g. increased sympathetic stimulation of the ANS (Cameron & Minoshima, 2002). This substance substantially raised resting heart rates to 120 beats per minute, and glucose metabolism significantly increased in several regions including left somatosensory cortex and the medial portion of cingulate gyrus. Increases in the rAI were modest by comparison, but rAI activity appeared to modulated by gender and handedness, i.e. activation of the rAI was only significant for right-handed or female participants (Cameron & Minoshima, 2002). These findings suggest that individual traits may modulate the importance of rAI activation during the process of interoception.

To summarise: the brain receives a number of cortical representations corresponding to internal stimuli during the process of interoception. These representations from somatosensory, gustatory and the anterior insula provide a dynamic image of internal sensations, which may originate from viscerception or external sources. A representation of homeostatic activity is provided by the lamina I spinothalamocortical system, which projects to the right anterior insula and the oribitofrontal cortex. This system is fundamental to the detection of symptoms and feelings associated with stress and illness. There is also evidence that hemispheric laterality and gender may modulate the neurophysiological pathways associated with interoception.

2.2 HEARTBEAT DETECTION AS AN INDEX OF INTEROCEPTIVE AWARENESS

Heartbeat detection studies aim to measure cardiac sensitivity. There are various methods of heartbeat detection, all of which require participants to provide an estimation of heart rate in real time. Research in this area is based on perceptual psychophysics and is generally laboratory based. Several methods for the measurement of heartbeat detection accuracy have been developed: from a simple heartbeat counting paradigm (McFarland, 1975) to the complex Whitehead protocol in which participants have to distinguish between a series of tones which may be synchronous or asynchronous with respect to heartbeat activity (Katkin et al., 1981; Whitehead et al., 1977; Yates et al., 1985).

The simplest method for heartbeat detection is called heartbeat counting, which requires participants to tap in time with their own heart rate. Participants are classified as “good or “poor” perceivers according to the discrepancy between the number of taps and the actual number of heart beats (McFarland, 1975). This method has been criticised because heartbeat counting may reflect beliefs about heart rates rather than measuring actual sensitivity (Ring & Brener, 1996). Participants with cardiac pacemakers conducted a heartbeat counting task where actual heart rate could be manipulated (Windmann et al., 1999). Three trials were conducted in which heart rate was adjusted to correspond with three pacing conditions: 50bpm (low pacing rate condition), 75 bpm (medium pacing rate condition) and 110 bpm (high pacing rate condition). Significant differences were found between all three conditions and the discrepancy significantly increased as actual heart rate was increased (Windmann et al., 1999). In the high pacing rate condition, the mean score for actual heart rate was almost twice that of the counted heart rate, illustrating that inaccuracy increased with increased heart rate. It was found that the men exhibited significantly superior accuracy relative to female participants (Windmann et al., 1999).

The Whitehead et al. (1977) method for measuring cardiac sensitivity involves discrimination of two series of temporal signals (e.g. flashing lights or tones), the timings of which may or may not accurately represent actual heart rate. Two time intervals were selected: 128 and 384 ms after the R-wave (the peak of depolarisation). The authors proposed that a delay of 128 ms between the R-wave and light flash represented immediate feedback because mechanical contraction of the heart occurs approximately 100 ms after the R-wave (Whitehead et al., 1977). Therefore, temporal stimuli presented 128 ms after the R-waves were perceived as synchronous whereas those presented after a delay of 384 ms were asynchronous (Whitehead et al., 1977). O'Brien, Reid & Jones (1998) used the Whitehead protocol to study heartbeat awareness in male undergraduates with hypertension (e.g. SBP > 139 mm Hg and/or DBP > 89 mm Hg) and normal levels of systolic blood pressure. Testing included a training period in which participants were given feedback on detection accuracy. The authors classified a participant as "aware" if the overall percentage of correct responses exceeded 70% (O'Brien et al., 1998). There were no significant differences between the groups in heartbeat perception before the training, however, 40% of the participants with elevated blood pressure, and 14% of the participants with normal blood pressure were classed as "aware" after the training. In addition, the relationship between BP level and heartbeat awareness was found to be statistically significant, suggesting that hypertensives benefited more from the training phase than the normotensives.

Katkin et al. (1981) suggested that performance was generally poor on the Whitehead paradigm due to the demands of the task. Their modification required participants to discriminate between stimuli that are presented at either a fixed or variable time interval after the heartbeat. A series of fixed tones were presented 100 msec after the R-wave, whereas the variable tones were presented at uniformly increasing intervals in relation to the R-wave. The variable tones are presented (N + 30Bi) msec after the R wave, where N is a random number between 1 and 200 and Bi is the ith heartbeat in a train of 10 beats (Katkin et al., 1981). One study compared performance on the heartbeat detection task to a simple light-tone discrimination task (Harver et al., 1993), in which participants judged whether the light-tone pairs were presented simultaneously (e.g. a measure of temporal sensitivity). The purpose of this test was to investigate general accuracy in discrimination, and participants were found to perform significantly better on the light-tone task than on the heartbeat task (Harver et al., 1993). Eichler & Katkin (1994) compared performance on the Whitehead task to the Katkin task, and results indicated overall superiority for performance on the Whitehead task. Forty percent of participants performed significantly better than chance on the Whitehead task, whilst only 26% of the participants performed better than chance on the Katkin task.

Yates, Jones, Marie & Hogben (1985) also criticised the Whitehead paradigm on the grounds that although participants may have the ability to accurately perceive their heartbeat, they may not always judge 128 ms to be synchronous with the R-wave. Yates et al. (1985) developed a new detection task where participants were presented with stimuli at variable intervals from their R- waves, e.g. 0, 100, 200, 300, 400, or 500 ms. These authors suggested that those who could not accurately perceive their heartbeats would be characterised by a uniform distribution of time judgements across the six intervals (Yates et al., 1985). This hypothesis was supported by a later study (Wiens et al., 2000), which reported a peak occurred at the 200 ms interval for heartbeat detection. It was also proposed that subsequent versions of the two-choice test should use intervals such as 0 and 200 ms or 200 and 500 ms to obtain the most accurate results.

Advances in the area of heartbeat detection have increased the sophistication of existing protocols. The heartbeat-counting task has been shown to be influenced by beliefs about heart rate (Windmann et al., 1999), whereas the Whitehead procedure offers results that are indicative of heartbeat detection accuracy as a pure perceptual test. The latter procedure has methodological shortcomings but the advances by Yates (Yates et al., 1985) may advance the validity of the technique.

2.3 RESPIRATORY RESISTANCE AS AN INDEX OF INTEROCEPTIVE AWARENESS

The detection of respiratory resistance involves subjective estimation of ease of breathing and is particularly relevant to the study of asthmatics. In order to gain a measure of awareness of respiratory resistance, external mesh resistors have been developed that can be adjusted to produce various resistive loads (Dahme et al., 1996). There are several methodologies available for the manipulation of respiratory resistance. Resistance detection is the most simple method and involves only one resistive load. Participants are asked to indicated whether or not the resistive load is present (Harver et al., 1993). The Threshold resistance task uses a range of resistors that are added at random orders and the participant is required to indicate whether or not there is any resistance present. The purpose of this test is to identify which level of resistance represents the threshold for detection of respiratory resistance (Harver et al., 1993). The final method involves participants breathing through a mask whilst air content is manipulated so varying amounts of CO^2 are inhaled and participants are asked to rate ease of breathing (Bergh et al., 2004).

Detection of respiratory resistance in asthmatic patients was compared to healthy controls using three external mesh resistors of different loads. The difference between the controls and asthmatics was found to be significant across all three resistors, however, the asthmatics were less sensitive when the resistive load was low (Dahme et al., 1996). An extension of this study evaluated the effect of biofeedback training on the perception of respiratory load for fifteen asthmatic patients over a period of four weeks (Dahme et al., 1996). The ability to estimate the strength of resistive load was tested before and after training and was subsequently compared to a group of asthmatic controls that had not completed biofeedback training. The training group did not show a greater improvement than controls in their perceptual ability to estimate the strength of added loads (Dahme et al., 1996). A further study was conducted on patients with asthma who had to estimate their peak expiratory flow rate (PEFR) and then measure their PEFR using a peak flow meter. Although the intraindividual correlations for measured and estimated PEFR differed within the group the mean correlation was $r = 0.63$, i.e. the asthmatics were quite accurate with respect to the perception of expiratory flow rate (Schandry et al., 1996).

Harver et al. (1993) studied respiratory resistance in non-asthmatics. Participants completed a signal detection task to detect whether a resistive load was present (respiratory resistance detection), alongside a task to determine the threshold for increases in resistance (threshold resistance task). Participants were reasonably accurate on the respiratory resistance task, although men were significantly more accurate than women. On the threshold task the average level of resistance (detected 50% of all trials) was $1.52cmH^2O/L/s$. This study also involved a heartbeat detection task using the same participants, and comparisons between the two-detection task showed that average sensitivity values differed significantly between the tasks (Harver et al., 1993).

Another approach to measure respiratory interoception requires participants to breathe through a mask and the volume of CO^2 in the air is adjusted so that they inhale either regular room air or air containing 5.5% CO^2. Participants are asked to describe respiratory functioning through completion of a hyperventilation checklist, and the 'faster and/or deeper breathing' rating was the focus (Bergh et al., 2004). This rating was correlated with actual ventilation to give a measure of accuracy of perception. Individuals high in negative affectivity were found to be less interoceptively accurate than those low in negative affectivity (Bergh et al., 2004). (Note that individual differences are covered in Section 4 of the current review.)

The respiratory resistance test has been shown to be effective, in that many participants are sensitive to the presence of respiratory load (Dahme et al., 1996), and this applies in non-asthmatics as well as

asthmatics (Harver et al., 1993). This suggests that it is not only asthmatics that are receptive to changes in their respiratory flow, and that the resistance task may have validity in a healthy sample.

2.4 SUMMARY

The interoceptive process is necessary for an awareness of internal sensory information, regardless of exteroceptive or visceroceptive source. This sensory information is collated as a thalamocortical representation, which is re-represented to the anterior insula and the orbitofrontal cortex. Evidence from functional magnetic imaging studies indicate that the right anterior insula (rAI) is heavily implicated during interoception; furthermore the level of activation and the physical size of the rAI is associated with interoceptive accuracy. Other neurophysiological evidence points to the potential role of handedness and gender as modulators of interoceptive pathways in the brain.

Studies of interoceptive accuracy using non-clinical groups have focused on heartbeat detection, however experimental protocols have significantly evolved and there is substantial variation in methodologies used. Recent research suggests that a two-choice heartbeat detection task should use a delay of 200ms as a synchronous with the heartbeat and a delay of 500ms as asynchronous (Weins & Palmer, 2001). Measures of respiratory resistance were developed specifically to study asthmatics, but there is evidence to support the use of these methodologies with non-clinical groups, i.e. non-asthmatics were also sensitive to increased respiratory resistance (Harver et al., 1993). The study of placebo effects using substances such as caffeine provides a promising method to investigate interoceptive awareness, provided that participants are low to moderate caffeine consumers.

A small number of studies have contrasted interoceptive sensitivity with perceptual sensitivity and the evidence is mixed; Critchley et al. (2004) reported equivalent performance on interoceptive and exteroceptive tasks, whereas an earlier study found higher accuracy on a perceptual task compared to two interoceptive tasks (Harver et al., 1993). In practice, it is difficult to control between tasks that differ so substantially; however, it is recommended that a perceptual task is included during studies of interoceptive accuracy in order to provide a “benchmark” measure of perceptual sensitivity for each participant.

3. ATTENTION AND SYMPTOM REPORTING

The role of attention has generally been overlooked with respect to symptom reporting and interoceptive processing. The processing of interoceptive information is an active, perceptual act prone to bias and selectivity. The direction and content of attention may determine whether a change in physiology is registered or if a specific symptom is noticed by the individual. The selectivity of attention will focus on salient or meaningful stimuli within an internal or external domain (i.e. the content of attention), whereas the division of attention between the self and the external world may be referred to as the direction of attention (Cioffi, 1991).

3.1 SYMPTOM REPORTING AND BELIEFS (CONTENT OF ATTENTION).

The content of attention is an important element of symptom reporting and health beliefs influence the salience of a symptom. Pennebaker (1982) demonstrated that beliefs regarding particular symptoms can be manipulated. He conducted an experiment in which half of the participants were told that it was the flu season. After a period of exercise, those participants in the "flu" group reported more flu symptoms compared to those who were not given the flu information (Pennebaker, 1982). Thoughts and beliefs concerning somatic symptoms are relatively stable but may differ due to the situational context (Cioffi, 1991). The participants in Pennebaker's (1982) study who were not informed that it was flu season did not consider their physical sensations to be symptomatic because they were attributed to the exercise.

