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**Mechanisms of Mindfulness: The role of feedback  
from the body.**

**Ruth Morgan**

D. Clin. Psy. Thesis (Volume 1) 2007

University College London

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## **OVERVIEW OF VOLUME ONE**

This volume is in three parts. The first part is review of the literature on mindfulness meditation focused on the mechanisms by which mindfulness might lead to a variety of benefits to mental and physical health. The review briefly describes mechanisms that have been proposed and then focuses on different methodological approaches that have been used to study these mechanisms, what this research tell us and what its limitations are. The second part is an empirical paper, summarising a study looking at whether mindfulness might work by changing feedback from the body. The effects of a mindfulness exercise that cultivates awareness of bodily sensations was compared to a mindfulness exercise focused on awareness of sounds to investigate the hypothesis that changing awareness of the body through mindfulness might lead to beneficial changes in emotion and cognition. The final part of this volume is a critical review which intends to extend the discussion of the empirical paper and discuss design decisions, limitations and to reflect on the process of completing the study.

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## **Part 1: Literature Review**

### **Mechanisms of Mindfulness**

## **ABSTRACT**

The aim of this paper is to provide a comprehensive review and evaluation of the psychological literature pertaining to mechanisms of mindfulness meditation. Mechanisms explored include meta-cognitive change, exposure, acceptance, relaxation, self management and changes in body-state feedback. A number of different methodological approaches have been used to explore these mechanisms. Examples of each approach are explored and limitations described. The vast majority of research into mindfulness has focused on treatment outcome studies which reveal little about what mechanisms are activated by mindfulness meditation. Other approaches have yielded some preliminary support for each of the proposed mechanisms although this support is methodologically weak. It is argued that there have been few direct tests of these mechanisms and that this is a priority for future mindfulness research.

## INTRODUCTION

Mindfulness based interventions are becoming increasingly popular in health settings for a wide range of health, mental health and general stress reduction purposes.

Research is starting to show that these interventions are often effective in what could be argued is a bewildering range of clinical problems (from stress levels in students to persistent psychosis to psoriasis and cancer), affecting an equally bewildering array of outcomes (including mood, empathy, immune function, spirituality, work performance). How can these effects be understood? Does mindfulness have widespread beneficial effects because it targets processes that are common across a range of clinical problems, or does it work through a range of different processes which are more or less important for different people?

This review aims to examine existing understanding of how mindfulness may lead to wide ranging health benefits. This will start with descriptions of mindfulness and of the major programmes or interventions in which mindfulness is currently being taught along with a brief summary of the efficacy literature to date, and a discussion of the importance of studying mechanisms of action. The main body of this review will summarise the different mechanisms of mindfulness which have been proposed to be important, focusing on meta-cognitive change, exposure, acceptance, relaxation, self management and body-state feedback. This will be followed by a review of the empirical research into mindfulness, organised by methodological approach, and how this research relates to the mechanisms that have been proposed. It will be concluded that although there is some preliminary support for each of the mechanisms there are significant methodological weaknesses, little research directly

testing these mechanisms and a lack of research testing competing mechanisms. All of these factors make it difficult to draw any clear conclusions about which mechanisms are most important at present. This review will argue that the different mechanisms need to be more clearly specified theoretically and that validated and reliable measures of these processes need to be developed. It will be concluded that decompartmentalising studies may be particularly useful in distinguishing between the different mechanisms.

This review will not focus on studies of the neurophysiological effects of mindfulness, for which readers are directed to reviews by Ivanovski and Malhi (2007) or Cahn and Polich (2006).

### **What is mindfulness - Definitions and descriptions**

Mindfulness has historically been described as “the heart” of Buddhist meditation (Thera 1962). The complexity in defining what mindfulness is has been discussed at length (see special issue of Clinical Psychology Science and Practice; 2003, 10(2)). For the purpose of this review all definitions of mindfulness have seemed to emphasise the following three components: ‘paying attention: on purpose in the present moment and non-judgementally’ (Kabat-Zinn, 1994, p3). ‘Paying attention’ refers to the monitoring of the focus of attention, that is being aware of where one’s attention lies. ‘On purpose in the present moment’ involves intentionally bringing awareness back to the present moment and to allow what is occurring in that moment, whether that be internal sensations, thoughts, emotions or external sounds and sights, to fill the awareness. That is, to accept *whatever* experiences are occurring rather than trying to change them, avoid them or prolong them. ‘Non

judgementally' refers to the attempts made whilst practising mindfulness to observe but not to evaluate as good or bad, whatever phenomena, internal or external, arise in the field of awareness.

One of the confusions in the literature is that the term 'mindfulness' has been used to describe both the state of mindfulness, that is a particular state of consciousness, as well as the practices that are used to cultivate this state. Often the term mindfulness is used interchangeably with meditation. However Brown and Ryan (2003) and others (e.g. Kabat-Zinn, 2003) argue against seeing mindfulness as merely a product of meditation and argue instead that it is 'an inherent natural capacity of the human organism'. Kabat-Zinn regards meditation practices as 'merely a launching platform....to invite cultivation and sustaining of attention in particular ways'.

However he also argues that it would be difficult to develop and sustain this capacity over time without some intentional disciplined practice. 'Mindfulness is not merely a good idea such that upon hearing about it, one can immediately decide to live in the present moment' (Kabat-Zinn; 2003, p148).

Shapiro, Carlson, Astin and Freedman (2006) agree that meditation is a powerful method to increase mindfulness but argue that dispositional mindfulness is increased to the extent to which individuals bring their practice into their daily lives and that it is possible that mindfulness might be cultivated via other practices such as psychotherapy. In some programmes that will be briefly mentioned in this review there is little emphasis on formal meditation practice and more emphasis on bringing awareness and acceptance to everyday life. The relative merits of these different approaches is not yet known.

### **Clinical interventions that aim to cultivate mindfulness.**

In the last 20 years Western Psychology has shown increasing interest in the theoretical ideas behind mindfulness and how it can be applied in clinical settings to alleviate distress. The most commonly cited mindfulness training programme is the Mindfulness Based Stress Reduction Programme (MBSR; Kabat Zinn 1982, 1990) which was originally developed to help patients in the management of chronic pain (Kabat-Zinn, 1982) and is now also used to treat emotional and behavioural disorders and to reduce psychological difficulties associated with chronic illness (e.g. Kabat-Zinn et al. 1998).

MBSR is a two month long group programme where participants meet weekly with an instructor to practice a variety of mindfulness meditation exercises and explore and discuss their experiences. Participants also commit to 45 minutes meditation practice at home for 6 days a week for the duration of the course. During the meditation practice participants are instructed to gently focus their attention on a particular aspect of their experience in that moment, initially starting with the breath and bodily sensations whilst lying, sitting, walking and doing yoga stretches and then to include sounds, thoughts and open awareness. In all of these exercises, when one realises that one's mind has wandered off (into memories, planning, worrying, daydreaming or pulled along into thoughts by a particular sensation or sound or emotion) as it will inevitably do over and over again, participants are encouraged to simply note where the mind has gone off to without judging or reacting. The task is then to gently return awareness to the present moment. Thus the task is to observe rather than be carried along by thoughts, sensations and emotions and by this

observation becoming gradually aware of the transient nature of these phenomena.

Mindfulness meditation contrasts to other forms of meditation such as transcendental meditation where attention is focused on a single stimulus and is brought back to that object if the mind wanders without attention to where the mind has wandered to. In mindfulness a particular aspect of experience may be held in the 'foreground' of awareness but awareness being pulled away and brought back again is seen as part of the practice.

Segal, Williams & Teasdale (1995, 2002) developed Mindfulness Based Cognitive Therapy (MBCT) as an intervention aimed at reducing depressive relapse in a high risk population (people who had previously experienced depressive episodes, which are known to increase the likelihood of successive episodes, Judd, 1997). Based on their theoretical model of depressive relapse, where negative mood triggers a ruminative discrepancy based thinking style that becomes self perpetuating, Segal et al. devised MBCT based largely on the MBSR program, including all the formal meditation practices but also incorporating aspects of cognitive therapy such as positive event scheduling, psycho-education about the nature of depression and negative automatic thoughts and relapse prevention.

Mindfulness is also a focus of two other approaches; Dialectical Behaviour Therapy (DBT, Linehan, 1993a&b) and Acceptance and Commitment Therapy (ACT; Hayes, Strosahl & Wilson 1999). However these therapies differ substantially from MBSR and MBCT in that formal meditation practice is much less emphasised and mindfulness is cultivated via exercises other than meditation. In addition alternative strategies are more prominent (e.g. building valued goals, emotion regulation, and



interpersonal skills). The focus of this review will be on interventions or manipulations where the main intervention is mindfulness meditation practice. Studies of Acceptance and Commitment Therapy and Dialectical Behaviour Therapy will be only be mentioned where relevant as the mindfulness components of these therapies has not been studied separately from the non mindfulness-based parts. Mindfulness practice looks very different in these approaches and the effect of those differences is not yet known.

### **The evidence base**

Two meta-analyses have summarised the empirical research into the effectiveness of mindfulness based interventions. Both of these have focused on MBSR and MBCT and did not include studies of DBT or ACT for reasons already mentioned. Baer's meta-analysis (2003) included 21 mindfulness studies and concluded that although the literature contains many methodological weaknesses it suggests that mindfulness interventions may help with a variety of problematic conditions including chronic pain, fibromyalgia, psoriasis, stress, anxiety, depressive relapse and eating disorders with an average effect size of 0.59 (medium effect size, as defined by Cohen 1977).

Grossman, Niemann, Schmidt and Walach (2004) found that only 20 studies of the 64 empirical studies they retrieved possessed the methodological rigour to be included in their meta-analysis. However consistent with Baer they found medium effect sizes for both mental and physical health outcomes and found that the effect sizes in the uncontrolled studies that were not included in their meta-analysis were broadly comparable with this. They concluded that the mindfulness based stress reduction

programme is useful for a broad range of conditions as well as raising the possibility that it enhances general well being and coping in everyday life.

### **The study of mechanisms**

As we have seen, there is a growing body of evidence, albeit methodologically weak at present, that mindfulness based interventions are effective in a variety of health and mental health disorders. What this research does not tell us however, is *how* do these interventions work? This is not an issue unique to the field of mindfulness. Marks (2002, p 203) describes all forms of psychotherapy's ability to explain its capacity to help certain problems as akin to 'a toddler taking its first steps on the long road to maturity'.

There are many reasons why studying mechanisms is important. Kazdin (2001) argues that rather than conducting efficacy and effectiveness research, the best way to identify effective treatments is to identify why therapy leads to change and what processes must be activated in treatment for that change to come about.

Understanding how different therapies work may therefore be crucially important in the further development of clinically effective treatments. Whilst mindfulness has been shown to be effective, effect sizes are modest and there are clearly people who do not benefit from this approach. In some cases there is an indication that a subset of people may even get worse (for a brief review see Melbourne Academic Group, 2006). For example Teasdale et al. (2000; see also Ma & Teasdale; 2004) conducted a randomised controlled trial of MBCT for depression, and found that for people who had experienced fewer than three episodes of depression, relapse rates were not improved and may even have been increased. Teasdale, Segal & Williams (2003)

amongst others therefore argue against mindfulness being widely disseminated without adequate theoretical formulation of how it might resolve a particular clinical problem. Teasdale et al. (2003, p158) argue that 'although mindfulness may modify processes that are common to a range of problems, awareness of those common effects rather than indiscriminate application of techniques is likely to enhance clinical outcome'. An understanding of the mechanisms which underlie mindfulness based interventions is therefore crucial in identifying who it might and might not be helpful for and what parts of the programmes might be most helpfully emphasised for whom. This may be particularly important given the demanding nature of many mindfulness based courses (Bishop, 2002).

In relation to the study of mindfulness there are two separate but related questions. The first question is: what component of mindfulness programmes work? That is to say, what are the important ingredients in programmes which contain many components. Whilst the non-mindfulness elements of DBT and ACT have already been emphasised, other mindfulness programmes often also include other elements, for example cognitive behavioural elements in MBCT. In addition there may be generic parts of mindfulness programmes that are not assumed to be part of mindfulness itself such as social support that nonetheless may exert powerful effects. The multi-component nature of most mindfulness programmes means there is a necessity for dismantling studies to study the various potential active components in the various programmes. It has been assumed that mindfulness based programmes work by cultivating mindfulness and that increased mindfulness leads to improved outcomes. However until recently the construct of mindfulness had not been well operationalised and therefore well validated and reliable tools to measure

mindfulness were not available although these are now starting to be developed and refined (Baer, Smith, Hopkins, Krietemeyer & Toney, 2006). Mindfulness-based interventions emphasise the practice of mindfulness meditation but discussions about that practice and the discoveries people make is also a significant part of these interventions. The importance of these group discussions is not known. Bishop (2002) argues that if meditation is not the primary active ingredient in MBSR then it may be difficult to justify the demands of the programme.

The second question is related to the study of mindfulness itself and forms the basis of this review. If we can assume that the cultivation of mindfulness is responsible for the positive changes observed in outcome research then the question becomes: by what processes or mechanisms does an increased tendency to be mindful lead to change and transformation? There are theoretical reasons to suppose that some elements might be more important in some clinical problems than others, for example; acceptance of physical sensations in chronic pain, exposure in anxiety, distancing from thoughts in psychosis and disengaging from ruminative processing in depression. Clinically it will be important to know what elements of the practice need to be emphasised for each client group in order to develop streamlined maximally effective programmes. Although this question is the focus of this review, few 'pure' mindfulness programmes have been researched and therefore this question will inevitably be complicated by research looking at multi component programmes.

### **What are the proposed mechanisms and how can they be studied?**

There are several ways to start answering the question 'How does mindfulness work?' Initially theory and models that explain the change process need to be

developed which can be used to drive research and produce clearly testable hypotheses. A variety of possible candidate mechanisms have been suggested by mindfulness' many proponents. Baer (2003) summarised these as exposure, cognitive change, self-management, relaxation and acceptance. In addition there is increasing interest in the role of feedback from the body.

The main section of this review will begin by briefly looking at the theoretical arguments for each of the mechanisms in turn. This will progress to a review of the research literature into mechanisms and which mechanisms have found support from this literature. The research literature will be divided into different types of studies and will include treatment studies, mediational analyses, individual differences studies, qualitative research, and decompartmentalising or analogue studies.

Overall I will argue that while theoretical arguments about how mindfulness works are increasing in the empirical literature there have been very few well designed empirical studies that have tested these models. A paucity of well validated measures of both mindfulness and of these mechanisms has made research of this kind difficult.

## **PROPOSED MECHANISMS OF MINDFULNESS**

### **Meta-Cognitive Change**

Many authors are interested in the role of meta-cognitive change in mindfulness and view this as the central mechanism by which mindfulness produces beneficial effects. In particular there has been much interest in how mindfulness practice may lead to a change in the *relationship* people have with their thoughts such that people

move from experiencing thoughts as reflections of truth or reality to understanding that ‘thoughts are just thoughts’. This is different to the proposed mechanism of change in traditional cognitive therapy where the emphasis is on challenging the *content* of ones thoughts. This change in relationship with ones thoughts has been given a number of names by different authors. Teasdale (1999) uses the terms ‘de-centering’ and ‘meta-cognitive awareness and insight’. Shapiro et al. (2006) posit that ‘re-perceiving’ is the central mechanism by which mindfulness training leads to change. Hayes, Luoma, Bond, Masuda & Lillis (1999) discuss ‘cognitive defusion’ as one of the key mechanisms by which ACT exerts its effect where the emphasis is on changing the context or relationship to mental activity rather than the content.

One model which emphasises the role of meta-cognitive change through the practice of mindfulness is Interacting Cognitive Subsystems (ICS, Teasdale & Barnard, 1993). ICS has been used to explain why people who have experienced depression are increasingly vulnerable to relapse with each successive episode and why mindfulness practice might help reduce this vulnerability. In ICS terms, depressed schema (known as implications) are maintained by schema congruent negative automatic thoughts (known as propositions) and bodily feedback, a state that they call ‘depressive interlock’. Mindfulness is proposed to encourage a shift in cognitive processing style, from the propositional dominated mode where thoughts are experienced as reflections of reality (as occurs in depressive interlock) to an implicationally controlled mode where thoughts are experienced as transient events in the mind. It is proposed that mindfulness meditation practice involves using intentional control of attention to establish this alternative information processing configuration which is incompatible with depressive interlock (and processing

configurations associated with other disorders) and which can allow for low mood without spiralling into depression.

Overall the theory that the development of meta-cognitive insight is a key mechanism of mindfulness would predict that mindfulness training would lead to reductions in how much people believe or 'buy into' their thoughts and that this reduction would mediate outcomes. However for some theorists this research may not be as straightforward as asking people to rate their beliefs in particular thoughts. Teasdale (1999) argues that there is an important difference between knowing intellectually that thoughts are just thoughts and may not reflect reality (which he terms meta-cognitive knowledge) and actually *experiencing* thoughts as thoughts as they occur (meta-cognitive insight). Teasdale (1999) argues that mindfulness meditation practice facilitates meta-cognitive insight, a process that may be much more difficult to measure using self report. There is clearly a need for research looking at meta-cognitive change to be explicit about this difference.

## **Exposure**

The benefits of exposure have long been known (e.g. Marks; 1975) and form the basis for many current treatments for anxiety disorders (e.g. Wells, 1997). Exposure may be to external stimuli (e.g. to a feared stimulus in a specific phobia) but also exposure to previously avoided internal experience such as thoughts, feelings and sensations (e.g. Craske, Barlow & Meadows; 2000). Mindfulness practice involves encouraging participants to observe and 'sit with' previously avoided uncomfortable or distressing thoughts, physiological states and emotions.

Bishop et al. (2004) suggest that mindfulness approaches may be particularly helpful where intolerance of negative affect and subsequent behavioural avoidance is central to the clinical problem. They argue that some evidence from this comes from research showing that MBSR reduces binge eating behaviour, reduces avoidance of activity in people with chronic pain and reduces frequency of panic attacks and agoraphobia in panic disorder. Similarly Kabat Zinn (1982; et al, 1992) has proposed that exposure and subsequent desensitisation may be responsible for some of the effectiveness of MBSR with people who suffer from chronic pain, where participants have shown reduced emotional reactivity to pain following MBSR, and in anxiety, where it is proposed that exposure to anxiety symptoms in people who experience panic attacks may lead to less fear about those symptoms as people discover that whilst unpleasant these symptoms do not cause them any harm. This explanation is consistent with modern cognitive models of anxiety disorders (e.g. Clark, 1986).

Although Baer (2003) cites exposure as a potential mechanism there has been a lack of specification about what exposure actually is in the mindfulness literature. The precise mechanisms by which exposure works is still under debate (e.g. Tryon 2005). Theories that propose exposure as a key mechanism of action in mindfulness practice predict that mindfulness training would lead to change when previously avoided phenomena had been experienced (without negative consequences) and that the more times this occurred the more effective the practice would be. One might therefore expect to see a pattern of reduced psychological symptomology over time. Additionally it is possible that mindfulness might work for some people as informal behavioural experiments (e.g. Bennett-Levy et al. 2004), where particular cognitions



are challenged by non catastrophic consequences of exposure to previously avoided stimuli.

### **Acceptance**

In contrast to cognitive and behavioural therapies which are explicitly aimed at reducing distress, mindfulness-based programmes encourage participants to ‘let go of’ attempts to feel better and to ‘open to’ experiences even if they are uncomfortable. Research has shown that attempts to control or change internal experience can perpetuate difficulties. For example, trying to suppress a particular thought inevitably makes you think of it more (Wegner, Schneider, Carter & White , 1987; see Purdon, 1999 for a review). Acceptance as used in therapies such as ACT refers to a *willingness* to remain in contact with, and to actively experience, particular private experiences (e.g. bodily sensations, emotions, thoughts, memories, behavioural predispositions), an emphasis that MBSR, MBCT and DBT all share.

While cognitive approaches may emphasise *control* over one’s experience (e.g. by challenging the content of negative automatic thoughts), exposure techniques may implicitly include acceptance, particularly when participants are encouraged to drop safety-seeking behaviours (Salkovskis, 1991) during exposure tasks. The concept of acceptance clearly links to exposure and it is unclear whether one is possible without the other. Baer et al. (2006) propose that acceptance may involve both non-judging (not criticising oneself for having an experience) and non-reactivity to experience. Further theoretical specification that emphasises similarities and differences between exposure and acceptance is needed.

## **Relaxation**

Relaxation can be defined as a state of decreased psycho-physiological arousal which is subjectively experienced as calming, a state which is the opposite of the stress response. There are a large number of different relaxation methods which vary in their approach but all contain instructions to intentionally release tension and relax, often by progressive muscle relaxation exercises, visual imagery or a combination. Relaxation has been shown to be effective in reducing distress in many different populations including people suffering from pain, anxiety and stress, related to medical problems (see Mandle, Jacobs, Arcari & Domar, 1996 for a review). Mindfulness has also shown to be helpful in these populations.

The induction of relaxation through meditation has been well documented (Benson, 1975). However Baer (2003) points out that mindfulness practice does not aim to be relaxing and may include the non judgemental observation of tension, arousal and difficult thoughts and feelings which are incompatible with relaxation. Nonetheless research is needed to determine whether relaxation is the main process by which mindfulness exerts its effects and in what ways mindfulness is distinct from relaxation.

## **Self management/self regulation**

Self management refers to the strategies and coping skills that a person uses to maintain a stability of functioning and adaptability to change. Many of the mindfulness programmes include a component that aims to actively develop self-management skills that complements training in mindfulness but is distinct from it. However authors have also suggested that mindfulness practices themselves might

also facilitate this process without any explicit discussion or focus on values or regulation strategies.

Segal et al. (2002) discuss how mindfulness training emphasises a distinction between 'doing mode', where behaviour is goal orientated to decrease the discrepancy between a current and desired state, and 'being mode', which involves an acceptance of what is without pressure to change it. They argue that 'doing mode' is dominant for most people in our culture but that cultivating 'being mode' through mindfulness practice can encourage a balance between these modes in our lives which will allow us to switch off automatic pilot and giving us choices about how to take care of ourselves. Similarly Shapiro et al (2006) argue that through the process of 're-perceiving' we become free of automatic behavioural patterns. For example rather than reacting to anxiety by reaching for alcohol a person can stand back and choose to respond in a way that is more conducive to wellbeing. Mindfulness emphasises attention to the present moment which it is argued (Roemer and Orsillo, 2003) may lead to more flexible responding rather than rigid reacting to situations based on non current circumstances (e.g. past events or future worries). This theory would predict that mindfulness programmes would lead to changes in observable behavioural reactions and responses to external and most importantly internal events, and that these changes would mediate outcomes. Thus as argued by Baer (2003) increased mindfulness may promote a range of new coping skills which in themselves may lead to change.