Somatosensory amplification has been defined as "the tendency to experience somatic sensation as intense, noxious and disturbing" (Barsky et al., 1988). Amplification involves a heightened focus on relatively weak sensations and a disposition to react to somatic sensations with negative affect and ruminative cognitions that intensify the original symptoms (Barsky et al., 1988). Barsky et al. (1988) reported a close association between somatic amplification and depression, they proposed two reasons to explain this relationship: the first is that those who are emotionally distressed are more likely to notice and report physical symptoms, and secondly, hypersensitivity to physical and psychological symptoms may result in a diagnosis of depression. Page, Howard et al. (2004) reported that those patients with chronic daily headache, who also scored 11 or above on the Hospital Anxiety and Depression Scale (HADS) scored highly on all measures of headache severity; they also believed that their illness would last longer and have more severe consequences. Therefore, negative mood can influence the process of symptom perception and that depression can provide a pathological context for symptom interpretation.

Socio-cultural factors and beliefs about illness have been suggested to influence symptom reporting and self-diagnosis of illness (Barsky & Borus, 1999). Mass psychogenic illness (MPI) occurs when a large group of individuals report the same physical symptoms that do not have a clear organic basis and often develops those who work together. It has been suggested that when one person shows observable symptoms, their reports influence the beliefs of others who may subsequently experience the same symptoms (Pennebaker, 1994). The physical sensations experienced during MPI are often not indicative of actual illness and may be due to short-term factors such as fatigue or boredom. However, the phenomenon of MPI serves to demonstrate how proximity to illness may cause a change in illness hypotheses resulting in a different attributional/attentional process with respect to symptom perception. A campaign in Leicester requesting the public to be vigilant to pigmented lesions resulted in GP consultations for this condition doubling (Graham-Brown et al., 1990). The opposite effect was found for a public health campaign in Australia advising people on how to deal with back pain, which had the principal message that individuals with back pain should remain active and at work. This resulted in claims for compensation decreasing 15% during the 2-year period that the campaign ran for (Bookbinder & Jolly, 2001). These studies can be differentiated in that the first study resulted in a heightened

awareness of a particular symptom, whereas the second persuaded individuals to be more cautious during the symptom reporting process.

Pennebaker & Epstein (1983) investigated the contributions of actual physiological state and beliefs about internal state to the perception of physiological functioning. Participants were asked to estimate heart rate, finger temperature and breathing rate after completing a variety of demanding tasks. A simulation group were provided with a description of the task and asked to provide an estimation of how they believed the tasks would affect physiology, but this group did not experience the actual tasks directly. It was found that simulator's beliefs predicted the greatest proportion of the variance associated with physiological change, but only for heart rate and breathing rate. The absence of any predictive value of beliefs with respect to finger temperature could be explained by the possibility that people do not hold any particular beliefs concerning the relationship between demanding activity and finger temperature, whilst beliefs regarding the relationship between task demand and heart rate/breathing rate are common and consensual.

A further experiment demonstrated that participants monitor bodily sensations in a selective manner and that they are more likely to notice sensations that are congruent with hypotheses held about the body (Pennebaker & Skelton, 1981). Participants were provided with information about the effects of ultrasonic noise on skin temperature; the experimental group were told that ultrasonic noise could cause their skin temperature either to increase or decrease. Actual finger temperature was not correlated with self-reported skin temperature; however, the experimental increase group reported increased finger temperature compared to the experimental decrease group (Pennebaker & Skelton, 1981). These studies indicate that beliefs are more influential regarding physiological processes for when prior hypotheses exist.

In summary, beliefs regarding the body and illness play an important role in creating symptom salience during somatic interpretation. Individuals with somatic disorders are more vulnerable to the process of somatic amplification and likely to react to physical sensations in a negative way that may lead to an attentional focus on those symptoms and subsequent amplification. There is also evidence that beliefs concerning illness can be manipulated (Pennebaker & Skelton, 1981) in order to influence symptom perception.

3.2 SYMPTOM REPORTING (DIRECTION OF ATTENTION).

The ability to filter sensory information is necessary because human beings have limited capacity as information processors (Cioffi, 1991) and therefore, only a portion of the available information is consciously processed (Kolk et al., 2002). Sensory monitoring of a symptom, i.e. focusing on the specific concrete properties of a physical sensation, is likely to reduce the level of distress associated with the sensation, whereas attention to an emotional reaction (to the symptom), particularly if negative, tend to intensify the symptom (Cioffi, 1991). The 'Competition of Cues' hypothesis proposes that there is competition for attentional resources between internal bodily cues and external cues (Pennebaker, 1982). Support for this hypothesis comes from a survey where low levels of external information/stimulation coupled with negative mood were associated with increased reporting of physical symptoms (Gijsbers van Wijk et al., 1999). Kolk, Hanewald, Schlagen & Gijsbers van Wijk (2002) conducted a survey which attempted to identify those variables related to the reporting of somatic symptoms. They found that selective attention to the body was an important predictor of somatic symptoms, with those reporting a higher tendency to be sensitive to internal bodily processes reporting a greater number of somatic symptoms (Kolk et al., 2002).

Miller, Brody et al. (1988) categorised individuals as monitors or blunters, based on their attentional focus during symptom perception. Monitors tend to focus attention on internal functions and illness information, whereas blunters adopt a strategy of distraction from information related to physiological functioning. Miller et al. (1988) reported that high monitors had significantly fewer serious medical problems than low monitors, as quantified by post-visit evaluations by the physician. However, high monitors reported less improvement in their medical problems relative to low monitors indicating that these participants had negative expectations with respect to recovery. The attentional focus of high monitors/low monitors results in his/her experiencing symptomatological distress that is greater than that of low monitors/high blunters, even when medical conditions are rated objectively as equal (S. M. Miller et al., 1988).

Gibbons, Carver, Scheier & Hormuth (1979) conducted an experiment on placebo effects, self-focus and body awareness. Participants were given an oral dose of baking soda and were either told the true identity of the substance, or were told that it was a drug than can produce changes in heart rate, constriction of the chest and sweaty palms. Half of the participants completed the experiment in front of a mirror (the self-focusing manipulation) and the control group did not. The self-focusing manipulation group did not experience the placebo effect and report symptoms of sympathetic arousal, whilst the control group experienced the placebo effect of increased arousal (Gibbons et al., 1979). Therefore, experimentally manipulated attention to the self counteracted the placebo effect by focusing attention externally (on the external body image).

Attentional strategies have been studied in terms of efficacy for coping with chronic pain. The two most common strategies are distraction and sensory monitoring (Cioffi, 1991). Distraction was originally used to attempt to reduce intensity of pain and has been found to be effective in a number of studies (Lautenbacher et al., 1998; Levine et al., 1982). It has been suggested that although distraction can be effective for stimuli of low intensity, sensation redefinition (focusing on the pain in order to reinterpret it) is more effective for symptoms of intense pain (Mc Caul & Malott, 1984). Sensory monitoring is proposed to produce a neutral perception of pain sensation that reduces negative, emotional responses associated with pain (Cioffi, 1991). Morgan & Pollock (1977) found that world class runners use a sensory monitoring approach and systematically scan their physical sensations, whilst college athletes prefer distraction strategies and attempt to ignore the pain caused by exercise. They suggested that this monitoring increased interoceptive sensitivity which allowed the professional athletes to adjust to the demands of the race and fine-tune their pace (Morgan & Pollock, 1977).

3.3 SCALES TO MEASURE ATTENTION TO THE SELF.

Measures have been developed to gauge a disposition to amplify somatic symptoms. The Somatosensory Amplification Scale (SSAS) is a brief self-report questionnaire that was developed to measure the amplifying somatic style (Barsky et al., 1990). It has been found to have satisfactory reliability in a sample of medical outpatients and in the general population (Speckens et al., 1996); however, the validity of this scale is in question. It has been proposed that the SSAS measures beliefs associated with somatic awareness as opposed to any objective index of interoceptive accuracy; for example scores of the SSAS failed to predict performance on a heartbeat detection task (Aronson et al., 2001). A potential drawback of the SSAS scale is that scores are correlated with scores on depression scales (Barsky et al., 1990), and a measure of negative emotionality from the Multidimensional Personality Questionnaire Negative Emotionality Subscale (NEM) (Aronson et al., 2001).

The Illness Attitude Scale (IAS) is a self-report measure designed to measure fears, attitudes and beliefs associated with hypochondriasis and abnormal illness behaviour (Kellner et al., 1987). Scores on the IAS are associated with SSAS scores (Speckens et al., 1996) and with scores on the Anxiety Sensitivity Index

(Stewart & Watt, 2000). It was also reported that IAS scores were positively correlated with trait anxiety (Steptoe & Noll, 1997), indicating that anxious individuals are likely to show hypochondriacal tendencies. The same authors also found an association that approached significance between IAS scores in men and accuracy of heartbeat detection, i.e. poor interoceptive accuracy among those with stronger hypochondriacal tendencies (Steptoe & Noll, 1997).

The Body Consciousness Questionnaire was designed to measure sensitivity to the body and selective attention to internal symptoms, whilst avoiding overlap with hypochondriasis (L. C. Miller et al., 1981). The questionnaire was found to contain three factors of private body consciousness, public body consciousness and body competence, and all items dealing with pain and illness were excluded. Private and public body consciousness were found to be correlated, suggesting that people who attend to one aspect of their body often also attend to the opposite dimension (L. C. Miller et al., 1981). Miller et al. (1981) conducted an experiment in which half of the participants were given caffeine and the control group were given a placebo. Neither group were specifically told they had been given caffeine, however, at the beginning of the experiment they were asked if they would mind drinking an alcoholic or caffeinated beverage. For the men and women in the caffeine condition, those who were high in private body consciousness reported more changes in bodily state than those who were low. The results suggest that individuals who are high in private body consciousness are more aware of their internal state and implying that the Body Consciousness Questionnaire has validity (L. C. Miller et al., 1981). The Body Perception Questionnaire (Porges, 1993) includes several factors, including: awareness (to bodily processes), perception of the stress response and autonomic reactivity and stress styles. The awareness factor failed to predict performance on a heartbeat detection task, but was correlated with the size of the right anterior insula (Critchley et al, 2004), a structure associated with interoceptive activity (see section 2.1).

3.4 SUMMARY

In conclusion, attentional factors play a crucial role in whether or not a symptom is experienced, and self-directed attention has been found to be related to both an increased report of somatic symptoms (Kolk et al., 2002), as well as a more accurate experience of physiological change (Gibbons et al., 1979). Experiments can be used to manipulate the direction of attention. Self-directed attention can be produced experimentally (Gibbons et al., 1979), whilst participants can be given tasks to complete which direct attention away from the body (Cioffi, 1991). The self-report measures which have been created to measure sensitivity to the body do not have adequate construct validity (Aronson et al., 2001; Steptoe & Noll, 1997) and are related to measures of depression/anxiety, therefore it appears that the experimental tests of interoception give the best measure as long as the effects of beliefs are controlled for (Pennebaker & Epstein, 1983).

4. THE INFLUENCE OF TRAITS ON SYMPTOM REPORTING

Research into interoceptive accuracy and symptom reporting have found substantial variation between individuals. These findings raise questions about the interaction between individual traits (e.g. gender, personality) and the interoceptive process. In broad terms, this interaction may be described by the differences in sensitivity to internal symptoms and consequent attributions. For example, some traits may influence the direction of attention, causing heightened sensitivity to internal symptoms for some and reduced interoceptive awareness in others e.g. monitors vs. blunters (S. M. Miller, 1987). Psychological trait factors, such as anxiety and negative affectivity, may influence beliefs about the meaning and consequences of physical sensations and may lead to over-reporting of symptoms due to a more negative cognitive style. This section will review research on interoceptive accuracy and awareness with respect to gender, negative affectivity, coping styles and anxiety.

4.1 GENDER DIFFERENCES

It has consistently been found that women report more symptoms of illness in self-report studies (Gijsbers van Wijk et al., 1999; Gijsbers van Wijk & Kolk, 1997; Pennebaker, 1982) and males exhibit higher levels of interoceptive accuracy than females both in the laboratory and the field (Cox et al., 1985; Harver et al., 1993; Mailloux & Brener, 2002).

Katkin et al. (1982) found that males performed better on their heartbeat detection task (see Section 2.2) compared to females and the performance of the males on the same task improved with practice whereas female participants did not (Katkin et al., 1981). Harver, Katkin & Bloch (1993) performed a study in which participants were subjected to three signal detection paradigms, involving heartbeat detection, respiratory resistance detection and a light-tone detection task. Males showed significantly greater sensitivity to both their heart rate and respiratory flow, but there was no effect of gender during the light-tone task (Harver et al., 1993). The implication of this study was that superior performance by male participants was specific to interoceptive perception. This finding was supported by an earlier study that reported a significant advantage for males during the detection of stomach contractions compared to females (Whitehead & Drescher, 1990).

Roberts and Pennebaker (1995) have suggested that women and men use internal and external cues differently during the perception and definition of bodily states. They proposed that women rely on both external and internal cues in appraising symptoms, whereas men tend to focus on internal signals (Roberts & Pennebaker, 1995). Cox et al. (1985) conducted a study using diabetic participants who were required to estimate blood glucose in a laboratory scenario (when the participant's glucose levels were directly manipulated) and in a naturalistic setting. The correlations between actual and estimated blood glucose were higher for men than women in the laboratory, but this advantage was overturned when participants estimated blood glucose in a naturalistic setting. These findings support the hypothesis advanced by (Roberts & Pennebaker, 1995) as only internal cues were available in the laboratory whereas the presence of internal cues were supplemented by situational cues in the home condition (Cox et al., 1985).

Research into pain perception has also reported consistent differences between the sexes; females generally report more severe pain, and pain of a longer duration than men (Riley et al., 1998). A lower pain threshold to oesophageal distention has been demonstrated in females (Nguyen et al., 1995), however, in patients with irritable bowel syndrome, there were no gender effects during experimental distention of the rectum (Berman et al., 2000).

Several studies have found variations in pain thresholds across the menstrual cycle in women (Fillingim et al., 1997; Hapidou & Rollman, 1998). It is possible that the internal state of women is more variable due to the menstrual cycle, which could account for women's reduced interoceptive sensitivity and varying pain thresholds. For both pressure pain and for the cold pressor task, an effect has been found with the follicular phase having the highest pain threshold (Hapidou & DeCantanzaro, 1988; Kuczmeirczyk & Adams, 1986). Fillingim et al. (1997) studied differences across the menstrual cycle using thermal heat, and reported that higher threshold and tolerance was found in the follicular phase than in the periovulatory and luteal phases. It has been proposed that the biological changes, as well as the psychological changes associated with menstruation may produce this fluctuating pain tolerance (Derbyshire, 1997). The effect could occur through anxiety and negative mood that often coincide with menstruation, as these variables have been found to be associated with lower pain thresholds (Keogh & Cochrane, 2002)

Women tend to report a greater frequency of physical symptoms compared to men (Popay et al., 1993; Verbrugge, 1989); (Pennebaker, 1982; Vassend, 1989). A longitudinal study conducted over twelve months found that women reported more symptoms than men, and reported increased absenteeism during the year (Green & Pope, 1999). Early findings by Gijsbers van Wijk, Kolk & Everaerd (1991) supported the hypothesis that women experience more minor health problems whilst men report fewer problems until later life when they experience more serious health problems. An alternative explanation concerns different coping strategies between the sexes once a symptom has been detected. Women may be more likely to focus their attention on a symptom and make judgements about what it could mean and whether they need to take action (e.g. monitors), whereas men are more prone to focus their attention on stimuli other than the symptom and avoid thinking about the implications of the symptom (e.g. blunters) (Gijsbers van Wijk & Kolk, 1997).

The majority of studies that reported higher symptom reports in females compared to males used healthy populations (Gijsbers van Wijk et al., 1999; Popay et al., 1993; Verbrugge, 1989) and it has been suggested gender differences may disappear when actual illness is present (Macintyre, 1993). However, evidence from medical populations supports the existing hypothesis (Kroenke & Spitzer, 1998). This effect persists even when gynaecologic and obstetric conditions were excluded from the analysis, suggesting that the difference is not due to women having gender specific symptoms (Gijsbers van Wijk et al., 1991).

In conclusion, there is evidence from interoceptive studies that women are less accurate than men in a laboratory setting with respect to heartbeat detection, respiratory resistance and estimation of blood glucose levels, however, this effect was reduced when an interoceptive task was conducted in a home setting (Cox et al., 1985). This suggests that women may use external and situational cues during the assessment of physical symptoms, whereas men exhibit superior interoceptive accuracy in the laboratory where only internal cues are available. Studies of symptom reporting have found that women report higher frequency of physical symptoms and time off work due to illness compared to men (Green & Pope, 1999). This finding may represent differences with respect to interoceptive activity (e.g. women experience greater interoceptive variability due to the menstrual cycle) or tendencies towards gender-specific coping strategies once a symptom has been detected.

4.2 NEGATIVE AFFECTIVITY

Negative affectivity (NA) has been studied for its influence on sensitivity to the body and subjective self-assessment, including symptom reports (Put et al., 2004; Stegen et al., 1998; Vassend & Skrondal, 1999). Watson & Pennebaker (1989) proposed a number of hypotheses to explain the effect of negative affectivity on health complaints. The first is the Psychosomatic Hypothesis that suggests that high trait

NA can cause physiological disturbance and increased symptoms, however, there is little evidence to support this theory. Their second idea is the Disability Hypothesis that proposes that health problems can lead to an individual developing higher levels of NA. This is undermined by the finding that NA scores are not related to the severity of a medical condition, and although illness may cause high state NA it is unlikely that change could be permanent (Watson & Pennebaker, 1989). The most plausible explanation is known as the Symptom Perception Hypothesis which does not assume any physical differences between high and low NA participants, but states that individuals differ in how they perceive physical sensations and that high NA participants are more likely to attend to and complain about physical symptoms (Watson & Pennebaker, 1989).

The Symptom Perception Hypothesis could be interpreted to suggest that an overlap exists between trait NA and hypochondriasis. However, the association between trait NA scores and somatic complaining is both linear and continuous, suggesting that the relationship is present at all levels of NA and symptom reporting and does not merely reflect extremes of high and low hyperchondriasis (Costa & McCrae, 1985). The hypervigilance of high NA individuals may explain why they report increased somatic complaints in two ways: one, they are more likely to notice and attend to normal bodily sensations (the direction of attention is internally focused), and two, because their scanning is fraught with anxiety they are more likely to attribute the symptoms to a pathological cause (the content of attention is negative and focused on illness) (Costa & McCrae, 1985).

Stegen et al. (1998) conducted an experiment on the effects of negative affectivity (NA) that involved a CO^2 inhalation paradigm (see section 2). Their participants were exposed to CO^2 concentrations of 5.5 and 7.5% compared to normal air, whilst completing self-reports of somatic symptoms. The only effect of NA occurred for the respiratory symptom scale, with those high in NA reporting more respiratory symptoms than those low in NA, but this effect was not present across all the CO^2 trials. For the physiological variables of heart rate and respiratory flow, there were no significant differences between the high and low NA groups (Stegen et al., 1998). Findings from this study did not support the hypothesis that high NA participants are more likely to report more somatic complaints and show physiological differences in a laboratory setting.

A study was performed to investigate how negative affectivity modulated the influence of suggestion with respect to asthma symptoms (Put et al., 2004). Asthmatics were required to take puffs from three placebo inhalers, which were described as being either an inert substance, a bronchoconstrictor and a bronchodilator. A physiological analysis showed that expiratory tidal volume significantly decreased during the bronchoconstriction condition and there was also a main effect for inspiratory tidal volume (i.e.. respiratory behaviour was attempting to adapt to the anticipation of bronchoconstriction). However, no physiological changes were found due to high and low NA. In all of the self-report categories, the number of symptoms was significantly higher for the high NA participants than for the low NA participants. There was also a significant interaction between the suggestion condition and NA for the symptom report subscale "Obstruction", indicating that the high NA subjects reported an increase of obstruction symptoms after the suggestion of bronchoconstriction, and subsequently less obstruction symptoms after the suggestion of bronchodilation (Put et al., 2004). The fact that the suggestion conditions had the most influence on self-reports is synonymous with the symptom perception hypothesis, i.e. high NA leads to over-reporting of symptoms in the absence of any physiological change (Watson & Pennebaker, 1989).

In subjective symptom reports, negative affectivity (or neuroticism) has been found to be highly correlated with all of the symptom checklists. It has been proposed that negative mood and symptom scales reflect the common underlying factor of somatopsychic distress (Watson & Pennebaker, 1989).

Negative affectivity can be measured either as a trait or a state, and individuals high in NA tend to be critical of themselves and others, and emphasise the negative aspects of their life (Vassend & Skrondal, 1999). Interestingly, trait NA is correlated with all measures of symptom reporting, whereas trait positive affectivity is largely independent (Watson & Pennebaker, 1989). It has been proposed that negative emotions may have an effect on health via lifestyle factors (Mayne, 1999): negative affectivity could lead to health problems through a lack of preventative health behaviour i.e. not eating and sleeping properly due to depression and lack of motivation, a more sedentary lifestyle due to a reduction in social behaviour (Mayne, 1999).

Vassend & Skondral (1999) conducted a study investigating the relationship of the Big Five personality dimensions to reports of somatic complaints. They found that high NA individuals reported more somatic complaints, but when current distress level (state NA) was included in the model the direct effect of trait NA disappeared. The effect of trait NA was interpreted as an indirect effect on symptom reporting through the mediating variable of state NA (Vassend & Skrondal, 1999). Williams, O'Brien & Colder (2004) found that individuals high in neuroticism rated their global health more poorly, and that individuals both high and low in extraversion were found to rate their global health more poorly. In terms of retrospective symptom reports, high levels of neuroticism and high levels of extraversion were found to be related to higher levels of retrospective symptoms (Williams et al., 2004).

Kolk et al. (2003) examined the association between trait and state negative affectivity and symptom reporting. They found that trait NA coupled with a low level of daily external information (the quantity of information received in daily life e.g. social stimulation) was significantly associated with negative mood (state NA), then increased state NA was directly related to the number of physical symptoms (Kolk et al., 2003). This is supportive of the findings by Vassend & Skondral (1999), that the effect of trait NA is mediated by state NA. In addition, trait NA appeared to exert an indirect influence through the variable of selective attention. Selective attention to the body was defined as "the tendency to be aware of, or sensitive to, internal bodily processes and states not typically associated with disease, illness or emotion" (Kolk et al., 2003). Individuals who were high in trait NA had increased physical symptom reports, suggesting that trait NA is a vulnerability factor that could interact with either negative mood or high selective attention to the body to increase the frequency of symptom reporting (Kolk et al., 2003).

Horner (1996) reported that neuroticism worked in combination with locus of control and stress to influence self-reports of physical illness. It was found that those individuals high in neuroticism reported an increase in stressors, the use of emotion-directed coping and high levels of perceived stress compared to those low in neuroticism. In a further regression analysis, the only term to significantly predict reported illness was the interaction of neuroticism, locus of control and stressors (Horner, 1996). This finding suggests that an individual with external locus of control beliefs and high neuroticism is more likely to complain of illness under conditions of stress, or possibly that external locus of control and high neuroticism interact to yield a higher frequency of symptoms.

In summary, it appears that negative affectivity should always be controlled for in symptom perception studies, but this variable should always be used in conjunction with a state variable, e.g. state NA or negative mood. Although there are various theories why individuals high in trait NA are more likely to over-report symptoms and illness, an individual explanation has not been clarified.

4.3 TRAIT ANXIETY

Anxiety sensitivity refers to the fear of symptoms of anxiety due to beliefs about the negative consequences of these sensations e.g. social embarrassment, appearing flustered to others (Sturges & Goetsch, 1996). These authors investigated the relationship between anxiety sensitivity and heartbeat

awareness using a sample of females who were classed into high- and low anxiety sensitivity groups depending on scores on the Anxiety Sensitivity Index (ASI). The participants were given a glass of grapefruit juice that either contained caffeine or a placebo. The task involved a mental arithmetic task that was alternated with intervals during which the participants counted their heartbeats. Women high on anxiety sensitivity were significantly more accurate at counting heartbeats compared to the other groups, despite the influence of the mental arithmetic task. There were no differences between the caffeine and placebo groups in heartbeat detection across the trials, indicating that the caffeine did not increase interoceptive sensitivity, however the high-ASI group did report greater ratings of caffeine-induced physical sensation compared to the low-ASI group (Sturges & Goetsch, 1996). This is also evidence that anxious female participants were more accurate than controls on a heartbeat counting task; however, these results may not generalise to male participants.

Panic disorder is associated with sympathetic arousal such as increased heart rate and blood pressure, therefore many studies have looked at the accuracy of individuals with panic disorder in a heartbeat perception paradigm (Asmundson et al., 1993; Ehlers et al., 1988; Zoellner & Craske, 1999). The studies that have used the Whitehead (Whitehead et al., 1977) and Katkin (Katkin, 1985) paradigms in heartbeat detection failed to find any significant differences between panic patients and controls, (Asmundson et al., 1993; Ehlers et al., 1988). However, the mental tracking paradigm (in which subjects are required to count their heartbeats silently during signalled intervals) revealed the greatest differences between the panickers and controls (Ehlers & Breuer, 1992; Zoellner & Craske, 1999). It has been suggested that this difference in the heartbeat counting task may be because panickers are more likely to have had experience of counting their heartbeat (e.g. checking the pulse during panic attacks) or that they have more practice of manipulating their heartbeat (Zoellner & Craske, 1999).