## **Body-State Feedback**

One area that has been ignored in much of this literature is the role of the body. Most mindfulness programmes include many practices focusing on cultivating non judgemental awareness of bodily sensations and the body as a whole. In the ‘body scan’ participants intentionally become aware of sensations in different parts of the body. Alternatively, awareness of the ‘the body in movement’ is cultivated in exercises such as walking meditations or hatha yoga exercises (Kabat Zinn, 1990). There is also an emphasis throughout the programmes on noticing the body sensations that occur in response to thoughts or external stimuli. The potential importance of this emphasis on the body has been missing from many discussions on how mindfulness might work until recently. Interacting Cognitive Subsystems model (ICS: Teasdale and Barnard, 1993) suggests a crucial role of body state information in the maintenance of low mood leading to depressive relapse; an idea that was used in the development of MBCT. Teasdale, Segal and Williams (1995) discuss the importance of proprioceptive body-state feedback contributing to the depressogenic schematic models which reoccur under conditions of dysphoric mood for people who have previously experienced depression. They discuss how the bodily aspects of mindfulness approaches, such as awareness of body and an absence of bodily activity, can provide a simple and direct means to change the schematic models which imply imminent threat, need for urgent action or global worthlessness, arguing that by bringing awareness to the body we may weaken habits in the body loop which can maintain depressed moods. In addition direct sensory experience provides an alternative to rumination

Although the potential role of body-state feedback changes has not been frequently mentioned, in the mindfulness literature, there is vast body of work that discusses the role of the body in cognition and emotion more generally. Most famously, the James-Lange theory of emotion (James, 1884, 1894, Lange 1885) claimed that our subjective experience of emotions was due to perceived changes in the body: we are afraid because we run, rather than we run because we are afraid (for reviews see Ellsworth, 1994 and Lange, 1994) . More recently Damasio (1994) has argued that our experience of emotion is inextricably linked to changes in the body. Damasio and James both posit a central role of feedback from the body in the generation of emotional experience. These models predict that being more aware of or ‘in tune’ with our bodies will lead to beneficial effects on cognition and emotion. In particular they predict that greater bodily awareness will lead to emotion being experienced more intensely and clearly, thus reducing anhedonia or emotional blunting, and that greater awareness of ‘somatic markers’ will improve decision making ability. These predictions have found support in studies of interoceptive awareness- defined as the extent of an individuals sensitivity to bodily signals- for example Pollatos, Gramann and Schandry (2007), Feldman Barrett, Quigley, Bliss-Moreau & Aronson (2004), Dunn et al (in prep) and in work with brain damaged patients (e.g. Bechara, Damasio, Damasio & Anderson, 1994; Bechara, Damasio, Tranel & Damasio, 1996).

Given the emphasis on the body in most mindfulness programmes, perhaps mindfulness might be asserted to be a form of interoceptive training - an idea which could potentially explain some of the helpful actions of mindfulness on emotional experience and rumination. This theory would predict that mindfulness interventions

would lead to changes in the body and/or changes in people's awareness of their bodies and that this would mediate outcomes.

### **Empirical Support for these Mechanisms**

Having briefly summarised some of the mechanisms that have been theorised to be responsible for the increased wellbeing produced by mindfulness programmes, this review will now summarise the status of research into mindfulness. In the study of mechanisms different methodological approaches have advantages and disadvantages. Therefore this section of this paper will review the research by looking at different types of study in turn and evaluate their strengths and weaknesses.

### **Treatment Studies**

By far the most extensive literature relating to mindfulness are the large number of treatment studies that have investigated the effects of mindfulness interventions on a variety of mental health, wellbeing and physical health outcome measures. For the most part these studies seek to answer the question: does this mindfulness-based intervention help X problem?, by comparing outcomes following the intervention with a control group or, in the case of uncontrolled studies, by looking at whether there were changes pre-post intervention. The majority of these studies have measured outcome in terms of symptom reduction rather than measures of psychological processes. Two meta-analytic reviews have already been mentioned that have summarised the outcome data on mindfulness treatment studies and shown that, on average, mindfulness-based interventions lead to medium effect sizes in both

mental and physical health outcomes across a range of clinical and non-clinical populations (Grossman et al., 2004; Baer, 2003)

It is beyond the scope of this review to discuss all the treatment studies that have been conducted, however one such study will be described in more detail to illustrate the advantages and disadvantages of this approach. Speca et al. (2000) conducted a randomised wait list control trial to investigate the effect of MBSR on symptoms of stress and mood in outpatients diagnosed with cancer. The mindfulness group showed a 65% reduction in mood disturbance scores and a 31% reduction in symptoms of stress scores compared to the control group. Average daily meditation practice predicted 15.5% of the variance in mood disturbance reduction thus providing some indirect evidence that the cultivation of mindfulness was important although it is possible that this simply reflected the influence of the motivation levels of these participants.

Speca et al.'s study illustrates some of the methodological problems with the majority of mindfulness treatment studies, most of which have used wait list or heterogeneous 'treatment as usual' controls which may lead to differential expectancy effects. Very few studies have been completed with an active control condition (for an exception see Jain et al; 2007, to be discussed in more detail in this review). In addition many of the mindfulness-based programmes that have been examined contained additional components that were tailored to the specific participant group but which are not integral to mindfulness. For example Speca et al. (2000) included visualisation and information on cognitive distortions in their intervention. It is therefore possible that these positive outcomes relate to non-

mindfulness elements of the interventions and in order to rule out this possibility dismantling studies are needed, for example to see whether the cognitive therapy elements in MBCT add anything to the more general mindfulness practices.

The difficulty in determining whether it is the mindfulness practices as opposed to other components that led to change in treatment studies is compounded by the fact that until very recently none of these studies measured whether the programmes led to changes in levels of mindfulness. 'Research has tested only the effectiveness of the training programmes and compliance with them in facilitating well-being' (Brown and Ryan 2003, p. 840). In the past few years measures of mindfulness have started to appear (see Baer, 2006 for a review) and there are now several studies that have shown increased mindfulness following a mindfulness based intervention (Cohen-Katz et al; 2005, Kingston, Chadwick, Meron & Skinner, 2007; Chambers Yee-Loo and Allen; 2006). In summary, treatment studies, while demonstrating that mindfulness interventions are effective, say relatively little about how they are actually working. Other approaches are desperately needed.

*Treatment studies that include some process of change exploration*

Whilst straight forward treatment outcome research is not particularly helpful in informing the debate about mechanisms, several treatment studies have gone beyond simple reporting of outcome measures and symptom reduction and have attempted to look at process of change variables associated with outcomes. For example, Ramel, Goldin, Carmona & McQuaid (2004) investigated the effects of MBSR on a group of currently and previously depressed participants and found, compared to a wait list control, that levels of both depression and anxiety were significantly reduced



following the course and that there was a large effect size for reduction in rumination, which remained significant when changes in depression, anxiety and dysfunctional attitudes were controlled for. The amount of meditation practice accounted for 15% of the variance in rumination at follow up. Ramel et al. conclude that it is likely that the practice of observing and noting thoughts and feelings in mindfulness meditation might lead to a less habitual pattern of reacting to or dwelling on thoughts and feelings, in line with the idea that mindfulness works by meta-cognitive change. However no measure of meta-cognitive change was employed in this study and therefore the possibility that reductions in rumination might have been achieved by a different means remains a possibility.

In another example Chambers et al. (2006) investigated the effect of a 10 day Vipassana<sup>1</sup> retreat on participants' capacity for attentional control, sustained attention and internal attention switching, hypothesised to have beneficial effects on people's ability to self monitor and self regulate mental and emotional states (metacognition and metaemotion). Overall this study showed that mindfulness training may enhance working memory capacity and sustained attention, and that these changes are associated with some improvements in affective functioning. The finding that increased self reported mindfulness, as measured by the Mindful Attention and Awareness Scale (MAAS; Brown and Ryan, 2003), was negatively correlated with reflective rumination suggests that a shift away from ruminative processing style may be an important process behind the benefits of mindfulness training, which may be consistent with meta-cognitive theories.

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<sup>1</sup> Vipassana is the Sanskrit term for Buddhist insight meditation from which mindfulness based interventions have largely been drawn

Kingston et al. (2007) compared the impact of a shortened mindfulness training to guided imagery relaxation sessions on a measure of pain tolerance. They found that the mindfulness trained participants rated pain intensity as significantly lower following a cold water submersion task after the mindfulness training than before, but this was not the case for participants trained in guided imagery. The mindfulness participants also submerged their hands in cold water significantly longer post intervention than pre whereas there was no significant difference for the guided imagery group. Given the differences between the mindfulness group and the guided imagery group this study suggests that mindfulness training is different from relaxation; a finding supported by questionnaire data that showed the mindfulness group felt significantly less relaxed and experienced significantly more physical discomfort and worrying and troublesome thoughts than the guided imagery group. Given that the training did not involve practising the cold water task it also suggests that mindfulness is not merely habituation, although differences in the amount of time spent training participants in the two groups may have confounded their results. While the mindfulness group did show greater increases in mindfulness as measured by the Kentucky Inventory of Mindfulness (KIMS; Baer, Smith & Allen, 2004) the KIMS did not mediate the relationship between training and pain tolerance, raising questions about whether it was mindfulness that led to change. The authors however suggest that this may be because the KIMS was not originally designed for use with students.

There are a number of studies of Acceptance and Commitment Therapy that have looked at change in process variables. For example Bach and Hayes (2002) found a

reduction in the believability of psychotic symptoms and reduced hospitalisation rates following brief ACT on an inpatient ward. This could suggest that meta-cognitive change (called 'cognitive defusion' in ACT) was an important process in reducing relapse. However the degree to which mindfulness as opposed to other practices was important in these studies is unclear and it is not clear if these same effects would be produced by mindfulness.

As previously mentioned there are considerable challenges in measuring meta-cognitive insight. Asking people to rate how much they *believe* their thoughts is one approach but measuring how much people actually *experience* thoughts as just thoughts as they occur is much more difficult. Teasdale et al. (2002) used a self developed measure called the Measure of Awareness and Coping in Autobiographical memory (MACAM). This measure involves observer ratings of how much people are able to distance from emotions and thoughts when describing memories (in response to vignettes designed to elicit memories of depressed mood). The MACAM was administered to recurrently depressed participants 8 weeks after they finished the MBCT course or Treatment As Usual (TAU). They found that, in response to depression related cues, meta-cognitive sets for responding to negative thoughts and feelings were greater following MBCT than TAU, suggesting that MBCT increases meta-cognitive awareness. However this study could not formally demonstrate that meta-cognitive awareness was the *cause* of relapse prevention because the design of the study did not allow for a full mediational analysis.

Given the correlational nature of all of these studies, further research is needed to establish whether any speculations about causality are borne out, especially because

most of these studies used inactive control conditions and therefore did not control for expectancy effects or non-mindfulness related changes. More rigorously controlled research using well established process measures are needed.

### **Mediation**

Mediational analyses can provide much stronger support for potential mechanisms than correlational studies. According to Baron and Kenny (1986, p.1176) a variable may be called a mediator 'to the extent it accounts for the relation between the predictor and the criterion'. Mediators explain how or why effects occur - in our case for example, why mindfulness meditation leads to reduced levels of depression - and are therefore at the heart of research into mechanisms. Baron & Kenny (1996) have specified a set of conditions that need to be met for full or partial mediation.

There are very few studies of mindfulness that have used this approach. One study has shown that acceptance of previously unwanted thoughts may be a mediating variable in mindfulness. Bowen, Witkiewitz, Dillworth and Marlatt (2007) investigated the frequency of thought suppression in a large group of prisoners before and after taking part in a 10 day Vispassana retreat and compared it with prisoners not taking part. They found that post-intervention the Vispassana group reported greater reductions in attempts to avoid unwanted thoughts, and that a reduction in suppression of unwanted thoughts (measured using the White Bear Suppression Inventory, WBSI, Wegner & Zanakos, 1994) partially mediated the relationship between participation in the Vispassana course and alcohol use and negative consequences of alcohol use 3 months after release from prison. The Vipassana group did not report significantly different number of intrusive thoughts to

the control group thereby supporting the assertion that increased mindfulness didn't lead to a reduction in intrusive thoughts but simply that people were responding to their thoughts in a different way. This study provides some support for acceptance rather than suppression of thoughts as being an important mechanism of mindfulness in addictive behaviours. However it might also suggest that exposure to previously avoided thoughts was an active process or indirectly that meta-cognitive change was important (people no longer had to avoid their thoughts because they were no longer seen as accurate reflections of reality).

Jain et al. (2007) conducted one of the first randomised controlled trials of mindfulness with an active control condition. While both mindfulness meditation and a progressive relaxation control group led to decreased distress and increased positive mood states, only the mindfulness group showed reduced distractive thoughts and reduced rumination compared to the control group. Reductions in distress were found to be partially mediated by reductions in rumination, which is interpreted as evidence of the ability of mindfulness meditation to prevent people becoming locked into a ruminative cognitive cycle. Jain et al. argue that the changes in rumination might be the result of developing the skill of redirecting attention to the present moment. This study provides some support for both commonalities between relaxation and mindfulness meditation as well as the unique ability of mindfulness meditations to reduce rumination.

Mediational analyses have been used much more extensively to support ACT (see Hayes Luoma, Bond, Masuda, & Lillis, 2006 for a review) A number of studies have shown a reduction in the believability of thoughts as a mediator in ACT (e.g. Zettle

& Hayes, 1986 cited in Hayes et al, 2006; Gaudiano & Herbert; 2006) and one study reported an increase in the level of acceptance of undesirable thoughts as a mediator of change in improved work place mental health by ACT (Bond & Bunce, 2000). However it is not clear to what extent the changes in these studies rely on mindfulness per se.

Research looking at mediation effects is clearly important in the question of how mindfulness may work. There is some preliminary support for acceptance as a significant mediating variable between mindfulness and reduced relapse in alcohol use, and that changes in rumination which may relate to meta-cognitive change might be important in reducing distress in student populations. However the studies reviewed contain multiple components and have not attempted to measure changes in mindfulness, so it is unclear whether specific aspects of mindfulness are sufficient or necessary to lead to changes in the proposed processes. In addition these studies do not rule out the possibility that the mediator that has been measured actually correlates strongly with other mechanisms, particularly given the lack of theoretical specification of how the mechanisms relate to each other. Mediation studies where the relative effects of different mechanisms are explored could make a valuable contribution to this debate. The utility of future treatment studies and trials will be much increased if, alongside symptom-based outcomes, measures of the various psychological processes are taken throughout. Mediation analysis can potentially provide an extremely useful technique to calculate how much of the variance in outcomes is explained by a particular psychological process.

## **Qualitative Studies**

One method to explore processes of change is to ask participants themselves how they experienced a particular intervention and how they think it helped them.

Qualitative approaches allow for more exploratory orientated research, which allows for a researcher to happen upon unexpected findings in a way which may not be possible when participants are restricted in the data they can provide. These methods do not claim that their findings can be generalised to wider populations, but they can be used to understand the core process of change for individuals and to hypothesise common processes which can then be explored further. There have been several published qualitative studies exploring participants experiences of both MBSR and MBCT (the findings of which will be briefly summarised) but no studies were found relating to DBT or ACT.

As a detailed example of a qualitative approach Mason and Hargreaves (2001) used grounded theory to explore commonalities and differences in seven participant's accounts of the MBCT programme for reducing depressive relapse. In particular Mason & Hargreaves were interested in participants' descriptions of their experiences and whether these fitted with the Interacting Cognitive Subsystems model's predictions about the mechanism of mindfulness (ICS, Teasdale & Barnard; 1993. Teasdale; 1999). Mason and Hargreaves argue that many of their findings are consistent with the ICS account in that; several participants' transcripts indicated they were able to experience mild negative affect without being overwhelmed by depressive cognitions and spiralling into depression; many participants used the phrase 'thoughts aren't facts' in the face of difficult thoughts (which the authors link to the development of meta-cognitive insight); participants mentioned a change in

relationship to thoughts and emotions - an observing rather than analysing approach - consistent with accounts that suggest mindfulness helps to interrupt ruminative processes by promoting a different relationship to thoughts.

Although the main focus of the discussion in this study was ICS, the open ended interview approach allowed for other themes to emerge in the analysis. Mason and Hargreaves discuss acceptance as a process mentioned by several participants whom they noticed talked humorously about difficulties in life. Group support was mentioned by *all* participants as an important aspect of the programme suggesting that some non-mindfulness related processes may have been important components of change for some people. In addition many of the participants that were interviewed following the programme commented on having developed an awareness of 'early warning signs'; that is personal indicators of deteriorating mental health which were then used to trigger protective action, a finding which provides some support for the idea that improving self regulation might be one way mindfulness works. However MBCT includes some explicit discussion of early warning signs which is in addition to mindfulness exercises, so it is unclear whether the acquisition of mindfulness skills was important for this.

For some individuals, changes in body-state feedback were an important part of mindfulness. One participant commented on her realisation through mindfulness that the sensations that she felt in her body during social situations were anxiety related, while another noticed that using a sitting posture was helpful during difficult periods whereas lying down was less so. The majority of participants reported relaxation



and calmness as one of the effects of doing the mindfulness exercises (although at least one person did not find it relaxing, suggesting this may not be a process universal to all participants).

Some of these findings have been echoed in other qualitative studies of mindfulness whilst other themes have also emerged. For example Abba, Stevenson and Chadwick (in prep.) named the main theme to emerge from their interviews, with sixteen people with unremitting psychotic symptoms who had completed a mindfulness programme, as 'freeing themselves from the tyranny of psychosis'. This involved three processes including accepting rather than avoiding psychotic experiences, reducing rumination and worry about those experiences, and self acceptance. Mackenzie, Carlson, Munoz and Speca (2006) found that participants in an oncology setting, with ongoing mindfulness practice, named increased self control as an important mechanism in that mindfulness helped them to 'respond rather than react' to stressors, fitting with the idea of self regulation as a mechanism. In addition the support of the group was very important to all the participants, as was personal growth (seeing new situations as a teacher) and spirituality.

Finuacane and Mercer (2006) explored the use of MBCT with 13 primary care patients with active depression and anxiety. In qualitative interviews participants reported that being in a group had an important normalising and motivating effect, again suggesting the importance of group support. They also reported several other benefits including new ways of dealing with emotions (not being scared of them), greater self acceptance, greater ability to relax, better sleep, and better ability to not jump to negative conclusions. This study also highlighted important differences in the way people interpret and use the exercises that are taught. For example some

people used what is known as the 3 minute breathing space to observe, accept and de-centre from worry, whilst others used it to reduce the physiological symptoms of anxiety (to 'calm down'), suggesting that different processes may be activated in different people.

Cohen-Katz et al. (2005) investigated the impact of MBSR on burnout in nurses using both quantitative and qualitative methodologies. Initially the benefits were cited as relaxation and calmness but by half way through the programme comments related to increased self acceptance, compassion, self awareness (awareness of thoughts, emotions, bodily sensations) and self care. Changes in relationship interactions also emerged as an important processes for many of the participants. In addition, in common with other writings on mindfulness (e.g. Kabat-Zinn; 1990, Segal et al; 2002) several participants reported that as their minds settled down, difficult unresolved emotional issues began to surface. Participants reported that though this was initially extremely painful, ultimately they felt it was useful and allowed further change.

In relation to the question 'how does mindfulness work?', qualitative studies have provided some support for all of the mechanisms mentioned by Baer (2003): meta-cognitive change, acceptance, self regulation, relaxation and for body- state feedback as well as suggesting that additional processes such as self acceptance, changes in relationships, the re-emergence of difficult emotions and their working through, and personal growth might also be important although what is meant by these terms requires further specification. The importance of the group experience was striking in all of these studies, however for many people the group was important for cultivating mindfulness and learning the practices not simply the normalising of symptoms or

diagnoses suggesting that group support per se cannot fully explain the benefits of mindfulness programmes . In addition two of the studies mentioned (Finuacane & Mercer, 2006; Mason & Hargreaves, 2001) identify the expectations participants have about the programme as an important moderating factor in the success of the approach and that people with overly positive and rigid expectations tended to fare less well.

In considering the findings of qualitative studies several drawbacks of these methods must be born in mind. The orientation of the researchers may influence the data collection and analysis (although in the studies reported steps were taken to verify the reliability of the findings). Another difficulty with qualitative research is that what people think is helpful isn't necessarily what is helpful. Mindfulness programmes, in particular MBCT, involve cognitively orientated explanations for example using the term 'thoughts are not facts' and it is therefore perhaps unsurprising that people explain their experiences in these terms. However open ended interviewing has the advantage over questionnaires in that they allow more complex and inconsistent views to be expressed. Whilst qualitative findings can't be generalised, as they may be unique to the participants in a particular study with their individual histories, they are clearly very useful for providing some face validity to theoretical ideas and for suggesting possibilities for further exploration.

### **Studies of Individual Differences**

Studies of individual differences allow comparisons between two or more groups of people who are already different in either trait levels of mindfulness, or people with

varying levels of mindfulness meditation experience, on tasks that relate to particular mechanisms.

One study by Nielson and Kasniak (2006) will be discussed in some detail. They hypothesised that meditation would lead to more accurate visceral perception abilities and that this accuracy would be associated with increased subtle emotional awareness and increased self reported emotional awareness in line with James' and Damasio's hypotheses that have previously been described. They compared long term meditators with non meditator controls on a heart beat perception task and on physiological and self reported responses to masked pictures (pictures that were presented too quickly to be consciously perceived). In line with their predictions, meditators reported greater emotional clarity than non meditators on self report measures. However, contrary to their predictions their findings suggested that non meditators were more sensitive to affective pleasant and unpleasant feelings elicited by masked pictures. The authors explain their unexpected results by reference to the importance in meditation practice on the development of equanimity in observing emotions which therefore allows feeling states to motivate but not drive or distort behaviour. Nielson and Kasniak argue that meditators may maintain an ability to allow emotions to evolve when the situation requires it whereas they develop a disposition towards equanimity when a situation is ambiguous. In contrast to meditators, controls may have elaborated on emotional states thus increasing valence discrimination. They suggest that meditation may cultivate both discrimination and regulation which develop separately in meditators and vie for priority.

The authors of this study removed from their analysis the five short term meditators that originally participated in their study because they were found to be substantially different from the eleven long term meditators. As short term meditators was defined as those with less than 10 years practice it is this group that is of most relevance to this review. In footnotes Nielson and Kazniak report that compared to long term meditators, short term meditators showed a hyper-bodily focused approach to describing their emotional experience, significantly more correct responses on the heart beat detection task and a tendency to rate higher arousal levels to masked pictures. This provides some preliminary support for the idea that discrimination of subtle emotions may be an important process activated by meditation particularly in the earlier stages of practice (although unfortunately statistical comparisons between short term meditators and non meditating controls are not reported due to lack of power). Overall these results suggest that in the very long term meditation may lead to increased equanimity of emotional states elicited by ambiguous situations. However it also suggests that the effect of meditation practice changes over time and that it is possible in the short term that meditation might lead to increased awareness of the body and enhanced ability to discriminate emotions. This possibility merits further investigation in relation to short term mindfulness interventions.

In another study, looking at whether mindfulness is associated with increased emotional awareness, Brown and Ryan (2003, Study 3) compared undergraduates with no meditation experience but who differed on their levels of self reported trait mindfulness. They found that the more dispositionally mindful undergraduates (as measured by the MAAS) showed a stronger relationship between implicit and explicit affective states than people who were less dispositionally mindful. This

suggests that more mindful individuals may be more attuned to their implicit emotional state and can reflect that awareness in explicit statements about how they are feeling.

Other studies have compared mindfulness meditators with people practising different forms of meditation to see whether there are any effects that are unique to mindfulness. Valentine and Sweet (1999) compared non meditating controls with meditators who practised mainly concentrative forms of meditation and with mindfulness meditators, on tasks requiring different sorts of attention. They found that mindfulness meditators performed significantly better on an unexpected stimulus task suggesting that mindfulness meditators may be less influenced by expectancy effects. Both groups of meditators were significantly more accurate on a task of sustained focused attention suggesting that that both sets of meditators were able to ignore distracting thoughts more than controls. They also found that long term meditators showed increased sustained attention than shorter term meditators. This study suggests an important role of executive function and attention, however while the authors argue that the ability to control attention has obvious implications for mental health, they do not specify the mechanisms which increased ability to focus attention would influence.