Zoellner & Craske (1999) predicted that participants with infrequent panic attacks exhibit higher interoceptive accuracy than control participants. Their experiment involved a baseline trial followed by administration of caffeine. Participants were randomised into either the no safety condition, who were informed of the likely symptoms of the substance as well as unlikely symptoms, or the safety condition, in which participants were reassured of the safety of those effects associated with the substance, i.e. the symptoms were described in detail and described as being harmless. After taking caffeine, the "no safety group" had significantly higher physiological arousal scores than the "safety" condition. The control group exhibited lower levels of interoceptive accuracy during the heartbeat detection task compared to those in the panic attack group (Zoellner & Craske, 1999). Self-rated anxiety scores for the entire sample were stratified into lowest, medium and highest levels of anxiety, and those participants who reported the highest levels of anxiety were more accurate on the heartbeat detection task (Zoellner & Craske, 1999). This suggests that panickers are more likely than non-panickers to be better able to perceive their heartbeats, and provides further support that anxious individuals produce higher scores on tests of interoceptive accuracy.

Research into pain perception has also shed light on the relationship between anxiety and interoception (Bar et al., 2003; Keogh et al., 2000). Peters, Vlaeyen & Weber (in press) studied a group of chronic back pain patients and found that both pain-related fear and catastrophising were related to pain intensity and disability. Health anxiety scores, as measured by the Illness Attitudes Scale (Kellner et al., 1987), were higher in a group of chronic pain patients compared to among a group of controls (Hadjistavropoulos et al., 2000), and those with high health anxiety tended to catastrophise, to report less control over their pain and to have lower pain tolerance on a cold pressor task compared to non-health anxious individuals (Hadjistavropoulos et al., 1998). Other studies have also reported a positive relationship between self-reported pain symptoms and catastrophising/anxiety sensitivity (Keogh et al., 2004; Linton; Peters et al.). For example, neuroticism and anxiety sensitivity scores were highest among individuals with irritable

bowel syndrome (IBS) compared to asymptomatic individuals, which suggests that these traits may be associated with the disorder (Hazlett-Stevens et al., 2003).

Individuals high in anxiety and panic disorder patients have been found to perform more accurately on heartbeat counting tasks compared to those low in anxiety and panic (Sturges & Goetsch, 1996; Zoellner & Craske, 1999). This indicates that anxiety is associated with an increased sensitivity to the body, and the fact that anxiety patients show low pain tolerance (Keogh et al., 2004) supports this hypothesis. The only flaw to this argument is the fact that heartbeat counting was used as opposed to the more formalised heartbeat detection tasks (Ring & Brener, 1996).

4.4 SUMMARY

Many explanations have been proposed for the sex differences in symptom reports, and one reason that women report more symptoms is because their bodies are subject to gender-specific disturbances such as the menstrual cycle (Gijsbers van Wijk & Kolk, 1997), which may influence interoceptive awareness via related changes such as psychological mood states. In addition, women are more involved with health and health care throughout their life than men, via menstruation, childbirth and often being the main caregiver for their children; therefore the prospect of visiting the doctor or reporting physical complaints to friends or family is a common experience. There may also be an effect of the media, in that magazines and television programmes aimed at women often include information about health. In general terms, women may be socialised to have higher selective attention to the body, whereas men are taught to ignore symptoms and use more repressive coping styles (Gijsbers van Wijk & Kolk, 1997). Women are more prone to fluctuating changes in bodily awareness due to the menstrual cycle and so interoceptive accuracy may vary throughout the month.

The psychological traits of anxiety and negative affectivity have been found to influence interoceptive accuracy (Sturges & Goetsch, 1996; Zoellner & Craske, 1999) and self-reports of symptoms (Vassend & Skrondal, 1999; Watson & Pennebaker, 1989). It has been suggested that individuals who are high in negative affectivity and/or anxiety show a general hypervigilance which causes them to show greater sensitivity to the body and makes them more prone to over-reporting of symptoms. These trait variables may exert their influence via state-related changes and result in an internal focus of attention at the expense of external factors. Defensiveness and repression represent traits associated with distraction and the projection of a positive image to the self and others. Defensive individuals tend to under-report symptom frequency and generally present a positive estimation of health. However, repressors tend to exhibit a dissociation between physiological reactivity to stress and self-reported emotional distress, therefore they do not use bodily awareness as a cue to detect elevated levels of stress.

5. THE INFLUENCE OF STATES ON SYMPTOM REPORTING.

Changes in psychological states represent relatively transient affective states that may last for minutes, hours and occasionally days. These changes are conceptualised as variations in mood (e.g. energy, tension, affect) and may be influenced by personality, health, lifestyle, work-related stress etc. The dynamic and highly variable nature of state change may exert considerable influence on responses to self-report scales, particularly when data are collected as a single "snapshot." The influence of states on symptom reporting and interoceptive accuracy have been assessed via laboratory studies in which cardiac change is achieved through exercise or stress tasks (Blascovich et al., 1992; Eichler & Katkin, 1994), or self-report surveys, which include an assessment of state level in conjunction with trait variables such as personality (Kolk et al., 2003; Vassend & Skrondal, 1999)..

Hantas, Katkin and Blascovich (1982) designed an experiment to investigate the relationship between emotional reactivity and interoceptive accuracy. Participants were asked to rate responses to emotion-eliciting slides, and it was revealed that participants with higher interoceptive accuracy (as assessed via a heartbeat detection task) reported a higher emotional response to noxious stimuli relative to those with poorer interoceptive sensitivity (Hantas et al., 1982). Katkin et al. (1982) conducted a study in which participants were shown slides of images that were either positive, neutral or negative whilst performing a heartbeat detection task based on the Katkin procedure (see section 2). They reported that the negative images produced a vagally mediated decline of heart rate, which significantly increased the performance accuracy on the heartbeat detection task. This finding was supported by a recent study where anxiety during the heartbeat detection task was correlated with both performance accuracy and activation of the right anterior insula (Critchley et al, 2004) (see Section 2.1).

A similar study was conducted by Wiens et al. (2000), in which participants initially completed a heartbeat detection task and were classed as either good or poor heartbeat detectors. During the second phase of the study, both groups were presented with films designed to provoke three emotions: amusement, anger or fear. It was found that the good detectors reported more intense emotions on all three of the mood dimensions (Wiens et al., 2000). These studies suggest that those individuals who experience greater intense mood are more accurate at heartbeat detection tasks, possibly because they are more sensitive to emotional stimuli and further that increased vagal tone also improved interoceptive accuracy; the latter finding suggesting that interoceptive accuracy is increased when the participant is in a relaxed state.

An experiment that looked at cardiovascular reactivity to stress found that good heartbeat detectors on the Whitehead task and/or the Katkin task showed greater cardiovascular reactivity to a mental arithmetic task (Eichler & Katkin, 1994). The authors hypothesised that good heartbeat detectors may have greater experience with the perception of heartbeats as a result of their greater cardiovascular reactivity to stress (Eichler & Katkin, 1994). The study conducted by Harver et al (1993) compared interceptive accuracy on a range of tasks across those with high and low sympathetic reactivity (as indexed by the frequency of galvanic skin responses). They reported that reactive participants had superior accuracy on the heartbeat detection task, but this effect did not generalise to respiratory resistance. Similarly, Blascovich, Brennan, Tomaka & Kelsey (1992) studied the effects of exercise on heartbeat detection. Participants performed the Katkin heartbeat detection procedure immediately after exercise when cardiovascular activity was elevated. The exercise manipulation successfully increased cardiac arousal, and the accuracy of heartbeat detection increased significantly more after exercise than after rest (Blascovich et al., 1992).

Self-report studies have looked at the effects of state negative affectivity (NA) (or current distress level) on symptom reporting (Kolk et al., 2003; Vassend & Skrondal, 1999). Vassend & Skondral (1999) found

that high NA individuals reported more somatic complaints, but when current distress level (state NA) was included in the model the direct effect of trait NA disappeared, suggesting that a state measure of NA exerted the stronger influence on symptom reporting. Kolk et al. (2003) looked at the association between trait and state negative affectivity and the quantity of daily external information. They found that trait NA and a low amount external information were significantly associated with negative mood (state NA). They also found that state NA was directly related to physical symptom reports (Kolk et al., 2003). The finding that low levels of external information were associated with negative mood supports the "Competition of Cues" hypothesis (Pennebaker, 1982) in which individuals are more likely to notice and report symptoms when information is lacking from their environment, and possibly more likely to dwell on the negative aspects of their life.

In conclusion, the experimental studies paint a contradictory picture. On one hand, increased activation due to exercise and emotional stimuli seems to increase interoceptive accuracy. It is assumed that sympathetic activation due to emotional activation or physical activity acts as a "gain" factor and basically amplifies the salience of internal symptoms. However, at least one study reported the opposite result, i.e. that a reduction of ANS activity improved interoceptive accuracy. This finding provokes a second hypothesis that somatic "quietening" increases sensitivity to specific symptoms by increasing the signal: noise ratio within the interoceptive process. The symptom reporting studies suggested a link between negative affective state and symptom perception, i.e. those in a negative mood reported a higher number of symptoms. This finding provides an indication of how negative mood states may inflate symptom reporting in the presence of stress.

6. DISCUSSION

This section is divided into three sections. The first presents a summary of the neurophysiological and psychophysiological links between interoception, occupational stress and bodily awareness. The second section summarises the psychological research on symptom reporting within the context of occupational stress.

6.1 INTEROCEPTION, OCCUPATIONAL STRESS AND SYMPTOM REPORTING.

The catabolic effect of stress on the autonomic nervous system (ANS) is well-known; elevated stress produces a characteristic pattern of: increased heart rate, blood pressure, respiration and the release of catecholamines (adrenaline) and cortisol into the bloodstream. This stereotypical pattern is proposed to derive from sympathetic activation in conjunction with a reduction of parasympathetic inhibition, although the same pattern may be derived from several distinct modes of autonomic control (Berntson et al., 1991; Berntson et al., 1994).

Occupational factors are known to mediate stress-related changes in psychophysiology and subsequently may have implications for the long-term health of an individual. High job demands coupled with low control over the pacing of work increased heart rate and blood pressure, particularly for those individuals who were "stress-reactive", i.e. exhibited substantial heart rate reactivity in response to a controlled laboratory stressor (A. Steptoe, 2001; A. Steptoe et al., 2000). Individuals who work in an environment with high external demands (e.g. overtime) in combination with low rewards were found to report increased frequency of health-related complaints (van der Hulst & Geurts, 2001). (Meijman, 1995) reported an explicit link between sympathetic activation and health, specifically his participants exhibited increased adrenaline in the bloodstream during work days (compared to rest days) and those individuals who reported frequent health complaints had elevated adrenaline levels relative to those with infrequent health complaints. A study on the need for recovery time following a period of work found similar results, i.e. elevated adrenaline at baseline and during rest days significantly predicted the number of health-related symptoms (Sluiter et al., 2001).

This relationship between stress, sympathetic activation and health is also moderated by personality traits. A Type D personality (a combination of social inhibition and trait negative affectivity) shows increased cortisol reactivity when exposed to a stressor and this trait has been linked to the development of cardiovascular disease (Habra et al., 2003). A disposition to express negative emotions, such as anger, in the workplace is also associated with elevated heart rate and blood pressure (Bongard & Al'Absi, 2005). Similarly, a failure to habituate to a repeated stressor, with respect to the cortisol reactivity, characterised those from an all-female sample who perceived their social status to be low (Adler et al., 2000). Other traits, such as over commitment to the job, express the interaction between personality and occupational demands. Recent research indicated that overcommitted workers were characterised by elevated levels of cortisol and increased systolic blood pressure during the working day (A Steptoe et al., 2004). The influence of stress on physiology may also express itself as an interaction between short-term states and trait dispositions, e.g. cardiovascular and neuroendocrinological responses to harassment are significantly enhanced for men with high hostility (Suarez et al., 1998).

The small number of studies that have addressed the interaction between sympathetic activation and interoceptive accuracy were reviewed in Section 5. The evidence supported a general view that increased sympathetic reactivity or the presence of a strong emotional responses improved interoceptive accuracy (Hantas et al., 1982). Therefore, sympathetic activation may act as a "gain" function, amplifying the intensity of physical sensation and increasing the salience of internal symptoms, which is

also used to cue specific feelings and emotional labels as suggested by (Damasio, 1999) (section 2.1). According to this view, the presence of occupational stress may enhance interoceptive accuracy or awareness as well as intensifying the experience of both positive and negative emotion.

The interaction between awareness and affect is crucial when interoceptive awareness is enhanced in presence of those negative emotions, such as anger, anxiety and depression, which are often associated with occupational stress. Increased negative affect raises awareness of bodily symptoms whilst simultaneously biasing interpretation of those symptoms towards of negative or "catastrophising" attributions, particularly for those already predisposed to this direction, e.g. individuals with high hostility, trait anxiety or negative affectivity (section 4.2).