There are several drawbacks to studies of individual differences the most obvious being that we cannot infer causation as it is not possible to rule out the possibility that differences between groups is related to pre-existing characteristics and not the mindfulness practice itself.

### **Decompartmentalising studies**

It has been argued throughout this review that one of the difficulties in researching mindfulness is that many clinical programmes are complex and contain multiple elements. One way to reduce this complexity is to use experimental versions or analogues of mindfulness in the laboratory setting. This kind of research can have several purposes, firstly to try and isolate different components in order to see what elements of a package are important and which are redundant, and secondly to measure if a particular component activates the expected mechanism of action and see if that leads to change. In the study of mechanisms of mindfulness this would involve studying each of the theorised key processes and seeing if each process is psychologically active in a way that fits with theory.

Three studies have investigated the effects of one off mindfulness exercises on mood immediately following the mindfulness induction. Arch and Craske (2006) used a 15 minute focused breathing exercise as an analogue to mindfulness and compared it to the effects of unfocused attention and deliberate worrying. Compared to the other groups the mindfulness group maintained moderately positive responses to emotional images slides and also reported reduced emotional volatility to all slide types (positive, negative and neutral). The mindfulness group were also significantly more willing to view an optional block of negative slides than the unfocused attention group. The authors interpret this finding as supportive of their hypothesis that mindfulness leads to increased tolerance for remaining in contact with unpredictable negative stimuli, akin to acceptance.

Broderick (2005) found that participants who were randomly assigned to a brief mindfulness meditation reported lower levels of negative mood following a dysphoric mood induction than participants who read distracting statements, and even more than those who read statements that encouraged them to ruminate. This research provides some evidence that mindfulness is effective in reducing low mood and does not achieve this simply by distraction. However caution is warranted as the techniques for delivering the mindfulness versus distraction techniques were different which may have accounted for the difference.

Watkins and Teasdale (2004) compared the effects of a self focus task in depressed participants, half of whom were instructed to focus analytically on symptoms and half who were instructed to self focus experientially. They found that the experiential self focus instructions led to reduced over general autobiographical memory, a phenomenon associated with poor clinical outcomes. The experiential awareness instructions used in this study, although not meditation per se, are strikingly similar to instructions used in mindfulness approaches. This study therefore provides some evidence that changing the 'mode' of processing from analytical self focus to experiential self focus can be beneficial, a finding that fits with the ICS information processing model.

A final approach is to use a brief and simplified mindfulness practice or one component of the mindfulness approach to see if it leads to changes on its own.

Ditto, Ecclache & Goldman, (2006) compared the physiological effects of practising a shortened mindfulness body scan, daily, over a one month period compared to equivalent progressive muscle relaxation practice. They found an interesting and



complex pattern of changes in physiological activity in the body scan group which were somewhat distinct from changes produced by relaxation. Future research should take advantage of this approach in the study of psychological approaches as it retains some ecological validity whilst allowing for the study of individual mindfulness practices and therefore more specific understandings of what elements of mindfulness programmes lead to beneficial effects.

While there are few component studies of mindfulness this approach has been used much more widely used to study the processes theorised to be important in ACT. For example Gutiérrez, Luciano, Rodríguez, & Fink (2004) found that acceptance instructions lead to increased pain tolerance even in the presence of higher pain levels compared to cognitive coping strategies. Other authors have found beneficial effects of acceptance instructions on increasing pain tolerance (e.g. Hayes et al; 1999), increasing willingness to experience uncomfortable anxiety symptoms and less anxiety in response to those symptoms (Eifert & Heffner; 2003, Levitt, Brown, Orsillo & Barlow; 2004), and quicker recovery from negative affect (Campbell-Sills, Barlow, Brown & Hofmann; 2006) In terms of meta-cognitive change Masuda, Hayes, Sackett and Twohig (2004) found that cognitive defusion techniques led to decreased believability of and discomfort caused by negative self referential thoughts. The manipulations in these studies are very different to the types of exercises used in mindfulness based approaches so while studies of ACT provide support for particular mechanisms being helpful, they do not tell us if these same processes are activated by mindfulness programmes. However these studies do provide a potentially useful framework for thinking about designing studies of mindfulness

One of the difficulties in this approach to studying mechanisms is that the processes that have been discussed are not necessarily easy to study in isolation from each other. When mechanisms are studied in isolation the studies lack ecological validity. In spite of these difficulties decompartmentalising studies have the advantage of allowing us to see whether in principle a particular mechanism of action influences outcomes in ways that are congruent with psychological theory. It is extremely likely that a one off analogue to mindfulness or a brief simplified component of mindfulness will differ significantly in its effects than the mindfulness programme as a whole, but that does not negate its utility. Marks (2002) argues that the fact that studying separate components of treatment packages may not reveal the potential for those components in combination, does not mean that these studies are not worthwhile, but that the components should eventually be studied in combination as well as alone.

## **CONCLUSION**

The study of mechanisms of mindfulness is still very much in its infancy. Researchers have used a variety of methodologies to investigate whether the various proposed mechanisms of mindfulness are associated with outcomes. To varying degrees all of the mechanisms proposed in Baer's (2003) review have found some support but the research is fraught with methodological difficulties which render any definitive conclusions premature. Multi-component programmes, lack of controls, complexities in defining and measuring mindfulness, an over reliance on self report, a paucity of suitable measures with which to measure psychological processes that have been suggested as mechanisms, and lack of theoretical specification of these mechanisms will all need to be addressed for this field to yield any clear answers.

This work will take time and is complex but the benefits may be great. By furthering an understanding of how mindfulness works researchers can improve clinical outcomes, streamline interventions, measure processes of change for individuals and thereby predict whether a particular approach will lead to the desired outcome. Crucially these studies can contribute to debates about mechanisms across the psychotherapies where similar processes may be shown to be activated by different means.

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## **Part 2 : Empirical Paper.**

**Mechanisms of mindfulness: Is feedback from the  
body important?**

## **ABSTRACT**

Mindfulness-based interventions are growing in popularity but there is currently little research examining the mechanisms by which these interventions lead to beneficial change. Many mindfulness interventions emphasise mindfulness of body sensations and the role of body-state feedback is a potentially important one about which little is known specifically, though research into interoceptive awareness may offer some leads. The present study investigated whether practising body-state awareness alters the nature of feedback from the body (in terms of awareness of body processes and/or changes to those processes), and so might lead to important changes in emotional experience and rumination. Participants practised a mindfulness exercise focused on the body over a week long period and were compared to participants practising an equivalent exercise focused on sounds. Contrary to prediction, the mindfulness of sounds exercise led to improved bodily awareness as measured by a heartbeat monitoring task but there was no change in bodily awareness in the mindfulness of body condition. Some changes in emotional responding, affect, and rumination were observed in both groups but could not be attributed to body-state feedback processes. Methodological limitations and suggestions for future research are discussed.

## INTRODUCTION

### **Mindfulness**

Mindfulness-based interventions (e.g. Mindfulness-Based Stress Reduction; MBSR, Kabat-Zinn, 1990; Mindfulness-Based Cognitive Therapy; MBCT, Segal, Williams & Teasdale, 2002 ) are growing in popularity in health and mental health settings and have been used to alleviate distress in clinical problems as diverse as chronic pain, cancer, psoriasis, binge eating, anxiety, relapse in depression, persistent psychosis as well as improving wellbeing in non clinical populations such as reducing stress in students and burnout in nurses. (e.g. Kabat-Zinn, Lipworth & Burney, 1985; Carlson et al., 2001; Kabat-Zinn et al., 1998; Kristeller & Hallett, 1999; Kabat-Zinn et al., 1992; Teasdale et al., 2000; Chadwick, Newman Taylor & Abba, 2005; Shapiro Schwartz & Bonner, 1998; Cohen-Katz, Wiley, Capuano, Baker, & Shapiro, 2004). Mindfulness has been described as ‘paying attention in a particular way: on purpose in the present moment, and non judgementally’ (Kabat-Zinn, 1994, p3.), a skill (e.g. Linehan, 1993) or even a ‘way of being’ which is practised and cultivated via meditation practice (e.g. Kabat-Zinn, 1990).

Two recent meta-analyses (Baer, 2003; Grossman, Neimann, Schmidt, & Walach, 2004) revealed that mindfulness based interventions lead to improvements in mental and physical health outcomes with an average of a medium effect size. With research establishing that mindfulness based approaches are, effective but not perfectly, so there has been increasing interest in understanding by what mechanisms or psychological processes the practice of mindfulness exerts these effects. This is not a simple question to answer. Most mindfulness programmes contain multiple



components many of which are not specific to mindfulness (e.g. cognitive psycho-education in MBCT; Segal et al., 2002; visualisations and loving kindness meditations in many MBSR courses e.g. Kabat-Zinn et al., 1998) and the relative contribution of non specific effects such as group support have not been fully established. Mindfulness practices themselves are varied and include formal periods of meditation focusing on different aspects of experience such as the body, sounds or thoughts as well as informal periods of bringing mindfulness into everyday life.

The questions of how mindfulness works is of clinical as well as theoretical interest. It is likely that a greater understanding of the processes that need to be activated for mindfulness to lead to improved quality of life and relief of symptoms for particular groups of people will lead to improved outcomes, streamlined interventions and interventions tailored to individual needs. Various authors have discussed the possible mechanisms that might be involved in mindfulness approaches (e.g. Shapiro, Carlson, Astin and Freedman, 2006, Roemer & Orsillo, 2003; Melbourne Academic Mindfulness Interest Group, 2006; Bishop, 2002;). In a review article Baer (2003) cites possible mechanisms as cognitive change, exposure, acceptance, self regulation and relaxation. Research is starting to show some preliminary support for these mechanisms but is currently methodologically weak, and unable to distinguish between the various competing theories. Few studies have tested these proposed mechanisms directly. Much of the current focus of research looks at how mindfulness leads to a shift away from ruminative processes leading to improved mood (e.g. Teasdale et al., 2002; Ramel, Goldin, Carmona & McQuaid (2004), Jain et al., 2007). It has been argued that meta-cognitive processes cultivated through

mindfulness practice are the mechanism behind reductions in rumination (e.g. Teasdale, 1999; Scherer-Dickson, 2004).

One way of breaking down the mechanism of action may be component or analogue studies. Studying a component of a treatment in isolation from the rest of the programme allows us to study a theorised key process and see if it is psychologically active in a way which fits with theory, whilst controlling for other important confounding variables that may be more difficult to control for in longer treatment studies. One example of this approach was used by Arch and Craske (2006) who used a one-off focused breathing exercise as an analogue to mindfulness and found some preliminary support for theories that propose that mindfulness practice leads to benefits because it decreases the impact and time needed to recover from negative emotional events and increases people's willingness to tolerate uncomfortable emotions. This study provides some support for the use of brief mindfulness exercises as a way of understanding the processes that may underlie mindfulness.

### **Mindfulness and the body**

One area that has been ignored in much of this literature is the role of feedback from the body. Most mindfulness programmes include many practices focused on cultivating non judgemental awareness of bodily sensations and the body as a whole. For example in 'the body scan' (Kabat-Zinn, 1990) participants intentionally become aware of sensations in different bits of the body in turn. Mindfulness-based interventions do also include exercises where the focus of awareness is on other aspects of experience such as sounds but the focus on the body is far more prevalent. The potential importance of this emphasis on the body has been missing from many

discussions on how mindfulness might work until recently. In a discussion of MBCT, Williams and Duggan (2006) define 'embodied cognition' as referring to a group of theories which acknowledge the way mind, body and the world interact and influence each other. This approach sees 'the body as fundamental to how the mind operates'. The influential Interacting Cognitive Subsystems model (ICS; Teasdale and Barnard, 1993) suggests a crucial role of body state information in the maintenance of low mood leading to depressive relapse, an idea that was used in the development of MBCT. Teasdale, Segal and Williams (1995) discuss the importance of proprioceptive body state feedback contributing to the depressogenic schematic models which reoccur under conditions of dysphoric mood for people who have previously experienced depression. They discuss how the bodily aspects of mindfulness approaches such as awareness of body and an absence of bodily activity can provide a simple and direct means to change the schematic models arguing that bringing awareness to the body may weaken habits in the body loop (part of 'depressive interlock') which can maintain depressed moods. In addition direct sensory experience provides an alternative to rumination.

It seems likely that the bodily exercises in mindfulness practices might increase awareness or sensitivity to information from the body as well as possibly changing the actual activity in the body. Some preliminary support for this idea comes from a magnetic resonance imaging study. Lazar et al. (2005) found that brain regions associated with somatosensory and interoceptive processing (and in particular the right anterior insula which has been implicated in tasks related to bodily attention and visceral awareness in monkeys and humans) were thicker in experienced mindfulness meditators than in matched controls which they argue is consistent with

an increased capacity for awareness of internal states by meditators. To understand how an increased sensitivity to bodily sensations might translate to enhanced wellbeing will require a brief review of the normative literature on the role of the body in emotion and cognition.

### **The role of body-state feedback in emotion and cognition**

Most famously, the James-Lange theory of emotion (James, 1884, 1894, Lange 1885) claimed that our subjective experience of emotions was due to perceived changes in the body: we are afraid because we run, rather than we run because we are afraid (for reviews see Ellsworth, 2004; Lange, 2003). More recently Damasio (1994) has argued that our experience of emotion is inextricably linked to changes in the body. Damasio views *feeling* as ‘the process of continuously experiencing what your body is doing while thoughts about specific content roll by’ (1994, p.145). Damasio and James both posit a central role of feedback from the body in the generation of emotional experience. It is beyond the scope of this paper to review these theories in full. What is important, is that these models predict that the more people are aware of or ‘in tune’ with their bodies the more intensely they should experience emotion, and the more effectively people may be able to make complex or intuitive decisions.

Support for these theories have come from studies of interoceptive awareness (the extent of an individuals sensitivity to bodily signals), an ability which is known to vary markedly between different individuals (Wiens, 2005). Heartbeat detection paradigms are the most commonly used method for measuring interoceptive accuracy and has been shown to correlate with the ability to detect changes in other

autonomically innervated organs ( Katkins, Wiens & Ohman, 2001). A number of studies have shown increases in intensity of self reported emotion, to both positive and negative stimuli, in people with greater interoceptive awareness accuracy (e.g. Pollatos, Herbert, Matthias and Schandry, 2007; Feldman Barrett, Quigley, Bliss-Moreau & Aronson, 2004; Wiens, Mezzacappa and Katkin, 2000).

Damasio's somatic marker hypothesis (Damasio 1994, see Dunn, Dalgleish & Lawrence, 2006 for a critical review) argues that in uncertain or complex situations, biasing signals from the body can help shape decision making. Damasio argues that 'gut feelings' (somatic markers) have been connected to particular classes of event through continuous learning processes and that prior to 'reasoning' these somatic markers act as 'alarm bells' or 'beacons of incentive' which signal the goodness or badness of a particular decision and increase the efficiency and accuracy of decision-making. Support for these ideas come from the observation of everyday decision-making difficulties in patients who have suffered brain injury to areas known to be involved in interoceptive ability, which have in part been understood in terms of loss of the ability to use subtle sensory cues from their body to inform complex decision making (e.g. Bechara et al 1994, 1996). In support of these theories, Katkin et al. (2001) found that good heartbeat detectors were better at distinguishing subtle gut feelings than bad heartbeat detectors. Dunn et al. ( in prep) have recently shown that anticipatory heart rate and electrodermal responses differentiated good and bad responses on an intuitive decision making task, and that interoceptive awareness moderated the relationship between bodily responses and successful intuitive decision making, suggesting that an individual's ability to detect changes in the body can improve successful decision making.

### **Mindfulness, the body and alleviation of distress**

It has been proposed that altered feedback from the body may contribute to the onset or maintenance of psychopathology, given that a variety of psychological problems include bodily changes and changes in bodily awareness (Dunn et al., 2006). One possibility is that mindfulness-based interventions, which focus on the body, might activate processes relating to body-state feedback, and that these changes might, in part, explain the alleviation of distress through mindfulness-based interventions. In ICS terms (Teasdale and Barnard, 1993), attention to, and awareness of the body in mindfulness may change body-state feedback and thereby prevent 'depressive interlock' (or equivalent in other disorders). Mindfulness exercises which focus on awareness of the body might reasonably be asserted to be a form of interoceptive training, increasing people's ability to know what is happening in their bodies and thereby increasing the intensity with which people experience emotion thereby reducing anhedonia, a problem found across a range of psychological disorders (e.g. Silverstone, 1991).

In addition, given the importance of body-state feedback to people's experience of emotions, upregulating that feedback might lead to enhanced ability to know what one is feeling and to distinguish one emotion from another, a concept known as emotional clarity. People who are high in emotional clarity have been shown to recover quickly from negative mood, and show a quicker decline in ruminative thought (Salovey et al. 1995). In line with the Somatic Marker Hypothesis, Dunn et al.(in prep.) suggest that training in bodily awareness might be one way of ameliorating some of the decision-making difficulties associated with depression and

anxiety. In a similar way, mindful awareness of the body could strengthen somatic marker signals, which could impact on rumination by simplifying the selection of a course of action, thus allowing the person to exit a chronic self-focused ruminatory state, aimed at reducing the discrepancy between current and ideal state but which has the unfortunate effect of maintaining negative affect.

To summarise the suggestion is that mindfulness-based interventions, with their focus on the body, might lead to changes in body-state feedback and that these changes could plausibly account for some of the helpful actions of mindfulness on emotional experience and rumination. In the first study we are aware of to have investigated these links between meditation, interoception and beneficial effects on wellbeing, Nielsen and Kasniak (2006) investigated whether differences in participants' visceral perception abilities were related to individual differences in the ability to distinguish between emotional intuitions elicited by masked pictures and whether this ability to detect very subtle emotional feelings could be cultivated by meditation practice. Contrary to their predictions meditators with more than ten years meditation experience did not differ from controls in their heart beat detection abilities and controls rather than meditators consciously discriminated between unpleasant and pleasant masked pictures on self-reported ratings of valence.

However, five participants in the Nielsen and Kasniak study who had been practising meditation for less than ten years were removed from their main analyses. Footnotes in this study reveal that short-term meditators were different from the long-term meditators in: 1) their tendency to be very bodily focused in their descriptions of emotional experience, 2) their superior heart beat detection ability, 3) their tendency

to rate higher levels of arousal to non masked pictures 4) their tendency to rate unpleasant pictures as more unpleasant in the masked condition. Inspection of the means reveals that the short term meditators may also have been different from the control group on some of these measures however unfortunately formal statistical comparisons between the short term meditators and the controls were not completed due to lack of power. In conclusion preliminary findings from Nielsen and Kasniak raise the interesting possibility that, at least in the shorter term, meditation practice may lead to enhanced visceral perception, higher self reported emotional responses and increased emotional awareness in line with theories that suggest an important role of feedback from the body in mindfulness.

### Hypotheses

The current study aimed to investigate these hypotheses further by comparing the effects of a mindfulness practice which focuses on cultivating awareness of the body with a mindfulness exercise focused on non-bodily phenomena (sounds). 1) Firstly it was hypothesised that the mindfulness of body meditation will lead to increased accuracy of body perception as measured by a heartbeat perception task, and self reported measures of bodily awareness , relative to a non-bodily based mindfulness exercise (sound condition). 2) Secondly it was hypothesised that the body meditation will lead to increased intensity of emotional responding as measured by self reported emotional ratings and physiological responses to an affective images task, relative to the sound condition. 3) Thirdly it was hypothesised that the body condition would lead to a greater reductions in self reported rumination than the sound condition. Together these effects might therefore plausibly account for some of the helpful actions of mindfulness-based interventions which have a large emphasis on the body.



The mindfulness of sounds exercise controlled for effects of mindfulness which might not be related to the body such as general increases in relaxation, meta-cognitive change, acceptance or increased attention or concentration and for practice effects on experimental tasks. It was assumed that this exercise would have less if any impact on body feedback processes and therefore any changes observed in the mindfulness of body group that were over and above those seen in the mindfulness of sounds group could be attributed to the importance of the focus on the body.

## **METHOD**

### **Design**

A 2X2 mixed between-within design was used. The between subjects factor was condition which had 2 levels (body and sound meditation). The within subjects factor was time which also had 2 levels (session 1 and session 2). Participants attended two testing sessions spaced one week apart in-between which they practised the mindfulness exercise they had been assigned to on a daily basis. A repeated measures design was chosen because it was predicted that there might be substantial inter-individual differences in heartbeat perception ability and psycho-physiological responding which might mask the effects of the mindfulness manipulation in a simple between subjects design.

Participants were successively allocated to either the body or sound condition. Half way through testing the two conditions were compared on basic demographic

variables (age and gender) and where a difference emerged, participants were then strategically allocated to even this up.

## **Ethics**

The study was approved by the Cambridge University local ethics committee. Prior to the study all participants gave informed written consent and it was emphasised that they could withdraw from the study at any time for any reason. For a copy of the ethics approval letter and participant information sheet and consent form please see Appendix 1. Participants received an honorarium of £6/hr for their participation and a small payment to cover travel expenses

## **Participants**

### Power Calculation

A power calculation was completed in order to estimate required sample size. Due to the complexity of power calculations when the main effect of interest is an interaction effect, and the novel nature of the current study which meant it was not possible to estimate means and standard deviations of the two conditions, power was calculated based on using independent sample t-tests as the test statistic. In order for any consequences of mindfulness practice to be meaningful theoretically and most importantly clinically it was decided that a large effect size was needed. This calculation indicated that 26 participants per group were needed (Cohen, 1992) in order to have power as (d) 0.8, assuming a large effect size and an alpha value of 0.05. The final sample size was 20 in the body condition and 19 in the sound condition. However, as we used a 2X2 mixed within (Pre-Post) between (Body vs.

Sound) subjects design this is likely to be very close to sufficient power with estimates provided by a statistician suggesting a power of 0.8 with this sample size.

### Participant characteristics

Participants were recruited into the study from the Medical Research Council

(MRC) Cognition and Brain Sciences Unit (CBU) Volunteer Participant Panel.

210 potential volunteers were initially contacted by email (or telephone if no email was available) and asked to reply if they were interested in taking part. Of those 47 said they were willing to take part. 6 of these people dropped out due to lack of availability of suitable testing dates. 2 people did not attend the arranged testing session leaving 39 participants in total, all of whom completed both testing sessions.

All participants were aged between 18 and 65 years of age with no mental health history were recruited from the subject volunteer panel at the MRC Cognition and Brain Sciences Unit. An estimate of IQ was taken from performance on National Adult Reading Test (NART, Nelson 1982). 20 of the participants were assigned to the mindfulness of body condition. They consisted of 12 women and 8 men, aged 23 to 60 years ( $M = 44.0$ ,  $SD = 11.94$ ), with a range of estimated full scale IQ (from the NART) from 112 to 124.4 ( $M = 119.15$ ,  $SD = 3.68$ ). 19 people were assigned to the mindfulness of sounds condition. They consisted of 13 women and 6 men, aged 21 to 64 years, ( $M = 48.63$ ,  $SD = 13.68$ ) with a range of estimated full scale from 108.7 to 126.78 ( $M = 120.44$ ,  $SD = 5.01$ ).

Independent sample t tests showed that there were no differences between the two groups in terms of age  $t(1, 37) = 1.128$ ,  $p = 0.27$ , or estimated intelligence,  $t < 1$ . A

Chi squared test showed no differences between the groups in terms of gender  $\chi^2(1, 39) = 0.30, p = 0.58$ . All participants had normal or corrected to normal eyesight.

### Experimental Conditions: Mindfulness Exercises

The mindfulness meditation instructions for the two groups were both based on shortened mindfulness meditation exercises used in the MBSR programme (Kabat-Zinn, 1990) and the MBCT programme (Segal et al, 2002). The exercises were recorded onto disc (in Wav or PC format.) by the author and were matched for the amount of instructions, length of time, and the tone and volume of verbal instructions. The transcripts for both exercises can be found in the Appendix 2. Both exercises lasted 15 minutes<sup>1</sup>.

The body based mindfulness exercise instructed participants to gently focus their attention on different parts of their body in turn and to become aware of whatever sensations they could feel in that part of their body and to observe those sensations non-judgementally. Several times during the exercise they were reminded to gently bring their awareness back to their body whenever they noticed it had ‘wandered off’ onto other things. The sound based mindfulness exercise instructed participants to

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<sup>1</sup> In the MBSR and MBCT programmes mindfulness exercises are typically 45 minutes long. However for the purposes of this study it was felt that asking volunteers whose motivation to practice these exercises was unknown to practice for this amount of time was unrealistic. Other treatments e.g. Dialectical Behaviour Therapy use much shorter mindfulness exercises.

Both exercises were piloted on 6 volunteers prior to the study. Qualitative feedback indicated that the two exercises were roughly equivalent in terms of how easy they were to follow. An experienced mindfulness practitioner also listened to the exercises and verified that they had face validity as mindfulness exercises.

gently focus their attention on sounds from inside the room where they were sitting and from outside the room in turn and to become aware of whatever sounds they could hear and to listen to those sounds non-judgementally. Several times during the exercise they were reminded to gently bring their awareness back to sounds in their environment whenever they noticed it had ‘wandered off’ onto other things.

All participants completed the mindfulness meditation task by following recorded instructions for the condition that they had been assigned to in the laboratory at the end of the first testing session. Psychophysiology measures were taken throughout in order to see whether the different exercises led to different activity in the body. The exercise was introduced as an attention exercise as it was felt that using the term ‘meditation’ might elicit more varied expectations amongst participants. First participants were instructed to sit quietly for 1 minute while pre meditation baseline psychophysiology measures were taken. They were then asked to rate how they were feeling on several different emotions (happy, relaxed, stressed, calm, anxious ) and also to rate how aware they were of sounds in their environment and sensations in their body on 100 point visual analogue scales presented on the computer screen. They were then instructed to close their eyes and sit on their chair in an erect but relaxed posture and to follow the recorded instructions from the speakers for 15 minutes<sup>2</sup>. At the end of the mindfulness exercise participants were instructed to open

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<sup>2</sup> The sound condition was complicated by the fact that all testing was completed in a sound proofed laboratory. Given that the sound condition involved instruction to listen to naturally occurring sounds in the environment this was problematic. To resolve this problem, during the initial mindfulness of sounds practice during session 1, pre-recorded sounds from a beach (mainly sounds of waves on pebbles) were added underneath the mindfulness instructions. Participants were instructed to focus their awareness on these as well as any sounds they could hear in the lab, e.g. humming of computer equipment. Participants were told that when they were practising during the week they would be instructed to just listen to naturally occurring sounds in their environment.

their eyes and were asked to re-rate how they were feeling and how aware of sounds and their body they were on the same visual analogue scales. These ratings were taken to examine whether the exercises worked as intended. Participants were then instructed to sit for a further 1 minute for post meditation psychophysiology readings.

Following the exercise the experimenter provided standardised answers to any questions. Participants were informed that they would be paid for the time they spent practising the exercise. It was emphasised how important it was for the study that they did practise every day and they were instructed to record the time and length of their practice each day. The experimenter gave the participants a handout of ‘frequently asked questions’ compiled with reference to the MBCT discussion of likely challenges for participants, and the experimenter’s own experience of mindfulness practice (see Appendix 3 for copies of these handouts). Participants were given a disk copy of the relevant exercise in the format that was most convenient for them.

### Psychophysiology and Behavioural Tasks

#### *Psychophysiology Equipment*

Heart rate (HR) was recorded throughout all the experimental tasks in both sessions and during the initial mindfulness practice at the end of session 1<sup>3</sup>. Heart rate was

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<sup>3</sup> In addition to heart rate, galvanic skin response (GSR) was also measured as an additional measure of psycho-physiological response. Unfortunately equipment failure meant that the GSR data was lost for 7 participants and did not look reliable for the majority. For this reason the GSR data has been excluded from this study and will not be reported. Preliminary analysis was attempted on this data and showed no effects.

recorded as a measure of bodily activity (both at rest and in response to emotional images) and also to enable accurate recording of heart rate in order to calculate accuracy on the heartbeat perception task.

Psychophysiological recording used a BIOPAC. MP100 unit, with one GSR 100B amplifier and one ECG 100B amplifier (BIOPAC, 1997). The ECG amplifier gain was set at x 2000, the R-wave detector was switched on, and the filter was switched off. The sampling rate was 200 samples per second for all acquisitions, providing a temporal resolution of 5ms. The MP100 was connected through the Comm port to a Pentium 300 computer, which recorded the amplifier output using the Acqknowledge. 8.0 software. The experimental tasks were presented on a separate Pentium 300 computer with a 15" display. This communicated with the digital input ports of the MP100 through the parallel port of the computer, marking when and what kind of events occurred during the experimental task on the Acqknowledge record. Prior to attaching the equipment, electrode sites were cleaned with an alcohol wipe. To monitor heart rate (in beats per minute) two disposable Ag-AGCI ECG electrodes with clip on shielded leads were attached to the top sides of each wrist or each participant.

### *Rest Psychophysiology*

At the start of each testing session, after completing self report questionnaires, resting baseline heart rate was taken while participants were asked to sit quietly and still for a 3 minute period. This enabled a comparison between the two groups at the start of the experiment to check they were comparable in terms of heart rate and to

check whether the mindfulness practices led to any differential changes in resting heart rate for either condition.

### **Bodily Awareness Measures**

Awareness of bodily sensations and functions was measured by a behavioural task and self report questionnaires.

#### *Heartbeat Perception Task*

Heart rate monitoring accuracy was measured using an amended version of the Schandry (1981) mental tracking task (e.g. Dunn et al., 2006). In each trial participants were asked to count how many heart beats they felt between two tones. They were instructed not take their pulse but to try and feel their heart beating. To ensure that heartbeat perception was not confounded by ability to estimate time, participants also estimated how many seconds passed between two tones on a number of trials. At each testing session participants completed a practice trial followed by three heart beat estimation trials (of 35 seconds, 25secs and 45secs), three time estimation trials (of 23s, 56s, 40s) and a further three heart beat estimation trials (35, 25, 45).

Prior to the task participants completed a scale of their current level of physical activity, rated on a 7 point scale as used by Ehlers & Breuer (1996) and height and weight were recorded in order to calculate body mass index (BMI) since it is known that these factors can influence task performance (Ehlers & Breuer, 1996).

Participants were asked to the remove any watches (which were taken out of hearing range) and given instructions which included asking them not to complete the task by



taking their pulse or holding their breath. See Appendix 4 for a full copy of the instructions used. Each trial began with a 800hz tone lasting 100ms to warn participants to get ready. Three seconds later a 1000hz, 50ms tone was sounded signalling the participants to start counting their heart beats (or seconds in the time estimation trials) After the trial period there was an identical tone which signalled the end of the trial for the participants to stop counting. Participants then entered their estimate onto the computer. The mean error scores of the six trials on the heart beat estimation task and three time estimation trials at session 1 and separately for session 2 were averaged to create a composite heart beat error score and composite time estimation error score for each session for each participant. Heart beat perception inaccuracy was calculated by taking the modulus of the actual number of heartbeats minus the counted heartbeats and multiplying by 100 to express the inaccuracy as a percentage.  $(|AB - CB| / AB \times 100)$ , where ANB = actual beats and CB = counted beats.<sup>4</sup>

#### *Self Reported Body Awareness*

To measure the impact of the mindfulness practices on people's bodily awareness three different self report questionnaires were used in addition to the heartbeat detection task. The Somatosensory Amplification Scale (SSAS; Barsky Goodson, Lane & Cleary, 1998 ) is a 10 item scale that measures self reported sensitivity to normal somatic and visceral sensations which may be uncomfortable but are not usually indicative of illness. It contains 10 items which are rated in terms of how true

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<sup>4</sup> Participants were also asked to rate their confidence in their heartbeat perception performance and at the end of the study completed a brief 'heart rate insight questionnaire' which aimed to establish how much people knew about their actual heart rate and how they believed they had completed the task.

they are have been of you in the past week from 1 not at all true to 5 extremely true. The final score is an average of the 10 responses yielding a range from 1-5. The test–retest reliability of the SSAS over a median of 74 days has been shown to be 0.79 and the internal consistency was 0.82 and has been found to correlate highly with measures of hypochondriasis and somatization (Barsky, Wyshak & Klerman; 1990)

The private factor of the Body Consciousness Questionnaire (BCQ, Miller, Murphy & Buss, 1981) is a subscale with 6 items which are statements measuring attention to internal body sensations. Participants rated how characteristic each statement has been of them in the past week with ratings ranging from 1, ‘extremely uncharacteristic of me’ to 4 ‘extremely characteristic of me’ yielding a total score ranging from 6 to 24. The full questionnaire contains 15 items comprising 3 subscales and has been shown to have good internal consistency (Cronbach’s  $\alpha = 0.70$ ), test-retest reliability ( $r = 0.85$ ) and discriminant validity)

The Porges Body Perception Questionnaire - Awareness Subscale (BPQ, Porges, 2003) is a 45 item questionnaire measuring how aware people are of their body processes. Participants rate whether they have been aware of each body process ‘during most situations over the past week’ on a 5 point Likert type scale from 1 never to 5 always. Examples of body processes include ‘my body swaying while I am standing’, ‘eye movements’ and ‘muscle tension in my arms and legs’. The final score is an average of all 45 items yielding a range from 1-5. There is currently no data on its reliability or validity however it has been used by a number of authors as a measure of bodily awareness (e.g. Critchley, Wiens, Rotshtein, Ohman & Dolan,

2004, Fairclough & Goodwin, 2007). The advantage of this measure is that it contains numerous items relating to a range of bodily processes and has less of a negative evaluative focus than the other measures used.

The reason for using these different measures is that each questionnaire has a slightly different focus, the SSAS being more associated with negative evaluation of normal bodily sensations, the BCQ being a very brief measure and the BPQ having received limited psychometric testing.

## **Emotional Responding**

### *Affective Pictures Task*

To measure the impact of mindfulness practice on processing of emotional material participants viewed a series of images and rated how those images made them feel. Participants completed a different version of the affective pictures task (A & B) on each of the testing sessions. For each version of the task participants were shown 2 practice images followed by 25 pictures selected from the International Affective Picture Sets (Lang, Greenwald, Bradley & Hamm, 1993), 5 of each of the following categories (happy, sad, disgusting, fearful, neutral; see Appendix 6 and 7 for a copy of instructions for this task and examples of each image type). Images were selected based on previous work that has shown these images reliably induce the target emotion and not other emotions (Dunn et al, 2004). Participants were asked to rate how happy, sad, scared and disgusted they felt in response to each picture on 100 point visual analogue scales. Participants viewed each image for 6 seconds, made their ratings after which followed an 8 second inter-trial interval before the next image was presented. Participants were asked to view the picture and rate how they

felt as honestly as possible. For a copy of the instructions please see Appendix 4.

The task took approximately 15 minutes to complete. The order of presenting the versions of the picture task was counterbalanced. Half the people in the body condition looked at version A at week 1 and version B at week 2 and the same in the sound condition. For every five consecutive trials one of each picture type was presented, called up in a random order. Exactly which picture of each type was called during each block was also fully randomised across participants.

Heart rate response was also recorded for each image. The reason for including psychophysiology responses to picture viewing was that emotions are viewed as having a number of component responses that can be measured (e.g. Lang et al, 1993) which may reveal a different pattern of findings to self reported responses as the latter may be more influenced by demand characteristics or social desirability.

#### *Self Report Mood Measures*

To measure the impact of the different mindfulness practices on depression, anxiety affective experience and rumination, participants were asked to make ratings over the week before and the week of the mindfulness practice on the following self report scales.

The Beck Depression Inventory (BDI; Beck et al, 1961) is a 21 item questionnaire measuring severity of depressive symptoms. Each item is rated from 0-3 measuring increasing severity of each symptom. It yields a total score ranging from 0 (asymptomatic) to 63 (severe depression). The BDI has been found to have high

reliability and stability and has also been demonstrated to correlate highly with clinicians ratings of depression (Beck, Steer & Garbin, 1988).

A modified version of the trait scale from the State-Trait Anxiety Inventory (STAI; Spielberger et al, 1983) was used to measure anxiety symptoms over a week long period. This scale contains 20 items and requires participants to rate how they have felt over the past week on a scale from 0 (Almost Never) to 4 (Almost Always) for each item. The STAI is one of the most frequently used and long standing measures of anxiety. Reliability and validity of the scale is high (Bieling et al, 1998), with test-retest reliability ranging from .65 to .86 and internal consistency reported to range from .83 to .92. The STAI is made up of two forms that generate a trait (stable propensity to experience anxiety) and a state (current experience of anxiety) measure. In the standard version of the trait scale, participants are asked to rate how they generally feel. In the version used in this study, participants were asked to rate how they had felt over the past week.

A modified version of the Positive and Negative Affect Schedule (PANAS , Watson, Clark & Tellegen, 1988) was used to measure affective experience over a week long period. The scale lists 10 positive and 10 negative emotions and asks participants to rate to what extent they have felt like that in the past week on a 5 point scale from 1 very slight/not at all to 5 extremely. Watson et al. (1988) have demonstrated the validity of the PANAS and both subscales of the PANAS have shown satisfactory internal consistency in large student samples (.84). The subscales were also found to be internally consistent for non student adults and psychiatric populations and the test re-test reliability was 0.68 and 0.71 respectively

### *Rumination*

Rumination, characterised by self reflection and repetitive and passive focus on one's negative emotions was measured using a 10 item version of the Response Styles questionnaire (RSQ; Nolen-Hoeksema & Morrow, 1991) Participants are asked to rate each item to indicate how often they responded in a particular way when feeling down, sad or depressed in the last week on a 4 point scale ranging from 'almost never' (scored as 1) to 'almost always' (scored as 4). Treynor, Gonzalez & Nolen-Hoeksema (2003) distinguished 2 dimensions of rumination. The Brooding subscale (characterised by 'moody pondering'; p252) contains 5 items (e.g. Thought "what am I doing to deserve this"). The Reflection subscale (characterised by neutral contemplation aimed at trying to overcome problems) contains 5 items (e.g. Analyzed recent events to try and understand why you feel depressed). Each subscale yields a score ranging from 5 to 20. Treynor et al (2003) found that both brooding and reflection are associated with concurrent depressive symptoms but only brooding predicts depressive symptoms longitudinally. Treynor et al. (2003) found that the coefficient alpha for the Reflection subscale was .72 at Time 1 and the test-retest correlation was .60. For the Brooding subscale, the coefficient alpha at Time 1 was .77 and the test-retest correlation was .62.

### **Procedure**

Participants were seen individually for two sessions, spaced one week apart. Testing took place in a small softly lit laboratory with participants seated on a comfortable chair facing the computer monitor. Lights were dimmed during the experimental tasks and mindfulness practice. At the first session, which lasted approximately 2

hours, after completing written consent, participants were screened. Participants then completed the self report questionnaires (as well as other measures not reported here), followed by the rest task, heartbeat perception task and the affective images task. The experimenter left the room during the slide viewings to reduce demand effects on the participants. After these tasks had been completed participants were introduced to the mindfulness exercise they had been assigned to. They practised this once on their own in the lab and were given a chance to ask any questions. They were then given an audio copy of the mindfulness exercise to take away with them and practice daily for a week. On the second testing session, one week later the procedure was the same except participants did not do the meditation task. This session lasted approximately 90 minutes. At the end of the second session participants were paid for their participation and given an opportunity to ask any questions. A table summarising the tasks and measures completed at each session can be found in Appendix 8.

### **Data Analysis**

Prior to analysis variables were checked to see if they violated normality assumptions. If there were problems with normality or significant outliers, transformations or removal of outliers were tried. When using the transformed variable made no difference to the outcome of the analyses, the results are reported with the original untransformed variable. Where problems with normality could not be resolved by transformations or removal of outliers, possible interaction effects were also explored non parametrically. When the non parametric results were equivalent to the parametric the latter are reported for simplicity.

Repeated Measures ANOVAs were the main statistical test used for the majority of the analyses, with Time (Week 1, Week 2) as the within subjects factor and Condition (body meditation, sound meditation) as the between groups factor. Where significant interactions were found, these were resolved with paired sample t-tests (cf Bonnfice, 1995). To check the groups were comparable at time one independent sample t-tests or chi-square tests were used. All means and standard deviations reported are based on the untransformed complete data set unless otherwise specified. Throughout the analyses Alpha was set at .05 for a significant result and at .1 for a trend.

## **RESULTS**

### **Examining comparability of conditions**

In order to verify that participants in each group were comparable at the start of the study on variables known to influence interoceptive ability, a series of independent t-tests and where needed non parametric equivalents were run on key variables.

These are reported in Table 1. Independent sample t tests showed that there were no differences between the two groups in terms of age,  $t(1, 37) = 1.128$ ,  $p = 0.27$ , body mass index, level of physical activity or on resting heart rate,  $t$ s all  $< 1$ . A Chi squared test showed no differences between the groups in terms of gender,  $\chi^2(1, 39) = 0.30$ ,  $p = 0.58$ . Therefore the groups were comparable at baseline, meaning that performance on the experimental tasks is unlikely to be confounded by these variables.



**Table 1.**

*Means and standard deviations of demographic variables of participants assigned to the body and sound conditions.*

Variable	Body condition	Sound condition
Age	44.00 (11.94)	48.63 (13.68)
Gender	12 f : 8 m	13 f : 6 m
BMI	26.68 (3.35)	24.31 (3.36)
Physical Activity Score	2.50 (0.96)	2.76 (1.18)
Heart Rate at Rest (in beats per minute)	68.28 (8.69)	67.30 (9.38)

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BMI = Body Mass Index

### **Manipulation checks**

The mean (standard deviation) number of days where mindfulness practice was completed was 5.50 (0.83) in the body condition and 5.68 (0.48) in the sound condition. Independent t tests showed the groups did not differ significantly in the amount of practice they did,  $t < 1$ .

To ensure the mindfulness meditation instructions were understood and followed by participants as intended, (that the mindfulness of body condition induced increased awareness of body and the mindfulness of sound condition induced increased awareness of sounds) comparisons were made between self report ratings immediately pre and post mindfulness practice.

### Self Reported Awareness of Body and sound

Table 2 shows self reported ratings of state awareness of body sensations and state awareness of sounds immediately before and immediately after practising the mindfulness exercise for the first time (at the end of the first testing session).

Independent sample t-tests showed that prior to the mindfulness practice the two groups did not differ in their ratings of body awareness,  $t < 1$ , or of sound awareness  $t < 1$ .

The data was analysed using 2 X 2 X 2 repeated measures ANOVA, with time (Immediately Pre meditation-Immediately Post meditation) and self reported awareness (of body, of sounds) as a within subjects factor and Condition (Body, Sound) as a between subjects factor. There was a significant time by awareness by condition interaction,  $F(1, 37) = 4.83$ ,  $p = 0.03$ . To resolve this interaction 2 X 2 repeated measures ANOVAs were conducted on the awareness ratings of body and sound separately.

For ratings of awareness of body sensations there was a significant main effect of time,  $F(1, 37) = 12.45$ ,  $p < .01$ , no main effect of condition,  $F(1, 37) = 1.10$ ,  $p = 0.30$ , and no time by condition interaction,  $F(1, 37) = 2.13$ ,  $p = 0.15$ . Paired t-tests showed that awareness of body sensations increased significantly pre-post meditation for the body condition,  $t(19) = 4.30$ ,  $p < 0.01$  but not for the sound condition,  $t(18) = 1.25$ ,  $p = 0.23$ .

For ratings of awareness of sounds there was a significant effect of time  $F(1, 37) = 4.11$ ,  $p = 0.05$ , no main effect of condition,  $F(1, 37) = 2.33$ ,  $p = 0.14$ . There was a

trend towards a time by group interaction,  $F(1, 37) = 3.12, p = 0.09$ . Paired t-tests revealed that awareness of sounds increased significantly pre-post meditation for the sound condition,  $t(18) = 2.18, p = 0.04$ , but not for the body condition,  $t < 1$ .

**Table 2.**

*Ratings of state awareness of body and sounds immediately pre and immediately post mindfulness practice for both conditions.*

		Body Condition	Sound Condition
Body Awareness	Pre Mindfulness	43.80 (27.52)	42.31 (26.87)
	Post Mindfulness	64.10 (18.07)	50.73 (28.43)
Sound Awareness	Pre Mindfulness	55.65 (26.77)	60.95 (23.83)
	Post Mindfulness	56.55 (32.24)	74.11 (17.40)

Note: Data are mean (standard deviation) rated on a 100 point sliding scale

Overall this pattern of results shows that each of the mindfulness exercises had the intended effects. Participants who completed the mindfulness of body exercise reported becoming more aware of body sensations and not sounds and participants completing the mindfulness of sounds exercise reporting increased awareness of sounds but not bodily sensations. These results suggest it is likely the manipulation worked as intended.<sup>5</sup>

<sup>5</sup> Ratings of state mood were also taken immediately before and after the mindfulness practice. Post mindfulness both groups reported feeling more relaxed and less stressed and the amount of change did not differ between conditions. There was no significant change on

### Meditation Task psychophysiology

Table 3 shows mean heart rate in the rest periods immediately before and after the mindfulness exercise for each condition. Two participants' data was missing due to equipment failure. An independent t test found that the two conditions were comparable pre-mindfulness practice for heart rate,  $t < 1$ . Two way repeated measures ANOVA was used to analyse change in heart rate immediately following meditation practice. Results revealed no main effect of time,  $F < 1$ , no main effect of group,  $F(1, 37) = 1.34$ ,  $p = 0.25$ , and no time by condition interaction,  $F < 1$ . Neither mindfulness practice led to any immediate changes in heart rate<sup>6</sup>

**Table 3**

*Mean Heart Rate in Rest periods immediately before and after meditation practice.*

	Body (n = 19)	Sound (n=18)
Mean heart rate at rest prior to meditation	67.38 (8.72)	64.64 (8.30)
Mean heart rate at rest after meditation	68.49 (9.64)	64.83 (7.66)

Note: Heart Rate in beats per minute.

### Rest Task Psychophysiology

Table 4 shows mean heart rate during initial rest period at week 1 and week 2 for both conditions. An independent sample t test found that the two conditions were ratings of sadness or happiness for either group. However whilst both groups reported a decrease in anxiety post mindfulness, the sound condition reported a significantly greater decrease in anxiety than the body group.

<sup>6</sup> An identical pattern of results emerged when heart rate variability was analysed.

comparable at baseline for heart rate,  $t < 1$ . Two way repeated measures ANOVA used to analyse change in heart rate following one weeks practice of meditation. The results showed no main effect of time,  $F < 1$ , no main effect of group,  $F < 1$ , and no time by condition interaction,  $F < 1$ . Practising the mindfulness exercise for 1 week did not change resting heart rate for either condition.