The findings of Katkin et al (1982) support this scenario, suggesting that interoceptive accuracy was enhanced by the induction of negative but not positive emotions. However, the study performed by Wiens et al (2000) reported that interoceptive accuracy improved following the induction of both positive and negative emotions. According to most analyses (Matthews, 1992; Russell & Barrett, 1999; Thayer, 1989), mood may be characterised according to several dimensions: affect (happiness-sadness), arousal/activation (alertness-tired) and valence (approach-avoid). As suggested earlier, it is easy to understand how high activation/arousal has a beneficial influence on interoceptive accuracy/awareness via an association with sympathetic ANS activation, but the influence of valence and affect on awareness and attention to physical symptoms is difficult to predict.

It is possible that affect may influence interoception via stress-related changes in psychophysiology as does activation/arousal. A field study conducted by(Shapiro et al., 2001) reported increased heart rate and blood pressure during negative mood states, but no significant physiological changes during episodes of positive mood. Similarly, an endocrinological study of female participants reported an increase of noradrenalin during episodes of distress; this effect was amplified by elevations of both adrenaline and cortisol when participants reported feeling "pressured" (Szczepanski et al., 1997). Therefore, an enhancement of interoceptive accuracy or awareness by negative affect may depend on patterns of neurohormonal release in conjunction with sympathetic activation of the ANS.

The link between negative affect and interoceptive accuracy is also supported by neurophysiological research. The work of (Critchley, 2004; Critchley et al., 2001; Critchley et al., 2004) emphasises the role of right anterior insula (rAI) during interoception (section 2.1). The level of activation of the rAI and the size of this structure were both correlated with interoceptive accuracy(Critchley et al., 2004). In addition, rAI activation was a significant predictor of perceived anxiety during the experimental task, which also correlated with interoceptive accuracy (no evidence was found of any correlation between positive affect and interoceptive accuracy). The same study also reported a significant association between the 'awareness' subscale of the Body Perception Questionnaire (Porges, 1993) and the size of the rAI. Therefore, size and activation of the rAI were associated with interceptive awareness and accuracy respectively. The process of interoception and the perception of emotional states appears to converge around the rAI and right orbitofrontal cortex, as these structures provide the "second-order representation of self" underlying subjective feeling states (Craig, 2002, 2004; Critchley, 2004; Damasio, 1999; Dolan, 2002).

There are at least three links between the neurophysiological foundations of interoception, stress and the literature on frontal asymmetry effects. Negative/withdrawal emotions are associated with greater right frontal activation, and these emotional states improve interoceptive accuracy/awareness via the rAI and the right orbitofrontal cortex. It is also proposed that a connection may exist between the approach/withdrawal dichotomy from the frontal asymmetry literature and the external/internal focus of

attention in the current review. A tendency to withdraw from a person or situation would tend to turn attention inwards from the outside world to focus on the self. When an individual wishes to approach a person or situation, attention is focused outwards into the external world. Therefore, the focus of attention may be subsumed within the left/right frontal asymmetry, which would explain why increased activation of the right hemisphere enhances interoceptive accuracy or awareness. Finally, it is assumed that stress would increase negative affect and a tendency to withdraw, which may be measured via increased activation of the right frontal sites. A recent study artificially created a physiological stress response by injecting participants with cortisol (Tops et al., 2005); they reported that a cortisol injection increased activation of right frontal sites. Therefore, a neurohormonal correlate of occupational stress is associated with those interoceptive sites in the right frontal hemisphere of the brain.

The consistent finding that males exhibit superior performance relative to females during laboratory tests of interoceptive accuracy may reflect underlying physiological differences, but evidence is sparse and this topic remains open to speculation. The study performed by (Cameron & Minoshima, 2002) reported that increased activation of the rAI in response to chemical stimulation was specific to female participants and right-handed individuals. There is evidence from work on frontal EEG asymmetry that defensive males exhibit higher right frontal activation (Kline et al., 1998; Kline et al., 1999) in direct contradiction to the expected pattern (see earlier), but recent evidence seems to contradict gender-specific effects with respect to frontal asymmetry (Kline et al., 2002).

To summarise: sympathetic activation of the ANS and elevated neurohormonal levels during occupational stress may increase interoceptive awareness by amplifying the salience of physical symptoms. This effect may be particularly relevant for those negative emotions that accompany occupational stress, which may: (a) increase physiological reactivity, (b) increase interoceptive accuracy, and (c) induce a pattern of behavioural withdrawal.

6.2 SYMPTOM REPORTING AND OCCUPATIONAL STRESS

Attentional processes to bodily symptoms have been discussed in Section 3 and lead to a conclusion that these factors are as significant as physiological change for the process of symptom reporting.

The direction of attention refers to the division of attention between the self and the external world and it has been suggested that in a stimulating environment containing many external stimuli a symptom is less likely to be recognised (Cioffi, 1991). In an occupational setting it could therefore be hypothesised that individuals in a job that could be described as “boring”, in an environment lacking interest, would be likely to report increased symptoms. Mohren, Swaen, Borm, Bast and Galama (2001) investigated factors that were related to the occurrence of the common cold. In the sample of employees who had reported a cold in the past 4 months, those in leadership positions were significantly underrepresented (Mohren et al., 2001). It could be inferred from this finding that those in leadership positions are predominantly in situations that are stimulating i.e. their environment is rich in information, compared to conditions where individuals in lower positions may have to perform routine and mundane tasks. Another interpretation is that those in powerful positions have more choice in their working lives and high levels of instrumentality in the workplace are protective against sickness absence (Evans & Steptoe, 2002).

Beliefs and illness hypotheses are an important determinant of attentional content and awareness of symptoms (Cioffi, 1991). The manipulation of beliefs was found to influence on the assessment of symptoms and related attributions (Pennebaker, 1982; Pennebaker & Epstein, 1983). An example of this effect in the workplace is mass psychogenic illness (MPI), when individuals who work together report the same symptoms that do not have a clear organic basis (section 3.1). It has been suggested that the illness

of a colleague influences attributional processes in regards to symptom perception and that common sensations, e.g. headaches, are perceived as being pathological (Pennebaker, 1994). Symptom attribution has been found to differ by position within a company. Linton & Warg (1993) looked at the attributional process in regards to back pain in a manufacturing company. Blue-collar workers tended to rate work-related factors as being involved in the development of their back pain whereas those in management who stated that individual factors were most important (Linton & Warg, 1993). The emergence or validation of work-related disorders can lead to an increase in the number of cases reported. This effect occurred in the U.S.A. when workers compensation laws were expanded to cover cumulative disorders of the upper extremities, leading to a rise in the reporting of this disorder and subsequently an increase in public recognition through press coverage (Brogmus et al., 1996). The same outcome was seen in Australia with the recognition of a condition named repetitive strain injury (RSI) (Cleland, 1987).

Gender differences have been revealed in symptom report studies and women consistently report more symptoms of illness than men (Gijsbers van Wijk et al., 1999; Gijsbers van Wijk & Kolk, 1997; Pennebaker, 1982) (Section 4.1). It would be hypothesised that women may be more likely to report occupational illness than men given that they score higher than men on most symptom report scales. Denton et al. (2004) found that of the socio-economic status indicators, occupational class was the most important determinant of health for women. Employed professional and semi-professional women had significantly worse self-rated health compared to those in semi/unskilled clerical roles. The effect of occupational class was less pronounced in men (Denton et al., 2004) indicating that the demands of high powered jobs may be more detrimental to women's health. The opposite effect was revealed when nurses and accountants were compared, as male nurses had significantly greater sickness absence than both female nurses and male accountants (Evans & Steptoe, 2002). This effect is possibly because the nursing profession has typically been seen as a feminine role that could create stress for men working in this position, or it could be because the men in this occupation are given the more strenuous and dangerous tasks e.g. lifting patients and working with the most dangerous clients.

Subjective reports of illness are influenced by personality factors, such as negative affectivity (Vassend & Skrondal, 1999; Watson & Pennebaker, 1989) (section 4.2.1). Trait negative affectivity has been found to be highly correlated with most symptom scales (Watson & Pennebaker, 1989). It has been proposed that individuals high in negative affectivity have a reporting bias, which may also lead to negative attitudes about their occupational role, hence the association between job satisfaction and subjective health reports (Heslop et al., 2002). Individuals high in negative affectivity may be more prone to experience difficulty at work and be less likely to reach managerial positions, whilst still finding the lower positions stressful. An individual high in negative affectivity is hypothesised to find an unstable work environment harder to cope with, amplifying the impact this situation has on his/her health status. Illness attributions are also important in relation to negative affectivity. An individual high in NA is likely to over-report, to attribute symptoms to stress at work and subsequently to take time off work (section 4.2.1).

A distinction can be made between trait and state negative affectivity, and state NA (current distress) has the greatest impact on symptom reports (Kolk et al., 2003). It is important to take account of both state and trait measures of personality variables, as a negative mood can influence subjective reporting. Kolk et al. (2003) found that gender was highly correlated with trait negative affectivity, whilst negative mood (state NA) showed only a weak correlation with gender. This provides evidence of a divergent effect between state and trait NA.

Symptom perception studies have used both current and retrospective self-report measures (Kolk et al., 2002, 2003). Significant differences have been found between both designs. When symptoms were

measured concurrently, high symptom frequency was associated with more chronic disease, greater selective attention to the body and less external information. This pattern disappeared when symptoms were measured retrospectively and higher symptom frequency was associated with female gender and a higher tendency to attribute symptoms to a psychological cause (Kolk et al., 2003). Retrospective accounts are reliant on memory and may be susceptible to the bias of current psychological state or the influence of other memories from the time period in question. It seems plausible from these findings that retrospective symptom reports do not measure actual physical state for the time the study is concerned with, but measures the extent to which an individual is vulnerable to over-reporting. It is possible that women would not show such different reports to men if current symptoms were always measured. Gijsbers van Wijk et al. (1999) suggested that longitudinal designs are most suited to investigate the effect the effect of mood variables on symptom perception, particularly in an occupational setting when stress levels fluctuate throughout the year.

The symptom perception model (Kolk et al., 2003) summarises many of the processes that have been discussed in the review. The model proposes that there is no simple correspondence between physiological change and the perception of physical symptoms. Physiological changes trigger receptors in the body that generate information about current physical state, but only a small amount of this information brings about awareness of bodily change. Awareness of physical sensations is influenced by attention to the body and negative affectivity, as well as the amount of external information. The next stage in the model, where a change in bodily state is interpreted as pathological or not, is influenced by illness schemas and ideas about disease. This interpretation also directs the content and focus of attention with respect to the symptom (Kolk et al., 2003). The final process of coping determines the behavioural outcome associated with symptom perception, e.g. talk to friends, seek medical advice, and suppress awareness of the symptom. The "coping" stage has the greatest impact in an occupational setting as this is when an individual decides whether or not to take sickness absence. One issue concerns how symptom perception influences the coping process, i.e. does an awareness of illness symptoms create an increased tendency to take sick leave? It has been found that episodes of sickness absence lasting 4-21 days were 1.5 times higher for women who had many physical symptoms than for women who had few symptoms, however, when the other variables, including psychological factors e.g. depression, sleep disturbances, tension, were entered into the model the influence of physical symptoms decreased (Vaananen et al., 2003). There is no sure way of predicting what action an individual will take but if more information is known about their psychological profile and the beliefs they hold one has a better chance.

REFERENCES

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, white women. Health Psychology, 19 (6), 586-592.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th edition). Washington, DC: American Psychiatric Association.

Aronson, K. R., Feldman Barrett, L., & Quigley, K. S. (2001). Feeling your body or feeling badly. Evidence for the limited validity of the somatosensory amplification scale as an index of somatic sensitivity. Journal of Psychosomatic Research, 51 , 387-394.

Asmundson, G. J. G., Sandler, L. S., Wilson, K. G., & Norton, G. R. (1993). Panic attacks and interoceptive acuity for cardiac sensation. Behaviour Research and Therapy, 31 , 193-197.

Bar, K. J., Greiner, W., Letsch, A., Kobele, R., & Sauer, H. (2003). Influence of gender and hemispheric lateralization on heat pain perception in major depression. Journal of Psychiatric Research, 37 , 345-353.

Barsky, A. J., & Borus, J. F. (1999). Functional somatic syndromes. Annals of Internal Medicine, 130 , 910-921.

Barsky, A. J., Goodson, J. D., Lane, R. S., & Cleary, P. D. (1988). The amplification of somatic symptoms. Psychosomatic Medicine, 50 , 510-519.

Barsky, A. J., Wyshak, G., & Klerman, G. L. (1990). The somatosensory amplification scale and its relationship to hypochondrias. Journal of Psychiatric Research, 24 (4), 323-334.

Bergh, O. V. D., Winters, W., Devriese, S., Diest, I. V., Vos, G., & Peutter, S. D. (2004). Accuracy of respiratory symptom perception in persons with high and low negative affectivity. Psychology and Health, 19 (2), 213-222.