**Table 4.**

*Mean Heart Rate during initial rest period at week 1 and week 2 for both conditions*

		Body Condition	Sound Condition
Heart Rate During Rest	Week 1	68.28 (8.69)	67.30 (9.38)
	Week 2	69.38 (11.46)	67.56 (9.26)

Heart Rate measured in beats per minute

Overall these results show neither manipulation lead to any changes in heart rate immediately following the first practice or following one week's practice for either condition.

## **Awareness of Body**

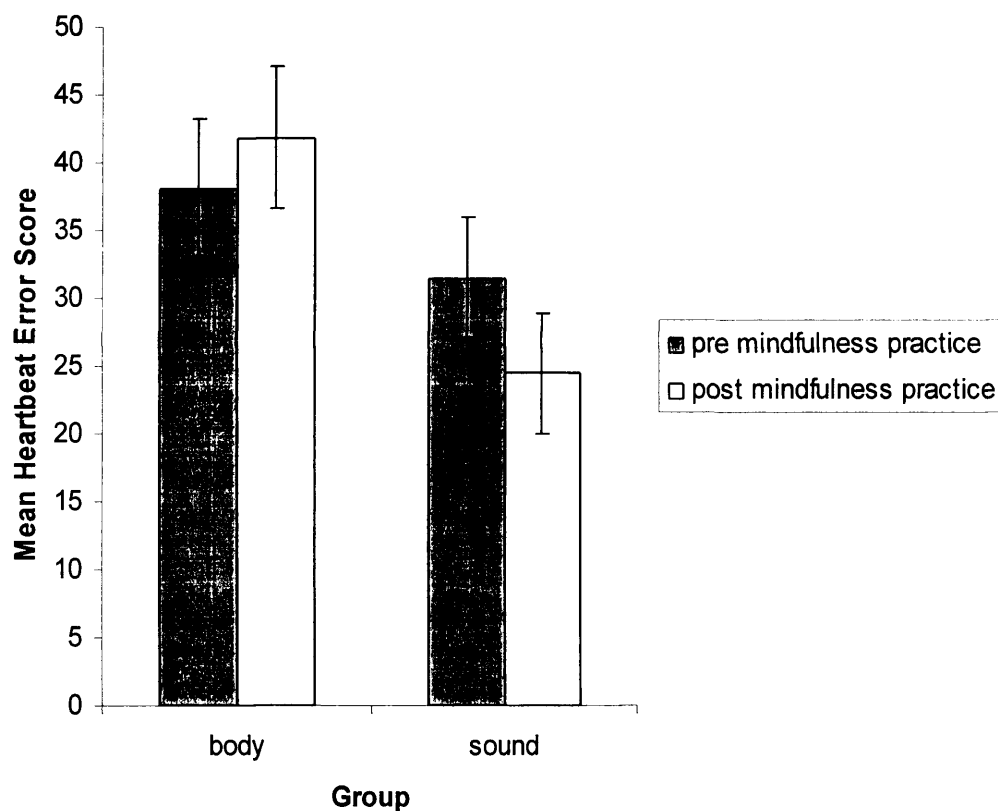
### Heartbeat Perception Accuracy

Figure 1 shows heartbeat perception accuracy pre and post mindfulness practice (at week 1 and week 2) for each condition. An independent sample t-test found that the two groups were comparable pre- practice for heartbeat error score,  $t < 1$ . Two way repeated measures ANOVA was used to analyse change in heartbeat perception following meditation practice. Two participants were excluded from this analysis as they had not followed the task instructions appropriately. Results revealed a trend

towards a main effect of time,  $F(1, 35) = 3.18, p = 0.08$ , suggesting overall there was a trend for participants to get more accurate at the task at week 2, no main effect of condition,  $F(1, 35) = 2.16, p = 0.15$ , and a significant time by condition interaction,  $F(1, 35) = 4.26, p = 0.05$ . To resolve this interaction, paired sample t-tests examined change in heartbeat perception accuracy for each group separately (cf Boniface, 1995). Contrary to prediction, the body group did not significantly change on the task,  $t < 1$ , whereas the sound group improved after practicing meditation,  $t(18) = 3.12, p < .01$ , Sidak corrected  $p < .02$ .

**Figure One**

*Performance on the heartbeat perception task pre and post meditation practice in each group*



Data are mean (standard error of the mean) values. Higher score = lower interoceptive accuracy.

### Self Reported Body Awareness

Table 5 shows mean scores on the three body awareness scales for the week before and the week of mindfulness practice in each condition. Independent sample t-tests found the two groups were comparable pre-meditation practice on the BCQ,  $t < 1$ , and the BPQ,  $t(1, 37) = 1.59$ ,  $p = 0.12$ , although there was a non-significant trend for the sound group to have a lower SSAS score than the body group,  $t(1, 37) = 1.77$ ,  $p = 0.09$ . Two way repeated measures ANOVA were used to analyse change in self reported body awareness following one week's mindfulness practice separately for each measure. On the SSAS there was no main effects of time  $F(1, 37) = 2.20$ ,  $p = 0.15$ , no main effect of condition,  $F < 1$  and no time by condition interaction,  $F < 1$ . On the BCQ there was no main effect of time or condition and no time by condition interaction,  $F_s < 1$ . On the BPQ, there was a significant main effect of time,  $F(1, 37) = 8.20$ ,  $p < 0.01$ , but no main effect of condition or condition by time interaction,  $F_s < 1$ . Participant's scores on the SSAS and BCQ did not significantly change following one weeks mindfulness practice in either condition, however participants in both conditions reported being less aware of body processes on the BPQ after the week's mindfulness practice than before.

**Table 5.**

*Mean scores on the three body awareness scales for the week before and the week of mindfulness practice in each condition*

		Body Condition	Sound Condition
SSAS	Pre	1.68 (0.40)	1.45 (0.40)
	Post	1.58 (0.42)	1.41 (0.35)
BCQ (Private)	Pre	10.45 (2.58)	9.68 (3.37)
	Post	10.25 (3.18)	9.83 (2.83)
BPQ	Pre	1.66 (0.30)	1.50 (0.31)
	Post	1.56 (0.34)	1.43(0.26)

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Data are mean score (standard deviation)

SSAS - Somatosensory Amplification Scale

BCQ - (Private) Private subscale of the Body Consciousness Questionnaire

BPQ - Body Perception Questionnaire (Awareness Subscale)

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## **Affective Pictures Task**

### Self reported emotional responses

Emotional responses to the affective images were analysed using the response to neutral pictures as a baseline in order to control for differences between how the rating scales were used between conditions<sup>7</sup>. This was achieved by subtracting the comparable rating from the neutral picture block from the emotion rating for each emotional picture (for example subtracting the mean happiness rating of neutral pictures from the mean happiness rating from happy pictures). A composite score for

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<sup>7</sup> Piloting had established that the images worked as intended with happy images eliciting mainly happiness, fear images eliciting mainly fear etc. Counterbalancing was also ruled out as a potential confound. The counterbalancing analysis is not included in order to make the results simpler to follow given that the pattern of results remained the same.



the negative emotions (sad, disgust and fear) was calculated by averaging the sum of the three scores (each relative to neutral).

Figure 2 shows self reported responses to positive and negative pictures (relative to neutral image baseline) before and after the week-long mindfulness practice for each condition. Independent t tests showed that the conditions were comparable at session 1 in their ratings of both positive (relative to neutral ) and negative (relative to neutral) images,  $t_s < 1$ . Three way repeated measures ANOVA with time (Pre-Post) and picture type (Positive, Negative) as the within subjects factor and condition (Body, Sound) as the between subjects factor was used to analyse change in response to different picture types following meditation practice. There was a significant Time by Picture type by Condition interaction,  $F(1, 37) = 6.05, p = .02$

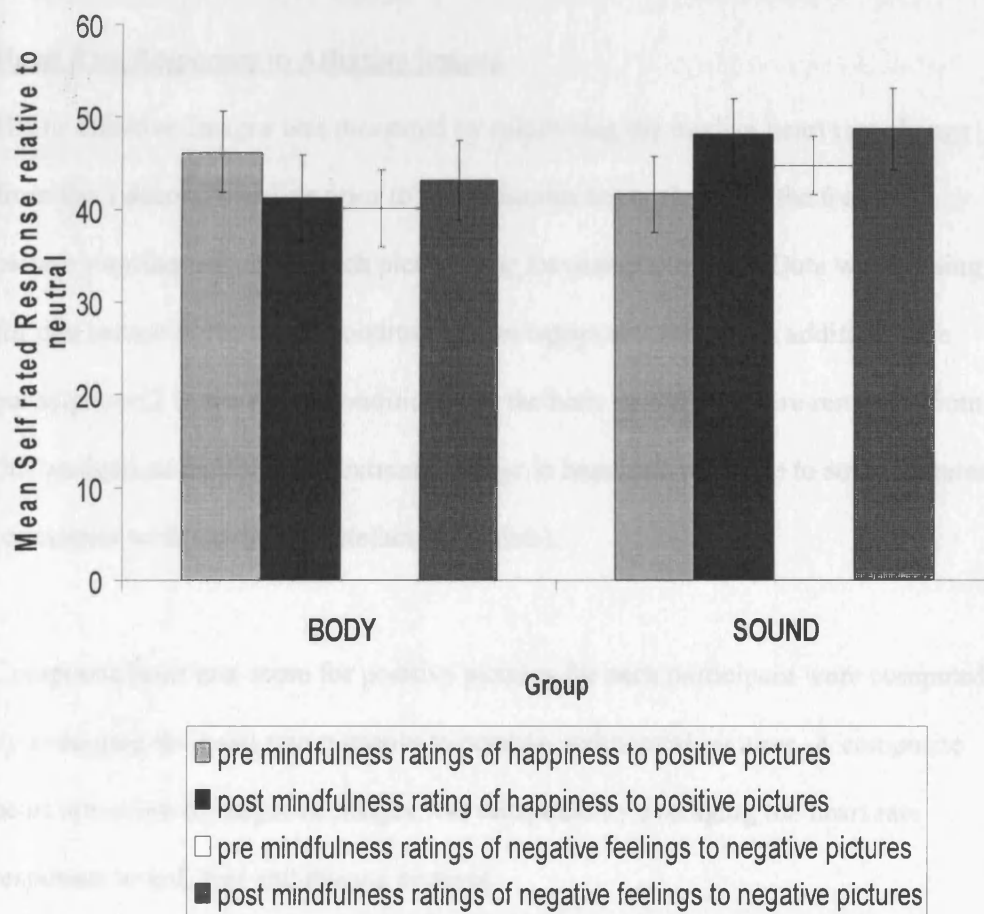
To resolve this three way interaction, positive and negative images were analysed separately using 2 way repeated measures ANOVAs with time as the within subjects factor and condition as the between subjects factor. For positive pictures (relative to baseline) results showed no main effect of time or condition,  $F_s < 1$ , but there was a significant time by condition interaction,  $F(1, 37) = 5.79, p = 0.02$ . Inspection of the graph revealed that the body group showed a diminished response whereas the sound group showed an increased response to positive pictures following one week mindfulness practice.

For negative pictures (relative to baseline) there was a significant main effect of time,  $F(1, 37) = 4.38, p = 0.04$ , showing that participants tended to rate negative pictures as more negative at week 2 than at week 1 regardless of which condition

they were in. There was no main effect of group,  $F < 1$  and no time by group interaction,  $F < 1$ .

**Figure 2**

*Self rated emotional response to positive and negative emotional images pre and post mindfulness practice for each condition*



Data are mean (standard error of mean) rated on 100 point sliding scale.

Given that the expected changes in heartbeat perception for the mindfulness of body condition did not occur, correlations between changes in body awareness and changes in the other key variables were calculated across the sample as a whole to

see whether changes in emotional responding were associated with increased heartbeat perception accuracy. There was no significant correlation between change in heartbeat perception accuracy and change in self reported emotional response to positive pictures,  $r = 0.07$ ,  $p = 0.70$  or for responses to negative pictures,  $r = 0.07$ ,  $p = 0.69$  suggesting changes in heartbeat perception did not account for changes in emotional responses to positive or negative images.

#### Heart Rate Responses to Affective Images.

HR to affective images was measured by calculating the median heart rate change from the 1 second baseline prior to each stimulus being shown to the 6 second picture viewing period for each picture type for each participant. Data was missing for one person in the sound condition due to equipment failure. In addition three participants (2 in the sound condition, 1 in the body condition) were removed from this analysis as they showed extreme change in heart rate response to some pictures (consistent with movement artefact in the data).

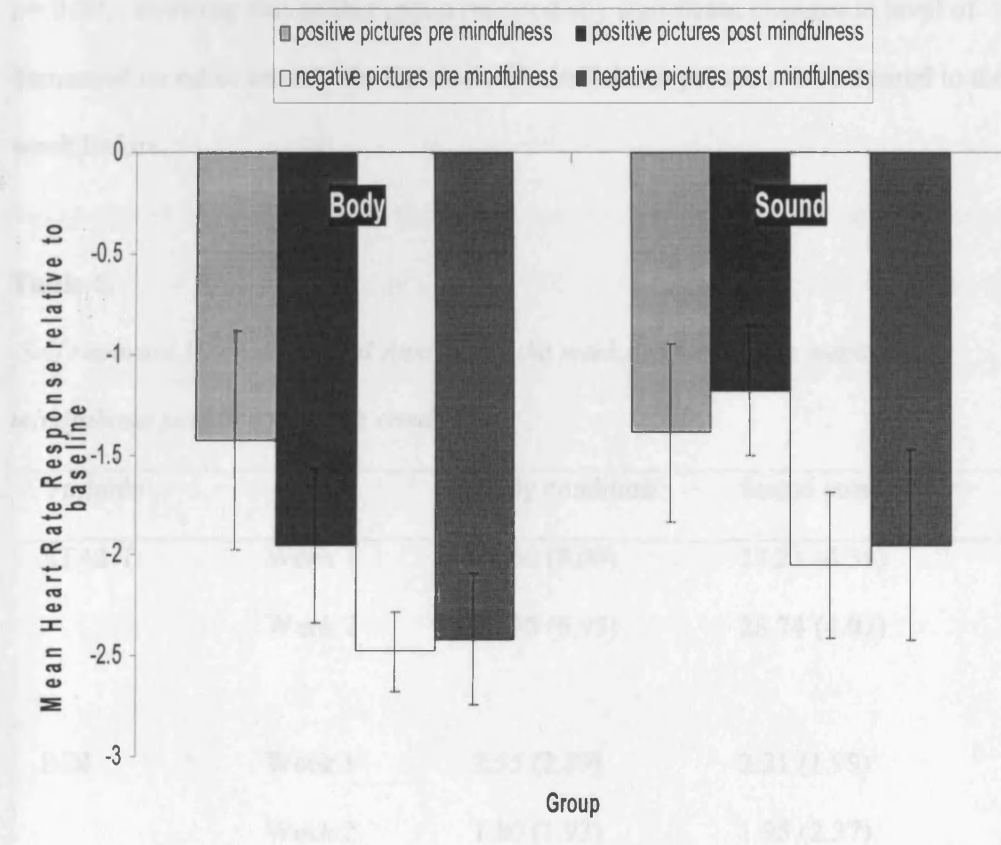
Composite heart rate score for positive pictures for each participant were computed by averaging the heart rate response to positive and neutral pictures. A composite heart rate score for negative images was computed by averaging the heart rate responses to sad, fear and disgust pictures.

Figure 3 shows heart rate response during picture viewing period before and after one weeks meditation practice for both positive and negative pictures for each condition. Independent sample t-tests showed that the groups were comparable at baseline in their heart rate response to positive pictures (relative to baseline),  $t < 1$  and

negative pictures,  $t(1, 33) = 1.01, p = 0.32$ . Three way repeated measures ANOVA with time (Pre-Post) and picture type (Positive, Negative) as the within subjects factor and condition as the between subjects factor was used to analyse change in heart rate response to different picture types following meditation practice. There was a significant main effect of picture type,  $F(1, 33) = 10.31, p < .01$  but no time by picture type by condition interaction,  $F < 1$ . Inspection of the graph reveals that all participants regardless of condition showed a more negative heart rate change in response to negative pictures than positive pictures. There was no main effect of time,  $F < 1$  or group,  $F(1, 33) = 1.35, p = 0.25$ , and there was no time by group interaction,  $F(1, 33) = 1.40, p = 0.25$ . This pattern of results shows that heart rate response to both positive and negative images did not significantly change following a weeks mindfulness practice for either condition.

**Figure 3.**

*Mean median heart rate change in response to positive and negative emotional images pre and post mindfulness for each condition*



### Self Report Questionnaires

#### Self Reported Mood Measures

Table 6 shows means scores on the Beck depression Inventory (BDI) and the Spielberger State-Trait Anxiety Inventory version (STAI) for the week before and the week during mindfulness practice. Independent sample t-tests showed that the groups were comparable on both of these measures,  $t_s < 1$ . Two way repeated measures ANOVA was used to analyse change in self reported mood following the start of mindfulness practice . On the BDI there was no main effect of time,  $F(1, 37)$

= 2.26,  $p = 0.14$ , no effect of condition,  $F < 1$  and no time by group interaction,  $F < 1$ .

On the STAI there was no main effect of time,  $F(1, 37) = 1.69$ ,  $p = 0.20$ , no main effect of group,  $F < 1$  and there was no time by condition interaction,  $F(1, 37) = 1.14$ ,  $p = 0.29$ , showing that neither group reported any significant changes in level of depressed mood or anxiety for the week of mindfulness practice as compared to the week before.

**Table 6.**

*Self reported Depression and Anxiety for the week before and the week during mindfulness practice for each condition.*

Variable		Body condition	Sound condition
STAI-T	Week 1	28.60 (8.00)	27.21 (4.34)
	Week 2	28.75 (6.95)	28.74 (4.07)
BDI	Week 1	2.55 (2.89)	2.21 (1.99)
	Week 2	1.80 (1.93)	1.95 (2.37)

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Data are mean (standard deviation)  
 STAI-T Total score on Spielberger State-Trait Anxiety Inventory  
 BDI Beck Depression Inventory

#### Positive and Negative Affect Scale (PANAS)

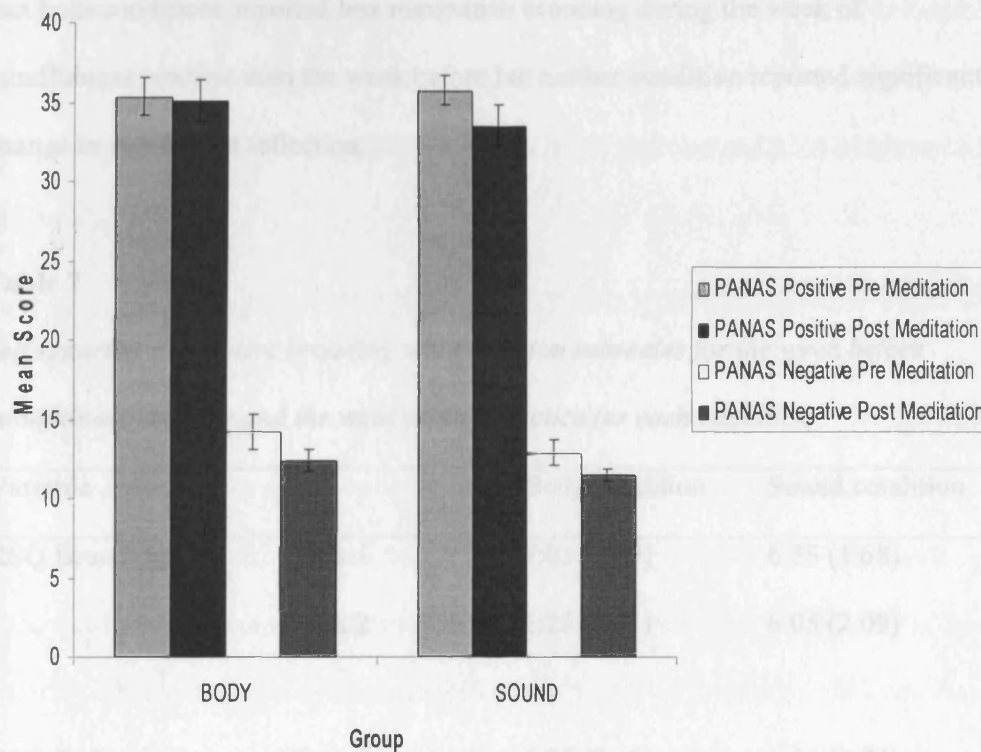
Figure 4 shows ratings of positive and negative affect for the week before mindfulness practice and the week during practice for each condition. Independent sample t-tests found that the conditions were comparable pre-practice for ratings of positive affect,  $t(1, 37) = 1.08$ ,  $p = 0.29$ , and negative affect,  $t < 1$ . Two way repeated measures ANOVA was used to analyse change in both positive and negative affect

for the week of mindfulness practice as compared to the previous week. The results showed that for ratings of positive emotions there was a significant main effect of time,  $F(1, 37) = 8.62, p < 0.01$ , no main effect of condition,  $F(1, 37) = 1.16, p = 0.29$ , and no time by condition interaction,  $F < 1$ . For ratings of negative emotions there was a significant main effect of time,  $F(1, 37) = 9.85, p < 0.01$ , no main effect of condition,  $F(1, 37) = 1.06, p = 0.31$ , and no time by condition interaction,  $F < 1$ . These results and inspection of the graph show that both groups reported less intense positive affect and less intense negative affect for the week of mindfulness practice as compared to the week before.

There was no significant correlation between change in heartbeat perception error and change in positive affect,  $r = 0.07, p = 0.67$ , or negative affect,  $r = 0.14, p = 0.42$  suggesting that changes in affect were not related to changes in heartbeat perception.

**Figure 4**

*Mean ratings of positive and negative affect on the PANAS for the week before and week of mindfulness practice for each condition.*



Data are mean (standard error of the mean)

### Rumination

Table 7 shows self reported ratings of rumination measured on the RSQ broken down into brooding and reflection subscales for the week before mindfulness practice and the week during practice for each condition. Independent sample t-tests showed that at baseline the groups were comparable on the total score and both of the subscales,  $t_s < 1$ . Two way repeated measures ANOVAs was used to analyse change in rumination scores for the week of mindfulness practice as compared to the previous



week. For the brooding subscale there was a significant main effect of time,  $F(1, 37) = 10.35$ ,  $p < 0.01$ , no main effect of condition,  $F < 1$ , and no time by condition interaction,  $F < 1$ . For ratings of reflection there was no main effect of time of condition and no time by condition interaction,  $F_s < 1$ . Overall these results suggest that both conditions reported less ruminative brooding during the week of mindfulness practice than the week before but neither condition reported significant change in ruminative reflection.

**Table 7**

*Self reported ruminative brooding and reflection subscales for the week before mindfulness practice and the week during practice for each condition*

Variable		Body condition	Sound condition
RSQ Brooding	Week 1	7.03 (2.47)	6.58 (1.68)
	Week 2	6.25 (1.71)	6.05 (2.09)
RSQ Reflection	Week 1	6.26 (2.49)	6.16 (2.83)
	Week 2	6.45 (3.14)	6.05 (2.27)

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Data are mean (standard deviation)  
RSQ = Response Styles Questionnaire

There was no significant correlation between change in heartbeat perception error and change in ruminative brooding,  $r = 0.15$ ,  $p = 0.39$  suggesting that changes in ruminative brooding were not related to changes in heartbeat perception accuracy.