Berman, S., Munakata, J., Naliboff, B. D., Chang, L., Mandelkern, M., & Silverman, D. (2000). Gender differences in regional brain response to visceral pressure in ibs patients. European Journal of Pain, 4 , 157-172.

Berntson, G. G., Cacioppo, J. T., & Quigley, K. S. (1991). Autonomic determinism: The modes of autonomic control, the doctrine of autonomic space, and the laws of autonomic constraint. Psychological Review, 98 (4), 459-487.

Berntson, G. G., Cacioppo, J. T., Quigley, K. S., & Farbo, V. T. (1994). Autonomic space and psychophysiological response. Psychophysiology, 31 , 44-61.

Blascovich, J., Brennan, K., Tomaka, J., & Kelsey, R. M. (1992). Affect intensity and cardiac arousal. Journal of Personality and Social Psychology, 63 (1), 164-174.

Bongard, S., & Al'Absi, M. (2005). Domain-specific anger expression and blood pressure in an occupational setting. Journal of Psychosomatic Research, 58 , 43-49.

Bookbinder, R., & Jolly, D. (2001). Population based interventions to change back pain and disability: Three part evaluation. BMJ, 322 , 1516-1520.

Brogmus, G. E., Sorock, G. S., & Webster, B. S. (1996). Recent trends in work-related cumulative stress disorder of the upper extremeties in the united states: An evaluation of possible reasons. JOEM, 38 (4).

Cameron, O. G. (2001). Interoception: The inside story - a model for psychosomatic processes. Psychosomatic Medicine, 63 , 697-710.

Cameron, O. G., & Minoshima, S. (2002). Regional brain activation due to pharmacologically induced adrenergic interoceptive stimulation in humans. Psychosomatic Medicine, 64 , 851-861.

Churchland, P. S. (2002). Self-representation in nervous systems. Science, 296 , 308-310.

Cioffi, D. (1991). Beyond attentional strategies: A cognitive-perceptual model of somatic interpretation. Psychological Bulletin, 109 (1), 25-41.

Cleland, L. G. (1987). 'rsi': A model of social iatrogenesis. The medical journal of Australia, 147 .

Costa, P. T., & McCrae, R. R. (1985). Hypochondriasis, neuroticism, and ageing: When are somatic complaints unfounded? American Psychologist, 40 , 19-28.
Cox, D. J., Clarke, W. L., Gonder-Frederick, L. A., Pohl, S., Hoover, C., Snyder, A., et al. (1985). Accuracy of perceiving blood glucose in iddm. Diabetes Care, 8 , 529-535.
Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. Nature Reviews: Neuroscience, 3 , 655-666.
Craig, A. D. (2003). Interoception: The sense of the physiological condition of the body. Current Opinion in Neurobiology, 13 , 500-505.
Craig, A. D. (2004). Human feelings: Why are some more aware than others? Trends in Cognitive Sciences, 8 (6), 239-241.
Critchley, H. D. (2004). The human cortex responds to an interoceptive challenge. Proceedings of the National Academy of Science, 101 (17), 6333-6334.
Critchley, H. D., Melmed, R. N., Featherstone, E., Mathias, C. J., & Dolan, R. J. (2001). Brain activity during biofeedback relaxation: A functional neuroimaging investigation. Brain, 124 , 1003-1012.
Critchley, H. D., Melmed, R. N., Featherstone, E., Mathias, C. J., & Dolan, R. J. (2002). Volitional control of autonomic arousal: A functional magnetic resonance study. NeuroImage, 16 , 909-919.
Critchley, H. D., Wiens, S., Rotshtein, P., Ohman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. Nature Neuroscience, 7 , 189-195.
Dahme, B., Richter, R., & Mass, R. (1996). Interoception of respiratory resistance in asthmatic patients. Biological Psychology, 42 , 215-229.
Damasio, A. R. (1999). The feeling of what happens: Body and emotion in the making of consciousness . New York: Harcourt Brace.
Denton, M., Prus, S., & Walters, V. (2004). Gender differences in health: A canadian study of the psychosocial, structural and behavioural determinants of health. Social Science & Medicine, 58 , 2585-2600.
Derbyshire, S. W. G. (1997). Sources of variation in assessing male and female responses to pain. New Ideas in Psychology, 15 (1), 83-95.
Dolan, R. J. (2002). Emotion, cognition and behaviour. Science, 298 , 1191-1194.
Ehlers, A., & Breuer, P. (1992). Increased cardiac awareness in panic disorder. Journal of Abnormal Psychology, 101 , 371-382.
Ehlers, A., Margraf, J., Roth, W. T., Taylor, C. B., & Birbaumer, N. (1988). Anxiety induced by false heart rate feedback in patients with panic disorder. Behaviour Research and Therapy, 26 , 1-11.
Eichler, S., & Katkin, E. S. (1994). The relationship between cardiovascular reactivity and heartbeat detection. Psychophysiology, 31 , 229-234.
Evans, O., & Steptoe, A. (2002). The contribution of gender-role orientation, work factors and home stressors to psychological well-being and sickness absence in male- and female-dominated occupational groups. Social Science & Medicine, 54 , 481-492.
Fillingim, R. B., Maixner, W., Girdler, S., Light, K. C., Sheps, D. S., & Mason, G. A. (1997). Ischemic but not thermal pain sensitivity varies across the menstrual cycle. Psychosomatic Medicine, 59 , 512-520.
Gibbons, F. X., Carver, C. S., Scheier, M. F., & Hormuth, S. E. (1979). Self-focused attention and the placebo effect: Fooling some of the people some of the time. Journal of Experimental Social Psychology, 15 , 263-274.
Gijsbers van Wijk, C. M. T., Huisman, H., & Kolk, A. M. (1999). Gender differences in physical symptoms and illness behaviour. A health diary study. Social Science & Medicine, 49 , 1061-1074.
Gijsbers van Wijk, C. M. T., & Kolk, A. M. (1997). Sex differences in physical symptoms: The contribution of symptom perception theory. Social Science & Medicine, 45 (2), 231-246.
Gijsbers van Wijk, C. M. T., Kolk, A. M., & Everaerd, W. T. A. M. (1991). Symptom sensitivity and sex differences in physical morbidity: A review of health surveys in the u.S.A. And the netherlands. Women and Health, 12 , 103-145.

Graham-Brown, R. A. C., Osborne, J. O., London, S. P., Fletcher, A. P., Shaw, D., Williams, D., et al. (1990). The initial effects of workload and outcome of a public education campaign on early diagnosis and treatment of malignant melanoma in leicestershire. British Journal of Rheumatology, 122 , 53-59.

Green, C. A., & Pope, C. R. (1999). Gender, psychosocial factors and the use of medical services: A longitudinal analysis. Social Science & Medicine, 48 , 1363-1372.

Habra, M. E., Linden, W., Anderson, J., & Weinberg, J. (2003). Type d personality is related to cardiovascular and neuroendocrine reactivity to acute stress. Journal of Psychosomatic Research, 55 (3), 235-245.

Hadjistavropoulos, H. D., Craig, K. D., & Hadjistavropoulos, T. (1998). Cognitive and behavioural responses to illness information: The role of health anxiety. Behaviour Research and Therapy, 36 , 149-164.

Hadjistavropoulos, H. D., Hadjistavropoulos, T., & Quine, A. (2000). Health anxiety moderates the effects of distraction versus attention to pain. Behaviour Research and Therapy, 38 , 425-438.

Hantas, M., Katkin, E. S., & Blascovich, J. (1982). Relationship between heartbeat discrimination and subjective experience of affective state. Psychophysiology, 19 , 563.

Hapidou, E. G., & DeCantanzaro, D. (1988). Sensitivity to cold pressor pain in dysmenorrheic women as a function of menstrual cycle phase. Pain, 34 , 277-283.

Hapidou, E. G., & Rollman, G. B. (1998). Menstrual cycle modulation of tender points. Pain, 77 , 151-161.

Harver, A., Katkin, E. S., & Bloch, E. (1993). Signal-detection outcomes on heartbeat and respiratory resistance in detection tasks in males and females. Psychophysiology, 30 , 223-230.

Hazlett-Stevens, H., Craske, M. G., Mayer, E. A., Chang, L., & Naliboff, B. D. (2003). Prevalence of irritable bowel syndrome among university students. The role of worry, neuroticism, anxiety sensitivity and visceral anxiety. Journal of Psychosomatic Research, 55 , 501-505.

Heslop, P., Smith, G. D., Metcalfe, C., Macleod, J., & Hart, C. (2002). Changes in job satisfaction, and its association with self-reported stress, cardiovascular risk factors and mortality. Social Science & Medicine, 54 , 1589-1599.

Hitchcock, P. B., & Mathews, A. (1992). Interpretation of bodily symptoms in hypochondriasis. Behaviour Research and Therapy, 30 , 223-234.

Horner, K. L. (1996). Locus of control, neuroticism, and stressors: Combined influences on reported physical illness. Personality and Individual Differences, 21 (2), 195-204.

Katkin, E. S. (1985). Blood, sweat and tears: Individual differences in autonomic self-perception. Psychophysiology, 22 , 125-137.

Katkin, E. S., Blascovich, J., & Goldband, S. (1981). Empirical assessment of visceral self-perception: Individual and sex differences in the acquisition of heartbeat discrimination. Journal of Personality and Social Psychology, 40 (6), 1095-1101.

Kellner, R., Abbott, P., Winslow, W. W., & Pathak, D. (1987). Fears, beliefs and attitudes in dsm-iii hypochondriasis. The Journal of Nervous and Mental Disease, 175 , 20-25.

Keogh, E., & Cochrane, M. (2002). Anxiety sensitivity, cognitive biases, and the experience of pain. The Journal of Pain, 3 (4), 320-329.

Keogh, E., Hamid, R., Hamid, S., & Ellery, D. (2004). Investigating the effect of anxiety sensitivity, gender and negative interpretative bias on the perception of chest pain. Pain, 111 , 209-217.

Keogh, E., Hatton, K., & Ellery, D. (2000). Avoidance versus focused attention and the perception of pain: Differential effects for men and women. Pain, 85 , 225-230.

Kline, J. P., Allen, J. J. B., & Schwartz, G. E. R. (1998). Is left frontal brain activation in defensiveness gender specific? Journal of Abnormal Psychology, 107 (1), 149-153.

Kline, J. P., Blackhart, G. C., & Joiner, T. E. (2002). Sex, lie scales, and electrode caps: An interpersonal context for defensiveness and anterior electroencephalographic asymmetry. Personality and Individual Differences, 33 , 459-478.

Kline, J. P., Blackhart, G. C., & Schwartz, G. E. R. (1999). Gender specificity of resting anterior electroencephalographic assymetry and defensiveness in the elderly. The Journal of Gender-Specific Medicine, 2 (4), 35-39.
Kolk, A. M., Hanewald, G. J. F. P., Schagen, S., & Gijsbers van Wijk, C. M. T. (2002). Predicting medically unexplained physical symptoms and health care utilization. A symptom-perception approach. Journal of Psychosomatic Research, 52 , 35-44.
Kolk, A. M., Hanewald, G. J. F. P., Schagen, S., & Gijsbers van Wijk, C. M. T. (2003). A symptom perception approach to common physical symptoms. Social Science & Medicine, 57 , 2343-2354.
Kroenke, K., & Spitzer, R. L. (1998). Gender differences in the reporting of physical and somatoform symptoms. Psychosomatic Medicine, 60 , 150-155.
Kuczmeirczyk, A. R., & Adams, H. E. (1986). Autonomic arousal and pain sensitivity in women with premenstrual syndrome at different phases of the menstrual cycle. Journal of Psychosomatic Research, 30 .
Lautenbacher, S., Pauli, P., Zaudig, M., & Birbaumer, N. (1998). Attentional control of pain perception: The role of hypochondriasis. Journal of Psychosomatic Research, 44 (2), 251-259.
Levine, J. D., Gordon, N. C., Smith, R., & Fields, H. L. (1982). Post-operative pain: Effect of extent of injury and attention. Brain Research, 234 , 500-504.
Linton, S. J. (in press). Do psychological factors increase the risk for back pain in the general population in both a cross-sectional and prospective analysis? European Journal of Pain .
Linton, S. J., & Warg, L. E. (1993). Attributions (beliefs) and job satisfaction associated with back pain in an industrial setting. Perception and motor skills, 76 , 51-62.
Macintyre, S. (1993). Gender differences in the perceptions of common cold symptoms. Social Science & Medicine, 36 , 15-20.
Mailloux, J., & Brener, J. (2002). Somatosensory amplification and its relationship to heartbeat detection ability. Psychosomatic Medicine, 64 , 353-357.
Manu, P., Lane, T. J., & Matthews, D. A. (1989). Somatization in patients with chronic fatigue. Psychosomatics, 30 , 388-395.
Martin, R., Lemos, K., & Leventhal, H. (2001). The psychology of physical symptoms and illness behaviour. In G. J. G. Asmundson, S. Taylor & B. J. Cox (Eds.), Health anxiety (pp. 22-45). London: John Wiley & Sons.
Matthews, G. (1992). Mood. In A. P. Smith & D. M. Jones (Eds.), Handbook of human performance (Vol. 3, pp. 161-193). London: Academic Press.
Mayne, T. J. (1999). Negative affect and health: The importance of being earnest. Cognition and Emotion, 13 (5), 601-635.
Mc Caul, K. D., & Malott, J. M. (1984). Distraction and coping with pain. Psychological Bulletin, 95 , 516-533.
McFarland, R. A. (1975). Heart rate perception and heart rate control. Psychophysiology, 12 , 402-405.
Meijman, T. F. (1995). Mental fatigue and the temporal structuring of working times. Paper presented at the 39th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, California.
Miller, L. C., Murphy, R., & Buss, A. H. (1981). Consciousness of body: Private and public. Journal of Personality and Social Psychology, 41 (2), 397-406.
Miller, S. M. (1987). Monitoring and blunting: Validation of a questionnaire to assess styles of information seeking under threat. Journal of Personality and Social Psychology, 52 , 345-353.
Miller, S. M., Brody, D. S., & Summerton, J. (1988). Styles of coping with threat: Implications for health. Journal of Personality and Social Psychology, 54 (1), 142-148.
Mohren, D. C. L., Swaen, G. M. H., Borm, P. J. A., Bast, A., & Galama, J. M. D. (2001). Psychological job demands as a risk factor for common cold in a dutch working population. Journal of Psychosomatic Research, 50 , 21-27.
Morgan, W., & Pollock, M. (1977). Psychologic characterization of the elite distance runner. Annals of the New York Academy of Sciences, 301 , 382-403.