## **DISCUSSION**

The present study investigated whether changes in body state feedback might be one of the mechanisms by which mindfulness-based interventions leads to health benefits. It was hypothesised that practising a mindfulness exercise focused on cultivating non judgemental awareness of bodily sensations would lead to enhanced visceral perception and self reported bodily awareness and that this would lead to increased intensity of emotional responses, both self reported and physiological and reduced rumination.

### **Body Awareness**

The first hypothesis, that a mindfulness exercise focused on the body would lead to greater increases in accuracy on an objective measure of body monitoring and on greater increases in self reported bodily awareness than a mindfulness exercise focused on sounds was not supported. Contrary to prediction the mindfulness of body exercise did not lead to any improvement on the heart beat perception task whereas the sounds exercise did lead to improved accuracy. On self report measures, also against prediction, the body group did not report any greater increases in awareness of bodily sensations than the sound group. On one measure, both conditions actually reported *less* awareness of body sensations following the week of mindfulness practice. However on two other measures of awareness of body sensations, there was no change for either condition.

The lack of neutral control group makes the heart beat perception results somewhat difficult to interpret as it is not clear how these results would compare with a group who simply completed the heartbeat perception task twice with no manipulation. We

can only speculate at present what led to the pattern of results. One possibility is that perhaps counter-intuitively the mindfulness of sound exercise is simply a more effective or faster means to increase bodily awareness than a mindfulness of body exercise. Perhaps focusing awareness on sounds (in the foreground of awareness) but having bodily sensations in the background of awareness leads to increased bodily awareness whereas an exercise with the body in the foreground of awareness has a different effect. Some support for this idea comes from Segal et al. (2002). They suggest that the benefit of the emphasis on the body in mindfulness-based interventions may not be on increasing bodily awareness as was hypothesised in this study but instead is a way of cultivating a different relationship to thoughts:

‘Paying attention to the body provides another ‘place’ from which to view things, a different vantage point for relating to thoughts. If we want perspective on our thoughts and feelings, if we can actually be in our bodies then we have a different place to stand and look at our thoughts and feelings rather than just be in our head’ (p.176)

In a similar logic perhaps being immersed in sounds might provide a different vantage point to observe body sensations whereas being in the body might make it harder (at least initially) to observe non judgmentally what is happening in body. This hypothesis would require further investigation. Ratings of bodily awareness did increase immediately after the mindfulness of sound exercise but it was not as big an increase as the mindfulness of body group reported. However the latter may have been influenced by demand effects having been aware that they should have become more aware of the body. In future research, administering a heartbeat perception task immediately after mindfulness practice would enable us to establish if participants’

self-reports of increased bodily awareness following mindfulness practice are validated by more objective measures.

An alternative explanation of these findings is that mindfulness practice in general does enhance ability to 'tune in' to what is happening in their body but that the heartbeat perception task interrupted this ability in the body group. One very speculative possibility is that participants in the body condition, having spent time observing body sensations, felt they should have improved on the heartbeat monitoring task and this may have triggered unhelpful attempts to 'try harder' which may be inconsistent with a mindful approach. Further research should aim to explore in more detail how people do these tasks, perhaps by interviewing participants about the extent to which they drew on things they had learnt in the mindfulness practice in attempting the tasks. Future research could use a sound monitoring task, as well as a body monitoring task to see whether the opposite pattern of results is observed.

It is also possible that the improvement shown by the sound group was simply a practice effect and that the mindfulness of body exercise actually made people worse at body-monitoring than no intervention would have done perhaps by triggering unhelpful attempts to try harder for reasons already outlined . Cameron (2000) reviewed the heartbeat perception literature and concludes that interoception may improve due to experience with the tasks but that the effect is small.

### **Self Report of Awareness of Bodily Sensations**

Self reported bodily awareness decreased for both conditions on the Porges Body perception Questionnaire (BPQ) but there were no changes for either condition on

the Somatosensory Amplification Scale (SSAS) or the Private Subscale of the Body Consciousness Questionnaire (BCQ). Due to the lack of control group it is not possible to rule out practice effects as the cause of changes on the BPQ and it is possible given the different pattern of results for the three scales that the significant result represents Type I error. Replication of this finding would therefore be important in order to interpret this result. However it is also possible that the inconsistent findings across the different self report measures of bodily awareness and between the self report and objective measures of heartbeat perception reflects the slightly different emphases of each measure. A lack of agreement between heartbeat monitoring accuracy and self reported bodily awareness have been found in many studies (e.g. Cameron, 2000, Pennebaker & Hoover; 1984). Barsky, Brener, Ceoytaux & Claery (1995) found that higher somatosensory amplification scores on the SSAS were related to improved heartbeat tracking however more recent research by Mailloux and Brener (2002) suggest that higher SSAS scores do not reflect heightened sensitivity to bodily sensations and instead may measure a cognitive bias of catastrophic interpretations of normal bodily symptoms. The BCQ contains only 6 items, and close to floor baseline scores in the current study may have made it difficult to detect any effect. The current study provides further support for the argument that concepts such as bodily awareness require multiple methods of measurement and point to the need for further research to assess what exactly the self report measures are tapping in to.

### **Physiological Responses**

The lack of any significant effects of either mindfulness practice on resting heart rate either immediately after the practice or after a week of practice is surprising. These

results may simply reflect the relatively brief nature of the practice and it is possible that longer term practice would have different effects. In contrast to the current study a number of studies have shown physiological changes from mindfulness meditation practice but suggest that these changes might be complex. Ditto, Ecclache & Goldman, (2006) found that the mindful body scan led to greater increases in cardiac respiratory arrhythmia (RSA) and a decrease in cardiac pre-ejection period compared to a relaxation condition. They argue that simultaneous increases in cardiac parasympathetic and sympathetic activity may explain the lack of an effect on heart rate in many studies of meditation and point to the complexity in measuring the physiological effects of mindfulness meditation.

### **Emotional Responding**

In contrast to our original predictions, the body group showed a diminished happiness response to positive pictures while the mindfulness of sounds group showed an increased self reported happiness response to positive pictures. Both groups reported more negative response to negative pictures following mindfulness practice than before. Preliminary analyses of the heart rate responses to the images showed that participants in both conditions showed a more negative heart rate response to negative images than to positive images, a finding that mirrors previous research (e.g. Pollatos et al. 2007, Lang et al, 1993) and suggests that the images were successful in inducing different emotional responses on both self report and physiological measures of emotion. . However contrary to predictions there were no changes on psychophysiology responses to either positive or negative pictures for either condition following mindfulness practice. Given that the body scan exercise did not have the intended effect on interoception, the results on the other

experimental tasks become difficult to interpret as increases in the intensity of emotional response to images was expected only as a result of changes in body-state feedback.

The failure of the key manipulation (the mindful body scan) to induce enhanced interoceptive awareness means that comparisons between the sound and body conditions become less meaningful to explore. Post-hoc correlations between change in heart beat monitoring accuracy and other variables were run to see if improvements in interoceptive ability were associated with up-regulated affect or reduced rumination irrespective of condition. However none of these correlations were significant suggesting that it is unlikely that change in body state feedback was the mechanism for these changes.

By what process/es the two mindfulness practices might have led to different effects on the experience of positive emotions is unclear and can not be answered by the present study, although it does suggest that component studies would be useful in future to determine the specific effects of the different mindfulness exercises. Both conditions led to reporting of more intense negative emotional reactions to negative images. Again a lack of control group requires interpretation of these findings to be made cautiously as they may represent practice effects. Nonetheless Roemer and Orsillo (2003) argue that mindfulness may not necessarily lead to a reduction in distress in the moment, because it precludes avoidance and therefore one argument that could account for this pattern is that mindfulness, with its emphasis on acceptance, may lead to an increased willingness to experience negative emotion (e.g. Linehan, 1993). However this study was not designed to measure these

processes and therefore future research would be needed to establish if there is any validity to these suggestions.

The relationship between heartbeat perception and emotional experience has not always been consistently found in the literature (see for example; Feldman-Barrett et al, 2004). One possibility to explain why improved heartbeat perception may not have the expected effects on emotional experience is that there may be individual differences in the importance of body feedback to emotional experience that mask effects. Feldman-Barrett et al. (2004) have recently argued that individuals may vary in the extent to which they incorporate feelings of activation or deactivation (which they term 'arousal focus') into their descriptions of emotional experience suggesting that interoceptive cues may be more important to the emotional experiences of some people than others.

No change was found on measures of mood or anxiety. This is perhaps not surprising given the non clinical sample and floor effects, particularly on the BDI. Both groups reported less positive and less negative affect on the PANAS for the week of the mindfulness practice as compared to the week before. Again any interpretation should be cautious in the absence of a control group to rule out the effects of completing the questionnaire twice. The decrease in positive affect may reflect the fact that the PANAS positive scale features positive emotions that are high in arousal (excited, enthusiastic strong), rather than low arousal states such as calm, contented, peaceful which are more associated with meditation. The decrease in negative affect reported in this study has also been shown by Chambers et al (2007) and Brown and Ryan (2003) who suggest that mindfulness may result in more moderate balanced



emotional demeanour characterised by low levels of negative affect and not necessarily increased positive affect. The finding that all participants reported more intense negative responses to negative images immediately after viewing but for the week as a whole reported less negative affect is consistent with theories that suggest mindfulness might lead to increased willingness to tolerate negative affect but also quicker recovery from negative emotional events.

The finding that both groups reported lower ruminative brooding is potentially interesting particularly given the non clinical nature of the group who scored very low on this scale at baseline. Obviously there is a need for a control comparison to check for practice effects and replication to ensure this isn't type 1 error. A reduction in rumination has been observed in other studies of mindfulness (e.g Chambers et al, 2007; Ramel et al, 2003, Jain et al.) and many theorists see this as the most important mechanism by which mindfulness approaches lead to health benefits. The present study proposed that changes in rumination might be mediated by increasing body-state information. However the lack of correlation between change in heartbeat detection and rumination in the current study suggests that this was not the case. A number of authors (e.g Teasdale, 1999; Segal et al, 2002, Scherer-Dickson, 2004) have suggested that mindfulness might reduce rumination by a process of meta-cognitive change, a key concept behind the development of MBCT for preventing depressive relapse. These theories suggest that low mood is more likely to lead to depression when thoughts are experienced as a true reflection of reality because people can become 'locked' in to ruminative processes which aim to change this 'reality' by decreasing the discrepancy between actual and desired state. In contrast to ruminative processing it is argued that mindfulness cultivates 'meta-cognitive

insight' when people experience negative thoughts as transient mental events, which you don't need to do anything about, which allows low mood to pass. Some preliminary research has shown that MBCT increases meta-cognitive insight (Teasdale et al., 2002) but further work is needed to see whether this predicts benefits from mindfulness programmes. The current research highlights the possibility that reductions in rumination may be elicited from very brief mindfulness manipulations thus providing a potentially useful method for future research.

In interpreting these results it should be acknowledged that the two conditions are potentially confounded by differences in the direction of attention (self vs. external). Self-focused attention has been defined as 'an awareness of self-referent internally generated information that stands in contrast to an awareness of externally generated information derived through sensory receptors' (Ingram, 1990, p. 156). It could be argued that the body condition is simply a self focus attention instruction and the sound scan an externally focused instruction. Various authors (e.g. Ingram, 1990, Spurr & Stopa, 2002) have proposed a role for excessive, rigid or sustained self focused attention (often termed 'self absorption') in psychopathology including depression, anxiety and psychosis. It is therefore possible in the current study that the differences emerging between the two groups was a result of the different focuses of attention, a model which might predict better outcomes with the sound condition. Wells (2002) explicitly argues that mindfulness approaches may be unhelpful because they run the risk of strengthening self consciousness which may contribute to stress vulnerability. He argues that a form of attention training focusing on external auditory stimuli in which patients explicitly resist capture of attention by internal, non target distracters during practice, may be more effective.

This may however not be a complete explanation given that on the BCQ, a measure of bodily self focused attention, neither group showed any significant change. In addition the mindfulness intervention used in the current study explicitly encourages people to self focus in an experiential way which Watkins and Teasdale (2004) argue, may have a quite different effect than the analytical self focus that the majority of the self focused attention research has focused on. The current study could be improved with the addition of a more complete measure of self-focused attention, including a measure of attention to mental activity, the most commonly used measure being the Self Consciousness Scale (SCS; Fenigstein, Scheier & Buss, 1975), in order to more fully test the two competing explanations.

### **Conclusions and clinical implications**

The current study does not offer much support for a key role of body-state feedback in mindfulness. However, the intervention used was much briefer than those used in mindfulness programmes which may have different effects. The measurement of interoceptive awareness in participants who have completed the full mindfulness-training would allow for a more ecologically sound exploration of this conclusion. Roemer and Orsillo (2003) suggested that component studies may be a way forward in understanding active mechanisms in mindfulness. The current study suggests that different mindfulness tasks can have different effects at least in the short term, and that these differential effects, if they can be understood, might provide us with important information about which processes need to be activated for mindfulness-based interventions to be effective.

In terms of clinical implications this study raises the possibility that even a very brief mindfulness intervention can potentially lead to beneficial changes, such as reduced rumination, which may question the need for a commitment to practice for 45 minutes a day that is emphasised in some mindfulness-based interventions. Another potential implication is that teachers of mindfulness bear in mind that the focus on the body in mindfulness may be a tool to induce meta-cognitive change. The comments and questions that mindfulness instructors ask about people's experiences of mindfulness of body exercises should therefore be sure to incorporate what people noticed about their thoughts while doing the exercise and not just what they noticed in their bodies. Quoting Teasdale (1999, p154) 'mindfulness provides repeated experiences in which the primary focus of awareness is on the body, against which the experience of thoughts can be registered as simply another event in awareness rather than the primary 'stuff' of the mind'.

The results also suggest that increased awareness of the body is not an essential process in mindfulness and therefore if someone reports difficulties with the body scan they may well still benefit from other practices. Benefits of mindfulness may be achieved through a variety of routes and the current study raises the possibility that both the body and sounds may be appropriate as 'an anchor' from which to begin to observe the activities of the mind.

### **Limitations**

Several limitations of this research have already been briefly mentioned and should be borne in mind in the interpretation of these results. Firstly the lack of a neutral control group means that practice effects cannot be ruled out as a cause of the

unexpected pre-post changes that were observed over both groups (for example on rumination). The decision not to include a neutral control group was made because it was essential to the research question that any differences between the groups could be attributed to the importance of a focus on the body and not other processes which a neutral control group would not allow us to distinguish. Practical testing considerations meant that testing three conditions was not feasible.

In addition the current study used a week long manipulation, using a shortened mindfulness meditation, with people whose motivation for practising may have been substantially different to people who take part in or benefit from mindfulness-based programmes. To date there is relatively little research that strongly supports mindfulness as the key component in mindfulness-based programmes (as opposed to other practices such as visualisation, loving kindness meditations or processes not specific to mindfulness such as group support) and the current study is an example of how specific components of mindfulness can be studied. However future research is needed to establish whether more complete training in mindfulness would produce similar or different effects. The current results do not rule out the possibility that in the longer term changes in awareness of the body through mindfulness are potentially important.

Thirdly the validity of the heartbeat perception task used in the present study has been questioned (see Van der Does, 2000 for a review) and it has been criticised for being more a measure of peoples beliefs about their heart rate than interoceptive awareness (e.g. Brener, Knapp & Ring, 1995; Windmann, Schonecke, Foehlig & Maldiner, 1999) One possibility is that people may estimate their heartbeats based on

time. However in the current study the time by group interaction effect remained when we controlled for differences in time estimation ability which suggests it is unlikely the sound group got better simply by being better at estimating heart beats by counting. The study could also benefit from a more detailed analysis of the reliability of the self report questionnaires used for the current participant group.

Finally, the current results represent the spontaneous effects of a brief mindfulness intervention rather than a deliberate attempt to approach the heartbeat monitoring task or emotional material in a mindful manner. Mindfulness-based approaches (e.g. Kabat Zinn 1990, Linehan 1993) explicitly advise practise at bringing mindfulness into every day life and perhaps one week of brief mindfulness practice was not enough for effects to generalise beyond immediate practice. A different pattern may also have emerged if we had asked participants to practise the mindfulness exercise at the start of session two. Future research examining the *immediate* effect of practice on emotional responding or the intentional application of mindful awareness during experimental tasks may enable us to understand the processes by which mindfulness works more fully.

The current study showed that a mindfulness of body practice did not have expected effects on heartbeat perception accuracy. Unexpectedly a mindfulness of sounds exercise did increase body monitoring accuracy. Both practices may have led to decreases in rumination and negative affect. While these effects could not be attributed to awareness of the body, this does illustrate the potentially beneficial effects of even a very brief mindfulness intervention and points to the need for future

research to explore the effects of individual components of mindfulness programmes.

In conclusion, although the current study does not provide any support for body-state feedback being a core mechanism of mindfulness-based approaches, neither does it provide strong evidence against body-state feedback as a mechanism of mindfulness, given the limitations described. In particular a lack of statistical power, the brief nature of the intervention, lack of neutral control group and the potential confound of self-directed attention mean that the current study was limited in its ability to robustly test the proposed mechanism. Further research is needed to address these limitations. In particular, future research should attempt to test competing mechanisms, for example by attempting to measure several mechanisms within a single study to compare how well each mechanism can account for beneficial effects. Other methodological approaches should also be considered, for example single case designs could be used to measure which psychological processes are activated by the different exercises in the mindfulness based programmes and to explore how these processes relate to symptom reduction.

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## **Part 3: Critical Appraisal**

## **Introduction**

In this critical review I aim to reflect on the process of conducting this research and to highlight for the reader some of the challenges and dilemmas that I faced during the development of the study, how these were resolved and what I might do differently were I to do this study again. For reasons of space this review cannot be totally comprehensive but I hope to cover the main issues that I grappled with and which the reader may have questions about. In part this review will extend the discussion of issues that were briefly highlighted in the discussion of the empirical paper.

## **Design Issues – The Challenge of the Control Group**

The major challenge in conducting this research was deciding on the design of the study. Balancing the practicalities in terms of time available for data collection and availability of participants with the need to maximise the chance of the study being able to answer the question we were most interested in was a central concern.

At the heart of this process was trying to keep in mind at all times the central question we were interested in ‘Does mindfulness work by changing body-state feedback?’ One of the problems with much of the research into mechanisms of mindfulness is that it isn’t able to isolate a particular mechanism and very few studies have directly tested the proposed mechanisms of action. Given the multi-component nature of mindfulness programmes, and that in most studies mindfulness has been compared to a no treatment or wait list control, it then becomes difficult to determine what the active ingredients of any given programme are or why they lead to changes.

Our starting point for this study was the hypothesis that mindfulness programmes, and in particular the parts of these programmes which emphasis awareness of the body, might work by changing body-state feedback. Having decided on a brief body scan as a way of manipulating body-state feedback deciding upon a control group was the next step. As with all research this necessitated making difficult decisions, and often solving one problem led to another. Over a period of many months myself and the people involved in this study discussed, discarded, and revisited ideas for control groups. A neutral control group was one option, a group that simply completed the experimental tasks and self report measures but did no intervention. This would allow us to be sure that any changes observed in the mindfulness group were not simply practice effects. However the considerable downside with this approach was that any differences between the two groups would leave us in the dark about whether the changes had anything to do with mindfulness or were simply demand or placebo effects that would have occurred with any intervention. Most importantly however this design would not be able to tell us whether it was the body in mindfulness that was important or whether changes occurred through different mechanisms. The numerous mindfulness treatment studies (e.g. Baer 2003, for a review) have provided some evidence that mindfulness does have an effect in comparison to no treatment or treatment as usual. Our questions was not 'Does the body scan have an effect' But rather 'Is the reason it has some effects because of something intrinsic it brings about in the body?'

We therefore needed something that was as similar to the mindfulness of body exercise as possible but which was unlikely to target body mechanisms. A mindfulness exercise focused on sounds allowed for controlling for the amount of

time participants practised, the way they practised (sitting comfortably in a chair with eyes closed), the length and structure of the instructions, the focus on simply observing whatever phenomena appeared in awareness and the changing nature of that phenomena each time a person came to the practice (it is likely that sounds in the environment and bodily sensations would change from practice to practice thus minimising differences in boredom levels between groups).

Choosing a sound meditation exercise provided a very stringent test of our hypothesis. Any change observed over and above what happened in the sound group, we reasoned, could be reasonably attributed to the importance of a focus on the body and was unlikely to be due to other mechanisms. However given the very preliminary nature of this study, we were not really sure what we needed to be controlling for, nor what the effects of a sound meditation would be. An ideal approach would be to have three groups, mindfulness of body group, a neutral control group to control for the effect of time and practice, and a non-bodily focused mindfulness group to clarify the mechanism of change. However we also felt that a mixed between-within design was needed because we needed be sensitive to individual differences which might wash out manipulation effects. For example there is known to be substantial individual differences in heartbeat perception accuracy with only a very small proportion of people being classified as 'good heartbeat perceivers' in most studies that have used this approach (e.g. Van der Does, Antony, Ehlers & Barsky, 2000). Testing three groups of people on two occasions each, with testing lasting a total of about 3 and a half hours per person was not feasible.

As our results show, the sound group showed completely unexpected changes which make the data hard to interpret. This suggests that mindfulness exercises may do more than we first imagined and influence processes that one might not immediately predict. The lack of neutral control group also means that time effects such as changes in rumination and mindfulness are difficult to interpret at present. The sound group showed some of the pattern of changes that we predicted a body-based mindfulness exercise would do; improved interoceptive ability, and more intense self-reported emotional responses to both positive and negative pictures, however a lack of correlation between these changes suggest that they were not related in the way that theories which propose the importance of interoceptive ability on emotional experience would predict.. How these processes were affected however is unknown but our findings do suggest that the body and sound practices may have different effects.

### **The Mindfulness Intervention**

The decision to use a week long mindfulness practice was made after careful consideration of other options. On one hand a one-off mindfulness exercise followed by immediate testing was the most practical option and allowed for most control over variation in participants practice. A similar one off mindfulness analogue has been used in other research, (e.g. Arch and Craske, 2006). However I felt that approach lacked the ecological validity that an ongoing practice similar to those in the mindfulness programmes would provide and I was keen that the clinical rationale behind the study was not lost. In addition it seemed unlikely that a one off practice would be sufficient to elicit change that would last throughout experimental tasks.

On the other end of the spectrum offering a full mindfulness intervention (usually lasting 8 weeks) was beyond the time and resource constraint available to us. The decision to use a week long mindfulness practice was therefore a compromise between these two positions. On reflection, asking people to practise the mindfulness exercise immediately before the experimental tasks at session two might have maximised the chances of the mindfulness practice influencing those tasks, and would be an avenue for future research.

Whether a week of 15 minute practices is a good enough approximation to full mindfulness practice, and whether changes are similar to what might be found following a full mindfulness programme, remains an open question. Most mindfulness programmes ask participants to practise for 45 minutes a day for 8 weeks, although the focus of that practice changes throughout. One study has found interesting results after much briefer practice. Ditto et al. (2006) found different physiological changes between a group completing a daily 20 minute body scan and a relaxation group after one months of practice. Even so, the authors caution against generalisation of their results to full length programmes. Mason and Hargreaves (2001), in a qualitative study of MBCT, found that several participants reported a period at the start of the programme in which they found the mindfulness practices ‘challenging and sometimes negative’ (p203). Cohen-Katz et al. (2004) collected weekly brief qualitative reports throughout their mindfulness programme for nurses at risk of burnout. They found, that in the first few weeks, benefits were noted as relaxation and ‘learning to be in the present moment’, but that in week five there was a large increase in comments relating to self awareness (including awareness of physical sensations) as well as self care and self acceptance. These findings strongly

suggest the possibility that the effects of mindfulness practices change over time.