Nguyen, P., Lee, S. D., & Castell, D. O. (1995). Evidence of gender differences in oesophagael pain threshold. American Journal of Gastroenterology, 90 , 901-905.
O'Brien, W. H., Reid, G. J., & Jones, K. R. (1998). Differences in heartbeat awareness among males with higher and lower levels of systolic blood pressure. International Journal of Psychophysiology, 29 , 53-63.
Pennebaker, J. W. (1982). The psychology of physical symptoms . New York: Springer Verlag.
Pennebaker, J. W. (1994). Psychological bases of symptom reporting: Perceptual and emotional aspects of chemical sensitivity. Toxicology and Industrial Health, 10 (4), 497-511.
Pennebaker, J. W., & Epstein, D. (1983). Implicit psychophysiology: Effects of common beliefs and idiosyncratic physiological responses on symptom reporting. Journal of Personality, 51 (3), 468-496.
Pennebaker, J. W., & Lightner, J. (1980). Competition of internal and external information in an exercise setting. Journal of Personality and Social Psychology, 39 , 165-174.
Pennebaker, J. W., & Skelton, J. A. (1981). Selective monitoring of physical sensations. Journal of Personality and Social Psychology, 41 (2), 213-223.
Peters, M. L., Vlaeyen, J. W. S., & Weber, W. E. J. (in press). The joint contribution of physical pathology, pain-related fear and catastrophising to chronic back pain disability. Pain .
Popay, J., Bartley, M., & Owen, C. (1993). Gender inequalities in health: Social position, affective disorders and minor physical morbidity. Social Science & Medicine, 1 , 21-32.
Porges, S. W. (1993). Body perception questionnaire : Laboratory of Developmental Assessment University of Maryland.
Put, C., Bergh, O. V. D., Ongeval, E. V., Peuter, S. D., Demedts, M., & Verleden, G. (2004). Negative affectivity and the influence of suggestion on asthma symptoms. Journal of Psychosomatic Research, 57 , 249-255.
Riley, J. L., Robinson, M. E., Wise, E. A., Myers, C. D., & Fillingim, R. B. (1998). Sex differences in the perception of noxious experimental stimuli: A meta-analysis. Pain, 74 , 181-187.
Ring, C., & Brener, J. (1996). Influence of beliefs about heart rate and actual heart rate on heartbeat counting. Psychophysiology, 33 , 541-546.
Roberts, T. A., & Pennebaker, J. W. (1995). Gender differences in perceiving internal state: Toward a his-and-hers model of perceived cue use. Advances in Experimental Social Psychology, 27 , 143-175.
Rosenstock, I. M. (1966). Why people use health services. Millbank Memorial Fund Quartely, 44 , 94-124.
Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. Journal of Personality and Social Psychology, 76 (5), 805-819.
Shapiro, D. A., Jamner, L. D., Goldstein, I. B., & Delfino, R. J. (2001). Striking a chord: Moods, blood pressure and heart rate in everyday life. Psychophysiology, 38 , 197-204.
Schandry, R., Leopold, C., & Vogt, M. (1996). Symptom reporting in asthma patients and insulin-dependent diabetics. Biological Psychology, 42 , 231-244.
Schwartz, G. (1982). Testing the biopsychosocial model: The ultimate challenge facing behavioural medicine. Journal of Consulting and Clinical Psychology, 50 , 1040-1053.
Sluiter, J. K., Frings-Dressen, M. H. W., van der Beek, A. J., & Meijman, T. F. (2001). The relation between work-induced neuroendocrine reactivity and recovery, subjective need for recovery, and health status. Journal of Psychosomatic Research, 50 , 29-37.
Speckens, A. E. M., Spinhoven, P., Sloekers, P. P. A., Bolk, J. H., & van Hemert, A. M. (1996). A validation study of the whitely index, the illness attitude scales, and the somatosensory amplification scale in general medical and general practice patients. Journal of Psychosomatic Research, 40 (1), 95-104.
Stegen, K., Neujens, A., Crombez, G., Hermans, D., Woestijine, K. P. D., & Bergh, O. V. D. (1998). Negative affect, respiratory reactivity, and somatic complaints in a co2 enriched air inhalation paradigm. Biological Psychology, 49 , 109-122.

Steptoe, A., & Noll, A. (1997). The perception of bodily sensations, with special reference to hypochondriasis. Behaviour Research and Therapy, 35 (10), 901-910.
Steptoe, A. (2001). Job control, perceptions of control, and cardiovascular activity: An analysis of ambulatory measures collected over a working day. Journal of Psychosomatic Research, 50 , 57-63.
Steptoe, A., Cropley, M., & Joekes, K. (2000). Task demands and the pressures of everyday life: Associations between cardiovascular reactivity and work blood pressure and heart rate. Health Psychology, 19 (1), 46-54.
Steptoe, A., Siegrist, J., Kirschbaum, C., & Marmot, M. G. (2004). Effort-reward imbalance, overcommitment, and measures of cortisol and blood pressure over the working day. Psychosomatic Medicine, 66 (3), 323-329.
Stewart, S. H., & Watt, M. C. (2000). Illness attitudes scale dimensions and their associations with anxiety-related constructs in a nonclinical sample. Behaviour Research and Therapy, 38 , 83-99.
Sturges, L. V., & Goetsch, V. L. (1996). Psychophysiological reactivity and heartbeat awareness in anxiety sensitivity. Journal of Anxiety Disorders, 10 (4), 283-294.
Suarez, E., Kuhn, C., Schanberg, S. M., Williams, R. B., & Zimmerman, E. A. (1998). Neuroendocrine, cardiovascular, and emotional responses of hostile men: The role of interpersonal challenge. Psychosomatic Medicine, 60 , 76-88.
Szczepanski, R., Napolitano, M., Feaganes, J. R., Barefoot, J. C., Luecken, L., Swoap, R., et al. (1997). Relation of mood ratings and neurohormonal response during daily life in employed women. International Journal of Behavioural Medicine, 4 , 1-16.
Thayer, R. E. (1989). The biopsychology of mood and arousal . New York: Oxford University Press.
Tops, M., Wijers, A. A., van Staveren, A. S. J., Bruin, K. J., Den Boer, J. A., Meijman, T. F., et al. (2005). Acute cortisol administration modulates eeg asymmetry in volunteers: Relevance to depression. Biological Psychology, 69 , 181-193.
Vaananen, A., Toppinen, S., Kalimo, R., Mutanen, P., Vahtera, J., & Peiro, J. M. (2003). Job characteristics, physical and psychological symptoms, and social support as antecedents of sickness absence among men and women in the private industrial sector. Social Science & Medicine, 57 , 807-824.
Vaitl, D. (1996). Interoception. Biological Psychology, 42 , 1-27.
van der Hulst, M., & Geurts, S. A. E. (2001). Associations between overtime and psychological health in high and low reward jobs . Work & Stress, 15 , 227-240.
Vassend, O. (1989). Dimensions of negative affectivity, self-reported somatic symptoms and health related behaviours. Social Science & Medicine, 28 , 29-36.
Vassend, O., & Skrondal, A. (1999). The role of negative affectivity in self-assessment of health. A structural equation approach. Journal of Health Psychology, 4 (4), 465-482.
Verbrugge, L. M. (1989). The twain meet: Empirical explanations of sex differences in health and mortality. Journal of Health and Social Behaviour, 30 , 282-304.
Wall, P. D., & Melzack, R. (1999). Textbook of pain (4th edition) (4th Edition ed.). London: Churchill Livingstone.
Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress and distress: Exploring the central role of negative affectivity. Psychological Review, 96 (2), 234-254.
Weins, S., & Palmer, S. N. (2001). Quadratic trend analysis and heartbeat detection. Biological Psychology, 58 , 159-175.
Whitehead, W. E., & Drescher, V. M. (1990). Perception of gastric contractions and self-control of gastric motility. Psychophysiology, 17 , 552-558.
Whitehead, W. E., Drescher, V. M., Heiman, P., & Blackwell, B. (1977). Relation of heart rate control to heart beat perception. Biofeedback and Self-Regulation, 2 , 371-392.
Wiens, S., Mezzacappa, E. S., & Katkin, E. S. (2000). Heartbeat detection and the experience of emotions. Cognition and Emotion, 14 (3), 417-427.

Williams, P. G., O'Brien, C. D., & Colder, C. R. (2004). The effects of neuroticism and extraversion on self-assessed health and health-relevant cognition. Personality and Individual Differences, 37 , 83-94.

Windmann, S., Schonecke, O. W., Frohlig, G., & Maldener, G. (1999). Dissociating beliefs about heart rates and actual heart rates in patients with cardiac pacemakers. Psychophysiology, 36 , 339-342.

Yates, A. J., Jones, K. E., Marie, G., & Hogben, J. (1985). Detection of the heartbeat and events in the cardiac cycle. Psychophysiology, 22 , 561-567.

Zoellner, L. A., & Craske, M. G. (1999). Interoceptive accuracy and panic. Behaviour Research and Therapy, 37 , 1141-1158.

APPENDIX B: FULL LISTING OF SYMPTOM CHECKLIST

1. Eyes water
2. Itching or painful eyes
3. Earache
4. Ringing in ears
5. Tinnitus
6. Temporary deafness of hard of hearing
7. Lump in throat
8. Hiccups
9. Choking sensation
10. Sneezing spells
11. Running nose
12. Congested nose
13. Bleeding nose
14. Asthma or wheezing
15. Coughing
16. Out of breath
17. Swollen ankles
18. Chest pains
19. Racing heart
20. Palpitations
21. Cold sweat
22. Cold hands or feet even in hot weather
23. Insomnia
24. Fatigue
25. Toothaches
26. Dry mouth
27. Loss of appetite
28. Upset stomach
29. Indigestion
30. Heartburn
31. Severe pains or cramps in stomach
32. Abdominal pain
33. Abdominal cramps
34. Painful breasts
35. Painful urination
36. Diarrhoea
37. Constipation
38. Flatulence
39. Anal itching or pain
40. Swollen joints
41. Stiff muscles
42. Leg cramps
43. Painful joints
44. Back pains
45. Sensitive or tender skin

46. Face flushes
47. Severe itching
48. Skin breaks out in rash
49. Acne or pimples on face/other than face
50. Boils
51. Sweat even in cold weather
52. Strong reactions to insect bites
53. Headaches
54. Sensation of pressure in head
55. Hot flushes
56. Chills
57. Dizziness
58. Feel faint
59. Numbness or tingling in any part of body
60. Twitching of eyelid
61. Twitching other than eyelid
62. Hands tremble or shake
63. Stiff joints
64. Sore muscles
65. Sore throat
66. Nausea