Whilst brief mindfulness based manipulations enable a more controlled and precise study mechanisms there is then clearly a need to extend the study of these processes to longer-term or more intensive practice.

### ***How did people practice?***

Unlike mindfulness interventions that people have signed up to as a form of stress-reduction or clinical intervention, and have potentially a lot to gain from participating in fully, we were relying on interest and payment to motivate our participants. I was struck throughout this process on the difficulties of asking people to practise mindfulness when they had no personal reason to. From my own experience of mindfulness meditation I was aware that it is very easy to ‘go through the motions’ of the practice, to sit and listen to the instructions without practising mindfulness at all. The issue of intention is not a trivial one. Shapiro et al. (2006) argue that the question of intention; ‘why one is practising’ is crucial to understanding the process, and is often overlooked in contemporary definitions of mindfulness and models of mechanisms. Kabat Zinn (1990, p 46) speaks to this ‘I used to think that meditation practice was so powerful, that as long as you did it at all you would see growth and change. But time has taught me that some kind of personal vision is necessary’

Various attempts were made to design brief questionnaires to measure the quality of people’s practice but these did not appear reliable. An alternative option would be to ask people how much effort they spent on following the instructions. However this raises the question of what the most optimal level of effort might be. In mindfulness practice, ‘too much effort’ can lead to attempts to control experience, a state which is



inherently unmindful. One option would have been to adopt the approach taken by Arch and Craske (2006) who asked participants to rate how much people *attempted* to follow the instructions in their one off manipulation. They found that in general their participants were not trying very hard. However, their study used undergraduates who were taking part to gain course credits. In contrast the participants in the current study were mostly non-students, older and impressions from the testing were that the majority were taking part in research because they found it interesting and/or because they wanted to help rather than for financial gain. However future studies would benefit from measure such as the one used by Arch and Craske as it would, as a minimum, have allowed us to check there were not differences between the two groups in how much they attempted to do the task. In addition a number of studies of mindfulness have suggested a mediating role of people's expectations in the prediction of therapeutic gain (e.g. Mason & Hargreaves, 2001; Shapiro et al (1996) and that expectations may change over time and with practice. Future research using analogue manipulations as well clinical trials would benefit from some measurement of expectations over time.

### **Non clinical participants**

The use of healthy volunteers rather than a clinical population means that any clinical implications need to be made cautiously. The participants were however more diverse in terms of age and background than the student populations that are often used as non-clinical participants and I would argue significantly more motivated. The justification of the use of non clinical populations is that to understand how therapies work we need to understand the psychological mechanisms they influence and that as a first step this can be done in healthy populations where these processes are known or

assumed to occur. Extending to clinical populations at a later stage of the research programme allows an exploration of whether the processes are affected in the same way. There are of course arguments that the processes in clinical populations are qualitatively different and that findings from analogue studies cannot be extrapolated. However given the exploratory nature of this research, it seemed a more ethical approach to start with a non clinical population before placing an additional burden on people with mental health problems. As with any research it was likely that useful refinements to the methodology would become obvious throughout testing and data analysis and therefore starting with a non clinical population allows for adjustments to be made before proceeding to clinical populations. In addition the effects of a very brief mindfulness intervention were not known and although there was no reason to think that the manipulation would be harmful, verifying this with a non distressed population first was essential. In practical terms the potentially confounding effects of psychotropic medication, other treatment and co-morbidity in clinical populations make interpretation of results potentially easier in non clinical populations.

## **Measures**

It has been argued that the heartbeat perception task in this study (Schandry, 1981; Ehlers & Breuer, 1996) may be more a measure of participant's beliefs about heart rate than their interoceptive ability (Brener, Knapp & Ring, 1995; Windmann et al, 1999). Some people could just base their heart beat estimates by counting seconds and estimating the number of heartbeats based on that. However brief questioning at the end of the study suggested this was not the case for the vast majority of participants. In addition, when controlling for time estimation ability, the superior

increase in heart beat detection remained in the sound condition suggesting that the differences between the groups were not due to time estimation differences. Another alternative is that people may simply count at a regular pace and dependent on their beliefs about how often their heart beats, some people might count more accurately than others. Alternative tasks exist that also aim to tap heart beat perception ability. The Whitehead Task (Whitehead et al: 1997) requires participants to state whether a regular tone is in or out of sync with their heart beats. This task is less sensitive to beliefs about heart rate.

The lack of reference control group makes it difficult to know the absolute change in heartbeat perception that can be attributed to each experimental condition by each group. As previously reported a number of studies have now shown a relationship between interoceptive ability and intensity of emotional responding. However I am not aware of any other previous research that has tried to deliberately manipulate heartbeat perception accuracy and then measured the effect of this on emotional responding. Known methods to improve heartbeat perception do exist, usually via feedback training (e.g. Katkin, Morell, Goldband, Bernstein & Wise, 1982; Cameron, 2001) but further research is needed to see whether increasing interoceptive ability leads to increased intensity of emotional experience in expected ways. This study attempted to do this using mindfulness practice but the expected relationships were not found. Whether heartbeat perception accuracy would be improved by studying people with more experience with mindfulness practices is not clear and should be investigated further. Another possibility is that perhaps the magnitude of change in heartbeat perception, shown by some people (mainly in the sound group) in the current study, was simply not large enough to significantly influence emotional

experience. Perhaps there is a particular threshold of heartbeat perception accuracy which needs to be reached for emotional experience to be significantly affected.

Of course perception of heart beat is only one index of awareness of the body and there may be others that are more important or that people vary in their sensitivity to different bodily changes or combination of changes across numerous systems. A different profile may exist when non-cardiac perception is examined.

### **Strengths of the Study**

Whilst it is important to recognize the limitations of this work, the current study had considerable strengths which should also be acknowledged. One of the strengths of the current study was the multiple methods of measurement used to index different processes or outcomes, including self report, behavioural and physiological methods. For me, this has really highlighted the advantages of not relying on self report questionnaires as there may be a lack of agreement between objective and subjective measures. In the current study in common with a number of other studies (e.g. Dunn et al., 2006) actual interoceptive ability on the heart beat monitoring task was not correlated with self reported awareness of body on any of the three questionnaire measures used. This may reflect the fact that the objective measure was very specific (heartbeats) and the subjective measures asked for a number of ratings of awareness of different bodily sensations. In future research however the discrepancy between self report and objective measures should be borne in mind.

The fact that differences between the two groups emerged, when the exercises they completed were so similar in so many ways, is striking and is a real strength of this

design, even though effects of time cannot be ruled out. The decision to use a mixed methodology with repeated measures, although involving a lot of extra time was shown to be worthwhile in its increased power to detect differences that would not have been visible in a simple between subjects design. In the process of conducting this research I was struck by how many studies lack a suitable control group which can really stringently test a particular hypothesis.

### **How findings fit into broader debate on mindfulness**

Damasio (1994) sees changes in our body as central to our experience of emotion and that those sensations or somatic markers can influence our emotions, behaviour and decision making. The current study is the first study that I am aware of that shows that the different exercises used in mindfulness programmes may have different effects on body awareness. The current study suggests that different components of the programme may have different effects on body-state feedback. In particular this study, if replicated suggests that mindfulness exercises can influence how accurately a person can perceive changes in their body (at least their heart rate) but that an explicit focus on the body might not be necessary for this. However whether these changes would be helpful or not to a person is unclear given the lack of relationship between improved heartbeat perception and other variables.

The current findings support the need for further component studies investigating the effects of different exercises used in the mindfulness-based interventions. These studies could investigate the effects of different exercises on processes thought to be important in mindfulness to see if particular exercises might be especially recommended for a particular kind of difficulty. It is also potentially important for

people designing and delivering mindfulness interventions to know what the effects of particular exercises might be. Several authors have reported that different people seem to show preferences for particular mindfulness practices (e.g. Kabat-Zinn, Chapman and Salmon) or have reported varying degrees of success with different mindfulness skills ( e.g. Mason & Hargreaves) . The current study suggests that if people struggle with the body scan, this does not necessarily matter, and that other exercises such as mindfulness of sounds might be more accessible to them and still have beneficial effects.

The fact that changes in rumination and affect occurred with such a brief amount of practice, and with participants who may not have been personally motivated to practice, is striking and if replicated and practice effects are ruled out, may suggest that further research investigate whether the 45 minutes a day practice advocated in MBSR and MBCT is necessary for health benefits. Of course the findings of the current study with people with very low baseline levels of rumination cannot necessarily be extended to populations where clinical levels of rumination are present but this is worth exploring.

### **Personal Reflections**

The process of completing this research has led me to view mindfulness in a different way to where I began from. In particular I have reconnected with the idea that mindfulness of the body is not simply about increasing awareness of the body. My personal experiences of practising mindfulness (which were at best occasional and irregular during the majority of this study) suggested that focusing on the body have

a number of effects but throughout the research I became more focused on the mechanism of the body and lost touch somewhat with my own experiences.

The unexpected finding that the sound group showed enhanced heartbeat monitoring ability reawakened other ideas. One possibility is that, focusing the foreground of attention on the body, provides a way to observe how other phenomena such as thoughts rise and fall away. Perhaps in the same way that a mindfulness of sounds exercise potentially increased awareness of the body, mindfulness of body exercises may increase meta-awareness of phenomena other than the body. This may have implications for my own personal practice and how I might think about teaching mindfulness to others. The literature on mindfulness contains many arguments for the need for mindfulness teachers to have their own mindfulness practice. For example Kabat-Zinn (2003) argues that unless a mindfulness instructor has their own extensive personal practice they will not be able to bring the appropriate energy, authenticity or relevance to their teaching which will be felt by programme participants, nor will they be able to answer appropriately or specifically to questions. The current study has really highlighted for me how mindfulness exercises are not as straightforward as they might appear to be and that personal practice might be an important way of knowing how each exercise might be useful, what questions to ask and how to answer others' questions.

In addition completing this research has highlighted for me the challenges in studying mechanisms of action in an intervention as complex as mindfulness.

Throughout the research my views about decompartmentalising/component studies have swung back and forth. At times the mindfulness intervention/manipulation we

delivered felt a long way from the mindfulness groups I had both taken part in and read about, and it was easy to feel that what we were doing (giving people a brief introduction and sending them off with a CD) had little to do with mindfulness approaches. On the other hand, many of the participants in the study commented positively on their experiences of the mindfulness practice. Of course this was not universally the case, some people did report finding the practice repetitive or irritating at times. In general however comments seemed to suggest that taking some time out of busy lives to sit and 'just be' was something very new to most people and something that many valued, with several people asking to keep their copies of the mindfulness CD or asking how they might pursue these practices further. Feedback of this kind made me think that even a very short intervention can have beneficial effects. It also pointed to the potential usefulness of studying components of mindfulness to explore active processes, whilst also holding in mind that the whole may still be more than the sum of parts. Components will still have to be studied in combination with one another but this does not negate the usefulness of studying them separately too (Marks, 2002).



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## **APPENDICES**

Appendix 1: Ethics Approval/Information Sheet and Consent Form

Dr B Dunn  
MRC Cognition & Brain Sciences Unit



UNIVERSITY OF  
CAMBRIDGE

CAMBRIDGE  
PSYCHOLOGY RESEARCH  
ETHICS COMMITTEE

7 July 2005

Application No: [redacted]

Dear Dr Dunn

**Exploring the Impact of Body-State Feedback on Emotional Experience and Decision-Making  
in Mood Disorders**

The Cambridge Psychology Research Ethics Committee has given ethical approval to your research project: Exploring the Impact of Body-State Feedback on Emotional Experience and Decision-Making in Mood Disorders, as set out in your application dated June 2005.

The Committee attaches certain standard conditions to all ethical approvals. These are:

- (a) that if the staff conducting the research should change, any new staff should read the application submitted to the Committee for ethical approval and this letter (and any subsequent letter concerning this application for ethical approval);
- (b) that if the procedures used in the research project should change or the project itself should be changed, you should consider whether it is necessary to submit a further application for any modified or additional procedures to be approved;
- (c) that if the employment or departmental affiliation of the staff should change, you should notify us of that fact.

Members of the Committee also ask that you inform them should you encounter any unexpected ethical issues.

If you would let us know that you are able to accept these conditions, I will record that you have been given ethical approval.

Yours sincerely

Cc: [redacted]

## Appendix 1: Ethics Approval

Ethics approval was granted by Chairmans approval of an existing ethics application. Below are a copy of emails that were part of this amendment.

>-----Original Message-----

>From:

>Sent: 16 February 2006 16:02

>To:

>Subject: amendment to ethics proposal

>

>

>Dear Margaret,

>

>further to our conversation a couple of minutes ago, here is a summary of the planned amendments to my existing ethics approval.

Existing ethics:

Application No 2005.32 - Exploring the impact of body-state feedback on emotional experience and decision-making in mood disorders.

Proposed changes:

The existing ethics application outlined a series of studies looking at the extent to which awareness of the body (e.g. how accurately people can count their heartbeats) related to emotional processing and decision making, so was in essence a correlational design.

The amendment we would like to make is to also run a series of manipulation studies, where we alter awareness of and activity in the body. We would do this by asking healthy control volunteers to practice half an hour a day for a week a technique called the 'body scan'. This is used routinely in relaxation and meditation practices, both in clinical and non-clinical settings, without adverse side effects. It is also a key technique in mindfulness based cognitive therapy, a new treatment with proven efficacy in preventing relapse of depression. basically it gets people to pay attention to the breath and tension in the body, both to promote relaxation and to block ruminative thoughts. What we are interested in measuring is whether practice of this technique will alter performance on the emotional processing and decision making we previously proposed. More specifically, we plan to contrast three groups: 25 people in a control condition, 25 people practicing the body scan for a week prior to experiment, and 25 people practicing a relaxation technique for a week prior to experiment.

As well as this change, I would like to add an additional member of staff to the ethics application: Ruth Morgan (clinical psychology trainee from University College London) BA (Hons). Ruth will be carrying out the body scan study as her research dissertation, assuming ethics approval is obtained.

I'd be grateful if you could let me know whether these changes can be made by chairmans action or whether you would prefer us to submit a new ethics application.

Thanks very much  
Best regards

Dr. Barney Dunn

At 09:21 20/02/2006, you wrote:

>Dear Barney

>

>Thanks for your email - . thinks we should go

>straight to the Chairman and ask whether he is prepared

>to give Chairman's approval or if he wants you to resubmit.

>

>I've a feeling he has been away over the last week not

>sure when he is back but he usually responds very quickly.

>

>Will get back to you when I have some news.

>

>Best wishes

>

>

From:

To:

Dear Barney

I have had a response from the Chairman of the Ethics Committee - he is happy to give Chairmans approval on condition that the Consent Form and Information Sheet are updated to reflect the procedures accurately.

If you could send me the updated forms (email will do) we can then give formal approval.

Best wishes

## Appendix 1: Ethics Approval/Information Sheet and Consent Form

Dr B Dunn

MRC Cognition & Brain Sciences Unit



UNIVERSITY OF  
CAMBRIDGE

CAMBRIDGE  
PSYCHOLOGY RESEARCH  
ETHICS COMMITTEE

23 March 2006

Application No: 2005.32

Dear Dr Dunn

**Amendment to Ethics Application PRE.2005.32: Exploring the Impact of Body-State Feedback on Emotional Experience and Decision-Making in Mood Disorders**

Thank you for your email dated 21 March 2006 in which you attached the revised Information Sheet and Consent Form as requested by the Chairman of the Psychology Research Ethics Committee.

I can confirm that the Chairman has given approval to these amendments.

Yours sincerely



## Appendix 1b

### Information Sheet for Volunteers Considering Participating In a Study Entitled:

#### **“Contrasting the effects of directing attention to sound and body on emotional processing”**

Please read the information below to decide if you would like to take part in the project:

##### **What is the purpose of the study?**

When suffering from mood disorders such as anxiety and depression people often report finding themselves caught up in their thoughts and feelings. A range of techniques have been developed to help people redirect attention to other sources of information, including how the body feels and what is happening in the external world. The aim of the study is to compare the effects of two different forms of training that redirect attention on how people think and feel. This issue is important because it may help us better understand how certain treatments might be helping people overcome mood disorders, and possibly lead to the development of new or improvement of existing treatments for these conditions.

##### **Why have I been asked to take part?**

You are being asked to take part so we can measure the effects of different forms of attention training on how healthy participants think and feel.

##### **What will I have to do?**

If you decide to take part we will ask you to attend the Cognition and Brain Sciences Unit, 15 Chaucer Road, Cambridge, for two sessions lasting approximately 90 minutes each spaced one week apart. The first session will measure how you have been feeling in the week before the experiment, using a combination of computerised emotional tasks and questionnaire measures. We will then train you in one of two fifteen minute exercises – either asking you to pay attention to sensations in your body or pay attention to sounds in the external environment. You will then be given a tape or CD of the exercise you completed to take home and to be asked to listen to, and follow the instructions once every day over the next week.

In the second session we will measure how you have been thinking and feeling in the week you practiced the technique. Unfortunately we cannot tell you which exercise you would be allocated to before you decide whether you wish to take part. If you decide to take part we will randomly allocate you to one of the two exercises. It is important therefore that if you agree to take part you will be happy to be allocated to do either of the two exercises.

In both sessions the emotional tasks will involve you looking at slides similar to that you would see in news broadcasts or newspapers, which you may find upsetting. While you complete all the experimental tasks we will measure activity in your body in terms of how much your heart rate changes and how much you sweat through the finger tips. In each session you will also be asked to fill in questionnaires asking you about symptoms of anxiety and depression you have recently experienced.

You will be given an honorarium of £6 per hour for your time (including attendance of both sessions and the time it takes you to practice the exercises). We will also contribute towards your travel expenses to and from the unit.

##### **Are there any risks in taking part?**

The sound and body tasks have been used with people to help reduce general stress as well as psychological problems and many people report them to be pleasant. All of the tasks we will ask you to complete and equipment we use have been used safely in previous research. You may, however, find some of the emotional tasks upsetting to complete. If you become very upset during any part of the testing we will stop the experiment and you will have the opportunity to talk to a clinical psychologist about your reaction if you wish to.

**Other information**

This study has received ethical approval from the Ethics Committee of the University of Cambridge. The data we collect will be used in the strictest confidence, and no identifying information will be stored with the data, to safeguard your confidentiality. The data will be stored in a locked filing cabinet, which only the investigators will have access to. Results from the study will be presented at conferences and written up in journals. Results will be presented in terms of groups of participants, so individual data will not be identifiable. You are free to decide not to take part in the study and can withdraw from the study at any time and for whatever reason. If you do decide not to take part or to withdraw you do not need to explain your reasons to us if you do not want to.

If you would like any further information about the project please contact Dr. Barney Dunn (tel: \_\_\_\_\_; e-mail: \_\_\_\_\_; address: \_\_\_\_\_). Thank you for reading this information sheet.

Appendix 1c: CONSENT BY VOLUNTEERS TO PARTICIPATE IN A STUDY  
ENTITLED:

**“Contrasting the effects of directing attention to sound and body on  
emotional processing”**

I.....

Of.....

.....

.....

hereby fully and freely consent to participate in the above study.

I understand and acknowledge that the trial is designed to add to medical knowledge. I note that I may withdraw my consent at any stage in the investigation and I acknowledge that the purpose of the trial, the risks involved from any procedures, and the nature and purpose of such procedures have been explained to me by:

.....

and that I had an opportunity to discuss these matters with him/her.

I have received a written explanation of these matters, a copy of which is attached to this form. I understand that I may change my mind and withdraw from the study at any time without any effect upon my rights.

Signed.....

Date.....

I confirm that I have explained to the volunteers the nature and effect of these procedures  
(Member of project team acting on behalf of the person responsible for the project).

Signed.....

Date.....

Place.....

## **Appendix 2: Transcripts for mindfulness exercises**

### **BODY SCAN TRANSCRIPT**

#### **START**

- A. Find a comfortable place to sit on a chair or in a place where you will be warm and undisturbed. It is very helpful if you can sit away from the back of the chair so that your spine is self supporting. Allow your back to adopt an erect dignified and comfortable posture, not stiff . Place your feet on the floor with your legs uncrossed, and gently close your eyes
- B. When you are ready, bring your awareness to the physical sensations in your body, especially the sensations of touch or pressure where your body makes contact with the floor or chair. There is no need to go searching for particular sensations. Instead as best you can simply open your mind so that it is receptive to awareness of sensations as they arise.
- C. The intention of this practice is not to feel any different or to feel relaxed or calm, this may happen or it may not. Instead the aim of the practice is, as best you can, to bring awareness to any sensations you detect, as you focus your attention to each part of the body in turn.
- D. Now bring your awareness to any physical sensations in the tummy area, be aware of the changing pattern of sensations as you breathe in and as you breathe out. Take a few moments to feel the sensations as you breathe in and as you breathe out.
- E. Now bring the focus of your awareness down into the left foot and specifically to the toes of the left foot. Notice, if you can, what each of your toes might be feeling in turn, perhaps noticing the sense of contact between the toes, a sense of tingling or warmth or no particular sensation. (pause) When you are ready, move your attention to any sensations in your left foot- bringing a gentle and curious awareness to the sensations on the bottom of your left foot, the top of the foot, the heel for example noticing the sensations where the foot makes contact with the floor

- F. At various points You may notice that your mind has wandered away, this is entirely normal. It is what minds do, it is not a mistake or failure. When you notice it, gently acknowledge it, noticing where the mind has gone off to, and then gently return your attention to the part of the body you intended to focus on.
- G. When you are ready let go of the left foot completely, allowing the focus of the awareness to move into the lower left leg. And bringing your attention to any sensations in the lower left leg, the calf the shin and knee, exploring any sensations in this region and then let go of your awareness of the lower leg and bring your attention to the sensations in your left thigh, bringing a gentle investigative awareness to the sensations in your thigh and being with your thigh and when you are ready letting go of the thigh completely
- H. and now lets move to the right foot and become aware of the feelings in the right toes and foot, without moving them if you can, just feeling the sensations in the right toes and foot
- I. as best you can noticing how the mind may evaluating or judging the sensations that arise seeing them as pain or irritation if they are unpleasant or undesirable, how it may be wanting different sensations better sensations, and noting this judging element whenever it appears but then as best you can opening to simply feeling whatever sensations are here to be felt moment by moment by moment
- J. and if the mind wanders, gently bringing it back
- K. letting your awareness shift to the whole of your right leg, your knee, lower leg and thigh and bringing a gentle curiosity to investigate the quality of the sensations you find in your right leg, perhaps noticing the sense of contact with the chair or floor and just experiencing this region of your body and being as precise as you can about feeling any sensations whatever they might be and then out let go of this region too
- L. and becoming aware of your pelvis, and whatever sensations you are feeling in this region between the hips letting your awareness shift to your back, from the lower

back which connects with the pelvis up through to the top of the back and being with whatever sensations are there and simply experiencing whatever you find (pause)

- M. and now allowing your attention to shift to the belly again and experiencing the rise and fall of your belly as you breathe and allowing your awareness to expand from your belly to your chest and just for a moment experiencing your chest as it expands on the in-breath and contracts somewhat on the out-breath and if you can tuning to the rhythmic beating of your heart within your chest, feeling it if you can as well as the lungs expanding on either side of your heart. Notice if you can your heartbeat, if you can just observe your hearts rythm or sense your pulse anywhere in your body just experiencing your chest, you belly as you sit here the entirety of the front of your body and when you are ready when you are ready just letting this region dissolve too
- N. and now gently bringing the focus of your awareness to your hands and fingers and we'' do both hands together and just allowing you fingers and hands to fill the field of your awareness and experiencing whatever sensations you find in this region and on an d then letting go of your hands and becoming aware as well of the lower arms and elbows upper arms and shoulders and bringing a gentle curiosity to investigate the quality of the sensations you find, whether it be a sense of tingling of pulsing, or warmth or moisture or no particular sensation, it doesn't matter, just experiencing your arms and letting go of your arms
- O. and now gently bringing your attention to your head and face and becoming aware of any sensations you find in your face around your eyes and mouth, jaw and nose and and whatever those sensations are, and letting any sensations you find fill the field of your awareness.
- P. And then letting go of your face and spend a few moments being aware of a sense of your body as a whole and of the breath flowing freely in and out of your body.
- Q. And as the tape ends bringing your awareness back to your body again and feeling it as a whole and now you might want to wriggle your fingers and toes before slowly opening your eyes.