APPENDIX C: MEDICATION USAGE IN OCCUPATIONAL SAMPLE

Type of Medication	Frequency
Anticoagulent medication	2
Anticonvulsant medication	2
Antidiabetic medication	3
Antihistamine	11
Anti-malaria medication	1
Antimetabolite medication	3
Antispasmodic medication - IBS	4
Asprin	16
Asthma medication	39
Benzodiazapines	2
Beta blocker	6
Bisphosphonate – osteoperosis	4
Co-codamol	4
Diuretic medication	2
Gabapentin - epilepsy	2
Hormone replacement therapy	16
Hypertension medication	44
Insulin	9
Isosorbide mononitrate – angina pectoris	1
Leflunomide – rheumatoid arthritis	1
Lithium	2
Loop diuretic - congestive heart failure	2
Migraine medication	1
Painkillers	4
Proton pump inhibitor - acid disease	17
Selective oestrogen receptor modulator	1
Sinemet - Parkinson’s disease	1
Sleeping tablets	4
Statins	31
Steroids	5
Thyroid medication	14

APPENDIX D: HEALTH HISTORY AND CATEGORISATION FROM THE OCCUPATIONAL SURVEY

Illness	Category	Frequency
Anaemia	Chronic Medical Condition	2
Arthritis	Chronic Medical Condition	99
Asthma	Chronic Medical Condition	98
Benign essential tremor	Chronic Medical Condition	1
C.F.S./M.E.	Chronic Medical Condition	11
Chronic pain	Chronic Medical Condition	3
Crohns disease	Chronic Medical Condition	2
Diabetes	Chronic Medical Condition	22
Epilepsy	Chronic Medical Condition	1
Fibromyalgia	Chronic Medical Condition	1
Glaucoma	Chronic Medical Condition	1
High cholesterol	Chronic Medical Condition	5
Hypermobility syndrome	Chronic Medical Condition	1
Hypertension	Chronic Medical Condition	99
IBS	Chronic Medical Condition	14
Kidney/liver problems	Chronic Medical Condition	15
Multiple sclerosis	Chronic Medical Condition	1
Musculoskeletal conditions	Chronic Medical Condition	17
Obesity	Chronic Medical Condition	69
Osteoporosis/osteoarthritis	Chronic Medical Condition	5
Other heart conditions e.g. arrythmia	Chronic Medical Condition	4
Partial deafness	Chronic Medical Condition	1
Psoriasis	Chronic Medical Condition	7
Sciatica	Chronic Medical Condition	1
Ulcers	Chronic Medical Condition	9
Acne	Medical Condition	1
Allergies/Hayfever	Medical Condition	8
Alopecia	Medical Condition	1
Ear condition	Medical Condition	2
Eczema	Medical Condition	87
Gall bladder problems	Medical Condition	1
Gastric distress	Medical Condition	93
Gynaecological conditions	Medical Condition	9
Haemorrhoids	Medical Condition	1
Hernia	Medical Condition	2
Macular edema	Medical Condition	1
Mennier's syndrome - ear related	Medical Condition	1
Migraine headaches	Medical Condition	185
Night cramps	Medical Condition	1
Plantar fascitis - inflamation	Medical Condition	1

of the foot		
Illness	Category	Frequency
Prostate problems	Medical Condition	1
Raynaud's disease	Medical Condition	2
Sleep disorders	Medical Condition	4
Thyroid conditions	Medical Condition	7
Urticaria - skin lesions	Medical Condition	1
Eating Disorder	Psychiatric Problem	13
Anxiety Disorder	Psychiatric Problem	123
Depressive Disorder	Psychiatric Problem	125
Stress/Work-related stress	Psychiatric Problem	14
Cancer	Serious Illness	5
Heart disease/Heart attack	Serious Illness	15
Parkinson's disease	Serious Illness	2
Pneumonia	Serious Illness	7
Stroke	Serious Illness	1

APPENDIX E: ROTATED COMPONENT MATRIX FOR FACTOR ANALYSIS OF BODY CONSCIOUSNESS VARIABLES

ITEM	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
PBC1	0.172	0.233	-0.129	0.683
PBC2	0.16	0.066	-0.033	0.596
PBC3	0.178	0.142	0.195	0.56
PBC4	0.094	0.056	-0.072	0.589
PBC5	0.193	0.055	0.067	0.659
SSA1	0.011	0.056	0.203	0.184
SSA2	-0.051	-0.047	0.078	0.347
SSA3	0.192	0.267	-0.067	0.683
SSA4	0.185	0.013	0.238	0.404
SSA5	0.038	0.109	0.288	0.447
SSA6	0.17	0.15	0.27	0.507
SSA7	0.08	0.092	0.178	0.499
SSA8	0.15	0.216	0.274	0.329
SSA9	-0.01	0.138	0.137	0.229
ANS1	0.139	0.117	0.663	0.057
ANS3	0.072	0.084	0.56	0.041
ANS6	0.196	0.113	0.651	0.07
ANS7	0.118	0.09	0.747	0.037
ANS9	0.185	0.064	0.476	0.052
ANS10	0.188	0.054	0.456	0.016
ANS11	0.158	0.013	0.578	0.262
ANS12	0.105	0.085	0.59	-0.064
ANS16	0.165	0.085	0.578	0.1
ANS18	0.139	0.061	0.607	0.267
BA2	0.424	0.108	0.306	0.148
BA3	0.556	0.132	0.242	0.206
BA4	0.567	0.102	0.096	0.178
BA5	0.761	0.113	0.026	0.057
BA6	0.782	0.037	-0.013	0.007
BA7	0.654	0.14	0.214	0.088
BA8	0.61	0.143	0.214	0.129
BA9	0.732	-0.023	0.154	0.063
BA10	0.564	0.018	0.279	0.099
BA11	0.537	0.015	0.211	0.214
BA12	0.399	0.097	0.161	0.222
BA13	0.737	0.064	0.033	0.138
BA14	0.665	-0.065	0.144	0.065
BA15	0.676	-0.018	0.134	0.059
HA1	0.04	0.591	0.146	0.148
HA2	0.139	0.422	0.1	0.128
HA3	0.33	0.363	-0.155	0.486
HA4	0.06	0.682	0.171	0.183
HA5	-0.004	0.757	0.04	0.018

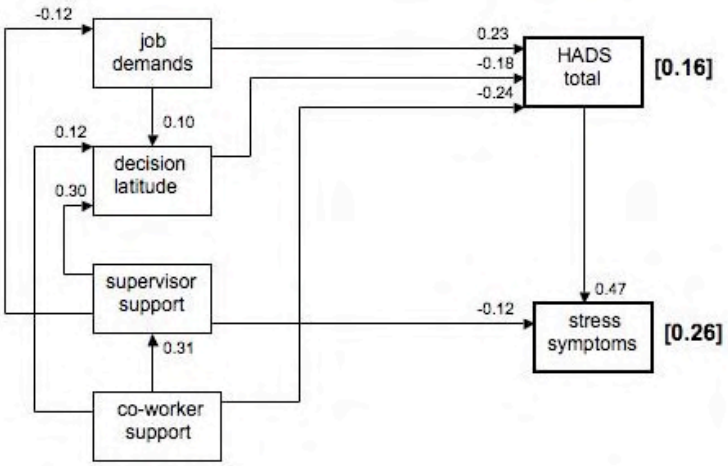
ITEM	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
HA6	0.053	0.653	0.11	0.086
HA7	0.061	0.719	0.148	0.136
HA8	0.082	0.547	0.124	0.041
HA9	0.019	0.51	0.069	0.003
HA10	0.134	0.557	-0.107	0.261
HA11	0.005	0.627	0.132	0.018
HA12	0.008	0.733	0.074	0
HA13	0.082	0.647	0.051	0.139

Key to abbreviated items:

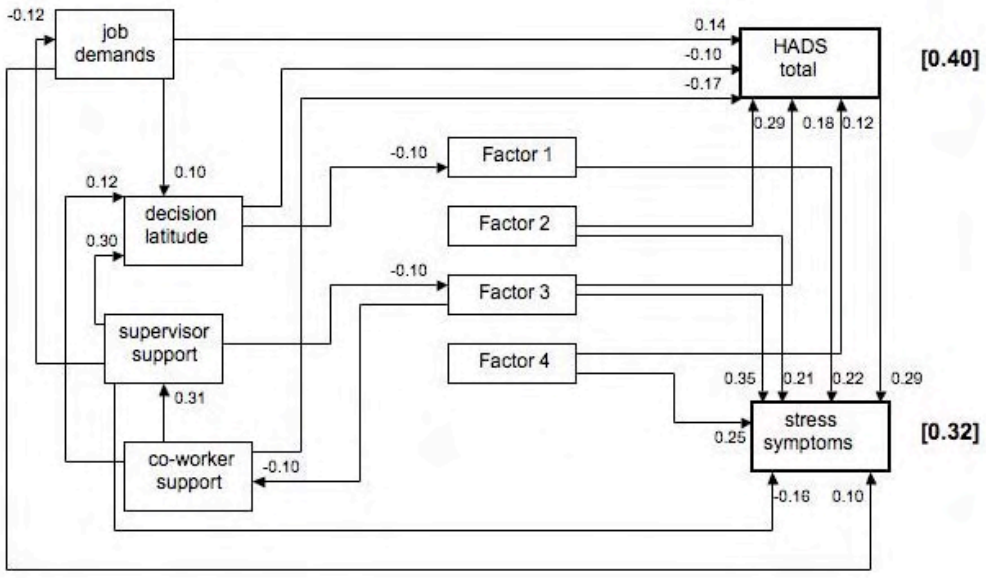
PBC1	I am sensitive to internal bodily sensations
PBC2	I know immediately when my mouth or throat gets dry
PBC3	I can often feel my heart beating
PBC4	I am quick to sense hunger contractions of my stomach
PBC5	I'm very aware of changes in my body temperature
SSA1	"When someone else coughs, it makes me cough too"
SSA2	"I can't stand smoke, smog or pollutants in the air"
SSA3	I am often aware of various things happening within my body
SSA4	"When I bruise myself, it stays noticeable for a long time"
SSA5	Sudden loud noises really bother me
SSA6	I can sometimes hear my pulse or my heartbeat throbbing in my ear
SSA7	I hate to be too hot or too cold
SSA8	"Even something minor, like an insect bite, really bothers me"
SSA9	I have a low tolerance for pain
ANS1	I have difficulty coordinating breathing and eating
ANS3	"When I am eating, I have difficulty talking"
ANS6	I have difficulty coordinating breathing with talking
ANS7	"When I eat, I am difficulty coordinating swallowing/chewing with breathing"
ANS9	"I drool, especially when I am excited"
ANS10	"I produce a lot of saliva, even when I am not eating"
ANS11	I have difficulty adjusting my eyes to changes in illumination
ANS12	I gag when I eat
ANS16	I have difficulty controlling my eyes
ANS18	I have trouble focusing when I go into dim or brightly illuminated places
BA2	Body swaying when standing
BA3	How fast I am breathing
BA4	Noise associated with digestion
BA5	Urge to urinate
BA6	Urge to defecate
BA7	Muscle tension in arms or legs
BA8	Muscle tension in face
BA9	Goosebumps
BA10	Clumsiness or bumping into people
BA11	Temperature of face
BA12	Grinding teeth
BA13	Fullness of bladder

BA14	Nose itching
BA15	Hair on neck standing up
HA1	Worry about my health
HA2	Notice aches and pains
HA3	Aware of bodily sensations
HA4	Can resist thoughts of illness
HA5	Afraid I have a serious illness
HA6	Have images of myself being ill
HA7	Have difficulty taking my mind off thoughts about my health
HA8	Am lastingly relieved if my doctor tells me there is nothing wrong
HA9	Must know the meaning of a bodily sensation or change
HA10	Feel at a very low risk of developing a serious illness
HA11	Never think I have a serious illness
HA12	Find it difficult to think about other things if I notice an unexplained bodily sensation
HA13	Friends or family would say that I am a hypochondriac

APPENDIX F: PATH ANALYSIS MODELS



Initial path model using JCQ components to predict stress-related symptoms and psychological distress (N=689)



Second version of the path model using JCQ components in combination with body awareness factors to predict stress-related symptoms and psychological distress (N=689)

Published by the Health and Safety Executive 06/08

HSE

Health and Safety Executive

Attention, awareness and occupational stress

Symptoms associated with occupational stress, such as muscular pain and fatigue, are common in the working population. These types of symptoms have been termed idiopathic; in other words, it is difficult to link these symptoms to a definite physical cause. To complicate matters further, idiopathic symptoms are often associated with psychological variables such as anxiety and depression. Despite these difficulties, idiopathic symptoms represent an important index of occupational health and play an significant role in the decision to seek medical consultation. However, the origins of these symptoms are not well understood particularly with respect to the influence of psychological factors.

This project is primarily concerned with the influence of attentional factors on the perception of idiopathic symptoms associated with occupational stress. Attention is fundamentally goal-driven and selective. We attend to a certain category of stimuli to reinforce existing beliefs. If a person has negative beliefs about health, they are inclined to actively monitor bodily signs and symptoms for evidence of illness. A person who is experiencing an uncomfortable or troubling symptom also tends to direct attention internally to the body, at the expense of attending to events in the external world. By directing attention internally, the person experiences a higher level of body consciousness or awareness.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

RR644

www.hse.gov.uk