## **MINDFULNESS OF SOUNDS TRANSCRIPT**

### **START**

- A. Find a comfortable place to sit on a chair or in a place where you will be warm and undisturbed. It is very helpful if you can sit away from the back of the chair so that your spine is self supporting. Allow your back to adopt an erect dignified and comfortable posture, not stiff Place your feet on the floor with your legs uncrossed, and gently close your eyes
- B. When you are ready, bring your awareness to any sounds you can hear in your environment. There is no need to go searching for sounds or listening for particular sounds. Instead as best you can simply open your mind so that it is receptive to awareness of sounds from all directions as they arise. sounds that are close ,sounds that are far away, sounds that are in-front, behind, to the side, above or below, open to the whole space of sound around you
- C. The intention of this practice is not to feel any different or to feel relaxed or calm, this may happen or it may not. Instead the aim of the practice is, as best you can, to bring awareness to any sounds you detect as you focus all of your awareness to hearing whatever sounds there are as you sit here.
- D. Now bring your awareness to any sounds you can hear, be aware of the changing pattern of sounds as you listen. Take a few minutes to hear any sounds as you sit hearing whatever sounds there are to be heard.
- E. Now bring your awareness to any sounds you can hear in the building where you are, perhaps the sounds of electrical equipment, of creaking or of other people or perhaps no particular sounds, not listening for particular sounds just hearing what there is to be heard. Notice if you can what each sound that you can hear is like, in turn. Perhaps noticing its loudness or softness, its regularity or irregularity, the space

between sounds. Not listening for anything in particular just hearing , letting sounds arrive at your ears and bringing a gentle curiosity to the sounds you hear

- F. At various points You may notice that your mind has wandered away, this is entirely normal. It is what minds do, it is not a mistake or failure. When you notice it, gently acknowledge it, noticing where the mind has gone off to, and then gently return your attention to hearing and the sounds y you intended to focus on.
- G. When you are ready letting go of sounds inside the building and moving your attention to any sounds you can hear from outside bringing a gentle and curious awareness of any sounds you can hear. You may for example notice sounds of traffic, of the weather, of birds or of people. Juts exploring the sounds from outside bringing a gentle investigative awareness to the sounds outside and just allowing the focus of your awareness be on any sounds you hear from outside
- H. Just being aware of any sounds, without trying to hear anything in particular just being aware of what sounds are there and the changing pattern of sounds moment by moment
- I. as best you can noticing how the mind may evaluating or judging the sounds that arise turning them into noise if they are unpleasant or undesirable, how your mind may be wanting different sounds better sounds and noting this judging element whenever it appears but then as best you can opening to simply hearing what is here to be heard moment by moment by moment
- J. and if the mind wanders, gently retuning the awareness back to sounds and to the spaces between sounds, the silences
- K. and giving yourself over to hearing what's already here to be heard in this moment and moment by moment just sitting here hearing , not listening for anything, just letting sounds and the spaces between sounds arrive at your ears. And bringing a



gentle curiosity to the quality of sounds that you hear and being as precise as you can about hearing sounds from outside, whatever they might be

- L. just hearing what's already here to be heard in this moment and moment by moment just sitting here hearing , just letting sounds and the spaces between sounds whatever they are fill your awareness.
- M. and now allowing your attention to be on any sounds you experience, sounds from in the room, or the rest of the building you are in, or from outside. Allowing your awareness to include sounds from anywhere and just experiencing all sounds loud or quiet, familiar or unfamiliar, soft or sharp, whatever you can hear it doesn't matter, just experiencing whatever sounds meet your ears , just hearing all there is to be heard, open to the whole space of sound around you be aware of obvious sounds and of more subtle asounds, aware of the space between the sounds, aware of silence
- N. and now gently bringing the focus of your awareness to outside of the room again and just allowing the sounds from outside fill the field of your awareness and hearing whatever sounds you hear outside. Brining gentle curiosity to investigate the quality of the sounds you find, and the gaps between the sounds, whether they be manmade sounds, natural sounds or unidentifiable sounds or no particular sound it doesn't matter, just experiencing sounds from outside
- O. and gently bringing your attention to all sound again whether inside or outside the room and just becoming aware of any sounds you find when you become aware of sounds, whatever those sounds are and letting any sounds you find fill the field of your awareness
- P. And just spending a few moments being aware of all sounds you can hear or the spaces between sounds, silences and just being here, hearing
- Q. And as the CD ends just bringing your awareness back to sounds again and hearing all there is to be heard. and now you might want to wriggle your fingers and toes before slowly opening your eyes.

## **Appendix 3: HANDOUTS FOR MINDFULNESS EXERCISES**

### **FREQUENTLY ASKED QUESTIONS ABOUT THE BODY SCAN**

This CD is the same guided body scan exercise that you did at the first testing session. It lasts 15 minutes. Please do the body scan once a day over the next week.

Try and let go of any expectations you have about this exercise, all you have to do is, as best you can, follow the instructions every day. There is no right or wrong way to do it.

#### **How should I sit?**

If possible try and do the exercise sitting upright in a chair with an erect but relaxed posture and your feet on the floor. Where possible wear loose clothing or loosen any clothing that is tight.

#### **Where shall I do it?**

It is best to do it in place where you will be warm and in which you feel comfortable and at a time when you will not be interrupted by anyone or by the telephone. This is often easier said than done. Some things other peoples have found helpful are;

- switching off mobiles
- telling people at home what you are doing and why its important you are not disturbed.

#### **When shall I do it?**

Most people find it is easiest to do the exercise at a particular set time every day. This helps people remember. We have also found that without a regular time we always tend to think 'oh I'll do it later' and never quite find the time.

#### **Should I feel relaxed at the end of it?**

It is important to remember not to try too hard to relax as this will just create tension. Some people do find this exercise relaxing but not everyone does so don't worry if you don't feel relaxed. You may find it has different effects on different days.

#### **I don't think I am doing it right**

There isn't a right or wrong way to do this exercise. If you notice that your mind has wandered off what you were supposed to be aware of, just gently bring it back to where you were in the body. You may have to do this lots and lots of times, that's completely normal. There are no right or wrong sensations to be feeling.

#### **I can't feel anything**

People frequently find that there are particular areas of their body where they can't feel anything. There is no need to worry when this happens. Just be aware of feeling nothing, don't strain trying to feel something, just be aware of no sensations. Be aware of not feeling.

#### **I feel uncomfortable (or pain)**

Please don't sit and strain yourself or be in discomfort. If you want to shift positions whilst doing this exercise that is fine. As far as possible do this gently and slowly and try to continue being aware of sensations in your body as you do it.

#### **Can I open my eyes?**

Most people find they get distracted much more easily when they have their eyes open. However if you don't feel comfortable doing it with your eyes open or if you have found yourself dropping off to sleep it is fine to open your eyes. If you do this it is best to have your eyes gently focussed on a spot on the wall or floor and perhaps have them slightly closed but so that you can still see.

## **FREQUENTLY ASKED QUESTIONS ABOUT THE SOUND EXERCISE**

This CD is the same guided sound exercise that you did at the first testing session. It lasts 15 minutes. Please do the exercise once a day over the next week.

Try and let go of any expectations you have about this exercise, all you have to do is, as best you can, follow the instructions every day. There is no right or wrong way to do it.

### **How should I sit?**

If possible try and do the exercise sitting upright in a chair with an erect but relaxed posture and your feet on the floor. Where possible wear loose clothing or loosen any clothing that is tight.

### **Where shall I do it?**

It is best to do it in place where you will be warm and in which you feel comfortable and at a time when you will not be interrupted by anyone or by the telephone. This is often easier said than done. Some things other peoples have found helpful are;

-switching off mobiles

- telling people at home what you are doing and why it is important you are not disturbed.

### **When shall I do it?**

Most people find it is easiest to do the exercise at a particular time every day. This helps people remember to do it. We have also found that without a regular time we always tend to think 'oh I'll do it later' and never quite find the time.

### **Should I feel relaxed at the end of it?**

Some people do find this exercise relaxing but not everyone does so don't worry if you don't feel relaxed. You may find it has different effects on different days. It is important to remember not to try too hard to relax as this will just create tension.

### **I don't think I am doing it right**

There isn't a right or wrong way to do this exercise. If you notice that your mind has wandered off what you were supposed to be aware of, just gently bring it back to the sounds you were listening to. You may have to do this lots and lots of times, that's completely normal. There are no right or wrong sounds to be hearing.

### **I can't hear anything**

The amount of noise that is around varies from house to house, from one hour to the next. If you find you can't hear anything from outside it might be worth opening a window or door if that's possible. Don't worry too much about the inside and outside instructions. If you can only hear noises from one area but not from another just listen to those. (But if you can hear noises from inside and outside then follow the instructions as best you can) Don't strain to hear sounds. There are often lots of gaps or silences between sounds, when you can't hear anything, try to just be aware of the silences, just be aware of not hearing.

### **I feel uncomfortable**

Please don't sit and strain yourself or be in discomfort. If you want to shift positions whilst doing this exercise that is fine. As far as possible do this gently and slowly and try to continue being aware of sounds as you do it.

### **Can I open my eyes?**

Most people find they get distracted much more easily when they have their eyes open. However if you don't feel comfortable doing it with your eyes closed or if you have found yourself dropping off to sleep it is fine to open your eyes. If you do this it is best to have your eyes gently focussed on a spot on the wall or floor and perhaps have them slightly closed but so that you can still see.

#### **Appendix 4: Instructions for Heartbeat Perception Task**

In this test we want to study how well people can feel their heartbeats. We will ask you to concentrate carefully on your heart and try to count the beats that you feel in your body. It is very important that you do not try to take your pulse with your fingers or hold your breath. Please remove any watch or time piece you are wearing and make sure it is out of your sight. While completing the task try and keep your arms still, as moving them will interfere with how accurately we can record your heart beat.

There will be three short test periods. Each of them starts with a low pitch warning tone. Shortly after that warning tone you will hear a higher pitch tone. As soon as you hear this second tone start counting your heart beats silently until you hear the same tone again. Then stop counting your heartbeats. We will ask you the number of heart beats you counted and how certain you were that you counted correctly. If you have difficulty feeling your heartbeats still try to decide whether a heartbeat has occurred and count the heartbeats you felt. You should not count aloud just tell us after the test period how many beats you counted.

To enter your heart rate and confidence estimates, click on the arrow buttons on the sliding scale displayed on the screen. Each time you click the right hand arrow the estimate will increase by one. Each time you click on the left hand arrow the estimate will decrease by one. We will begin with a practice trial. Please ask the experimenter if these instructions are not clear, otherwise click on the button below to begin.

*After practice trial and 3 heartbeat trials, the following instructions appear:*

Now the task will change slightly. For the next few trials we want you to estimate how many seconds pass between the beeps. As before, you will hear a warning beep and then a few seconds later the start beep. Try and estimate how many seconds pass between the start beep and the end beep.

*After 3 time estimation trials, the following instructions appear.*

Now the task will be to count your heartbeats again. You will hear a warning beep and then a few seconds later the start beep. Count the number of heartbeats you have between the start beep and the end beep.

## **Appendix 5:**

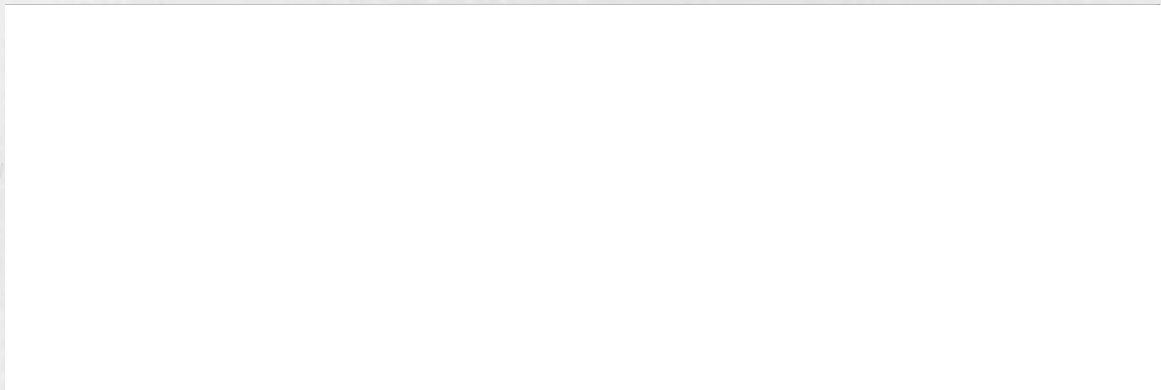
### **Instructions of Affective Images Task**

In this task we are interested in how people respond to pictures that represent different events that occur in life. You will be asked to look at photographs on the computer screen and rate how they make you feel. There are no right and wrong answers and we would like you to be as honest as possible. We are interested in how you actually feel, rather than how you think you should feel. Some of the pictures may be upsetting, similar to images you may see in television news broadcasts. We will ask you to rate how you feel in various ways.

First, we will ask you to rate how much anger, sadness, fear or disgust you experienced to each image (from 0 not at all to 100 extremely). Second, we will ask you to rate how pleasant each picture was (from 1 very unpleasant to 5 neutral to 9 very pleasant). Third we will ask you to rate how arousing each picture was (from 1 not at all arousing to 9 extremely arousing). By arousal, we mean feeling physically switched on, wide awake and alert, as opposed to sluggish dull and sleepy. Please remember to rate all emotions on each of the sliders - if you do not rate all emotions the task will not continue. After you have rated the picture, there will be a break of a number of seconds before the next picture is shown. We will begin with two practice trials. Please click the button when you are ready to start.

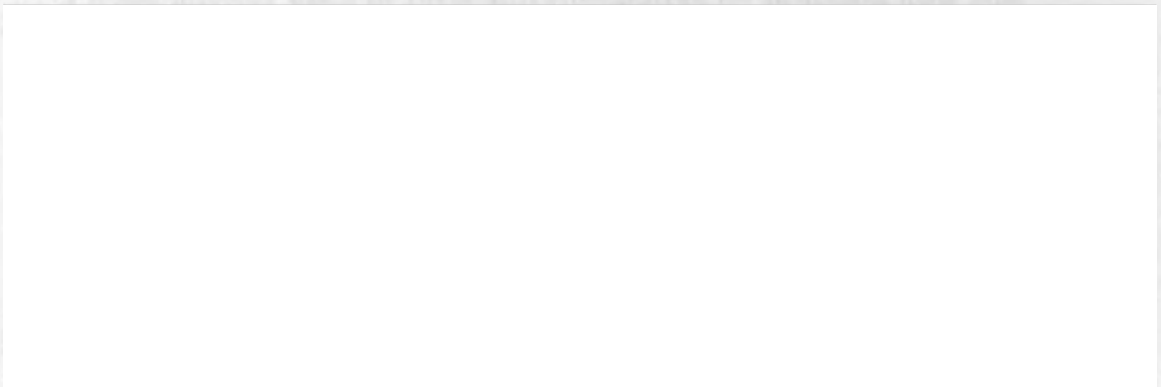
## Appendix 6

### International Affective Picture Scale – Example pictures for each emotion.



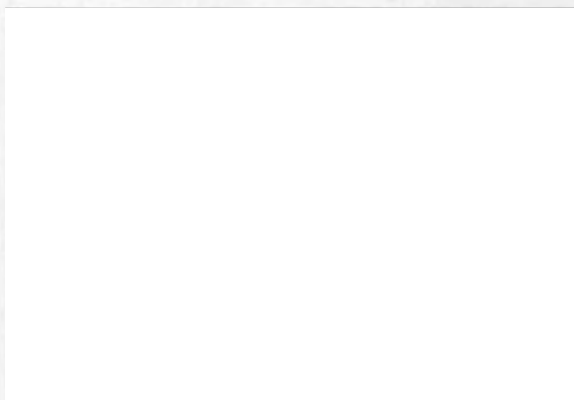
Neutral

Happiness



Sadness

Fear



Disgust

## **Appendix 7**

**Participant Code** \_\_\_\_\_

**Date** \_\_\_\_\_

**Session Number** \_\_\_\_\_

### **WEEKLY MEASURES**

**Please answer each of these questionnaires by thinking how you have been feeling OVER THE PAST WEEK**

PANAS

This scale consists of a number or words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent *you have felt this way during the past week.*

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	extremely
.....		Interested		
.....		Distressed		
.....		Excited		
.....		Upset		
.....		Strong		
.....		Guilty		
.....		Scared		
.....		Hostile		
.....		Enthusiastic		
.....		Proud		
.....		Irritable		
.....		Alert		
.....		Ashamed		
.....		Inspired		
.....		Nervous		
.....		Determined		
.....		Attentive		
.....		Jittery		
.....		Active		
.....		Afraid		



**PORGES BPQ (WEEK VERSION)**

Imagine how aware you have been of your body processes **IN THE PAST WEEK**.  
Select the answer that most accurately describes you. Rate your awareness on each  
of the characteristics described below using the following 5-point scale:

1) Never 2) Occasionally 3) Sometimes 4) Usually 5) Always

**During most situations IN THE LAST WEEK I have been aware of:**

Body processes	Rate 1-5
1. swallowing frequently	
2. a ringing in my ears	
3. an urge to cough to clear my throat	
4. my body swaying when I am standing	
5. my mouth being dry	
6. how fast I am breathing	
7. watering or tearing of my eyes	
8. my skin itching	
9. noises associated with my digestion	
10. eye fatigue or pain	
11. muscle tension in my back and neck	
12. a swelling of my body or parts of my body	
13. an urge to urinate	
14. tremor in my hands	
15. an urge to defecate	
16. muscle tension in my arms and legs	
17. a bloated feeling because of water retention	
18. muscle tension in my face	
19. goose bumps	
20. facial twitches	
21. being exhausted	
22. stomach and gut pains	
23. rolling or fluttering my eyes	
24. stomach distension or bloatedness	
25. palms sweating	

1) Never 2) Occasionally 3) Sometimes 4) Usually 5) Always

**During most situations IN THE LAST WEEK I have been aware of:**

	Rate 1-5
26. sweat on my forehead	
27. clumsiness or bumping into people	
28. tremor in my lips	
29. sweat in my armpits	
30. sensations of prickling, tingling, or numbness in my body	
31. the temperature of my face (especially my ears)	
32. grinding my teeth	
33. general jitteriness	
34. muscle pain	
35. joint pain	
36. fullness of my bladder	
37. my eye movements	
38. back pain	
39. my nose itching	
40. the hair on the back of my neck "standing up"	
41. needing to rest	
42. difficulty in focusing	
43. an urge to swallow	
44. how hard my heart is beating	

### SSAS (WEEK VERSION)

Please indicate the degree to which each of the following statements have been **true of you in the past week**. Please circle your answer.

- 1 = Not at all true  
2 = A Little Bit True  
3 = Moderately True  
4 = Quite A Bit True  
5 = Extremely True

	Not at All True	A Little Bit True	Moderately True	Quite A Bit True	Extremely True
1. I have not been able to stand smoke, smog, or pollutants in the air.	1	2	3	4	5
2. I have often been aware of various things happening within my body.	1	2	3	4	5
3. When I bruised myself, it has stayed noticeable for a long time.	1	2	3	4	5
4. I have sometimes been able to feel the blood flowing in my body.	1	2	3	4	5
5. Sudden loud noises have really bothered me.	1	2	3	4	5
6. I have sometimes been able to hear my pulse or my heartbeat throbbing in my ear.	1	2	3	4	5
7. I hated being too hot or too cold.	1	2	3	4	5
8. I have been quick to sense the hunger contractions in my stomach.	1	2	3	4	5
9. Even something minor, like an insect bite or a splinter, has really bothered me.	1	2	3	4	5
10. I haven't been able to stand pain.	1	2	3	4	5

## BCQ

Please try to decide on the extent to which each of the following statements is characteristic of yourself **in the past week** by placing a number in the blank space preceding each statement. The number should be anywhere between 1 (extremely uncharacteristic of you in the past week) and 4 (extremely characteristic of you in the past week)

- 1) \_\_\_\_\_ I have been sensitive to my internal body tensions
- 2) \_\_\_\_\_ My mouth and/or throat have been feeling dry
- 3) \_\_\_\_\_ I could feel my heart beating
- 4) \_\_\_\_\_ I have felt the hunger contractions in my stomach
- 5) \_\_\_\_\_ I have been very aware of changes in my body temperature
- 6) \_\_\_\_\_ I have been concerned about my posture

### **Responses to Depression**

People think and do many different things when they feel depressed. Please read each of these items below and indicate whether **OVER THE PAST WEEK** you never, sometimes, often or always thought or did each one when you feel sad, down or depressed. Please indicate what you have done in the PAST WEEK currently, not what you think you should do.

<b>Almost never</b>	<b>Sometimes</b>	<b>Often</b>	<b>Almost always</b>	
				Thought "What am I doing to deserve this?"
				Analysed recent events to try to understand why you are depressed
				Thought " Why do I always react in this way?"
				Went away by yourself and think about why you feel this way
				Wrote down what you are thinking about and analyse it
				Thought about a recent situation wishing it had gone better
				Thought "Why do I have problems other people don't have?"
				Thought "why can't I handle things better?"
				Analysed your personality to try to understand why you are depressed
				Went someplace alone to think about your feelings

**THANK YOU FOR COMPLETING THESE QUESTIONNAIRES**

**Appendix 8 Summary of measures taken at each session.**

<b>Session 1</b>	<b>Daily 15 minute practice of either Body or Sound Mindfulness Exercise</b>	<b>Session 2 (1 week later)</b>
Self Report Questionnaires (rated over last 7 days ) including body awareness questionnaires SSAS, BCQ, BPQ and mood questionnaires BDI, STAI, PANAS, RSQ		Self Report Questionnaires (rated over last 7 days ) including body awareness questionnaires SSAS, BCQ, BPQ and mood questionnaires BDI, STAI, PANAS, RSQ
3 min Rest Task (psychophysiology readings)		3 min Rest Task (psychophysiology readings)
Heart Rate monitoring Task		Heart Rate monitoring Task
Affective Pictures Task. Counterbalanced (self rated emotional response and psychophysiology readings)		Affective Pictures Task. Counterbalanced (self rated emotional response and psychophysiology readings)
Instructions for Mindfulness Training (Body or Sound)		FINISH
1 minute rest psychophysiology Readings  Brief ratings of state awareness of body/sounds and state mood		
15 minute mindfulness practice		
1 minute rest psychophysiology Readings  Brief ratings of state awareness of body/sounds and state mood		
Answer any questions and give CD of exercise to practice at home.		