The Role of Psychological Flexibility within the Detection and Regulation of Emotion

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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ABSTRACT

Introduction: A central assumption in the Acceptance and Commitment Therapy (ACT) model is that greater psychological flexibility (PF) requires the ability to notice (interoception) and appraise emotion. However, interoceptive accuracy (IA), defined as the convergence between subjective (reported) and objective (measured) bodily states, has not yet been objectively assessed alongside PF. The aims of this thesis were to explore the relationship between PF and the detection and regulation of emotion in a non-clinical sample, in order to test the theoretical basis of ACT.

Method: Interoception was assessed using a heartbeat detection task, where participants are asked to count their own perceived heartbeats in a given timeframe over six intervals. This is compared against an objective (recorded) number of heartbeats to give an IA score. Participants also rated their subjective confidence in each interval on a visual analogue scale, which was calculated against IA to ascertain Interoceptive State Prediction Error. PF was assessed by the Acceptance and Action Questionnaire II. Alexithymia (difficulty identifying and describing emotion), mood and emotion regulation was also measured using questionnaires. Interoceptive sensibility (an individual's subjective perception of their interoceptive abilities) was assessed using body awareness and dissociation subscales of the Scale of Bodily Connection Questionnaire.

Results & Discussion: There was no significant positive correlation found between PF and interoceptive accuracy, and methodological limitations and possible explanations for this are discussed. Replicating previous findings, PF was significantly negatively correlated with alexithymia, meaning that one's subjective ability to identify and describe emotion improves alongside PF. PF was negatively associated with body dissociation but was not correlated with body awareness. Significant relationships were revealed between PF and both emotion regulation strategies in the predicted direction. Further research is also recommended following ACT treatment to investigate the nature of any relationship between PF and bodily emotion.

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INTRODUCTION

This thesis presents a body of research examining various components of emotion processing and the relationships between them. Initially, the current study was focussed on understanding difficulties in emotion processing in people who experience non-epileptic seizures. However, due to problems recruiting a clinical sample, the focus was switched to another valuable research question that could be answered within the non-clinical control group - regarding the psychological flexibility model which underlies the Acceptance and Commitment Therapy (ACT) model. The existing experimental design involved assessing psychological flexibility as well as measuring facets of emotion processing in an in depth, objective way. ACT specifically aims to improve psychological flexibility, a multi-faceted concept which includes one's ability to notice embodied emotional states as a central feature (Hayes, 2016; McCracken & Morley, 2014). Thus to validate the psychological flexibility model, an investigation into various aspects of emotion processing and psychological flexibility is presented.

1. Initial Plans and Change of Focus

The initial starting point for the research described in this thesis was an investigation of the bodily detection of emotion (interoception) in people who experience non-epileptic seizures (NES). NES is a common functional neurological disorder (FND), characterised by paroxysmal events resembling epileptic seizures, but lacking the corresponding abnormal electrophysiological brain activity (Reuber, Mitchell, Howlett, Crimlisk, & Grünewald, 2005). Considered 'psychogenic', there is not yet a clear consensus on causal factors or underlying pathology, although altered neuro-cognitive, behavioural and psychological processes have been implicated in the development of NES (van der Kruijs et al., 2012). Starting with Freud, who characterised these incidents as the result of abreacted intra-psychic conflict (Breuer & Freud, 1956), aberrant emotional processing has long been central in explanatory models of medically unexplained symptoms (MUS) such as NES. For example, a cognitive behavioural model of MUS (Deary, Chalder & Sharpe, 2007) presents a symptom maintenance cycle featuring emotional difficulties (characterised as physiological sensitisation and distress intolerance) as fundamental alongside illness beliefs.
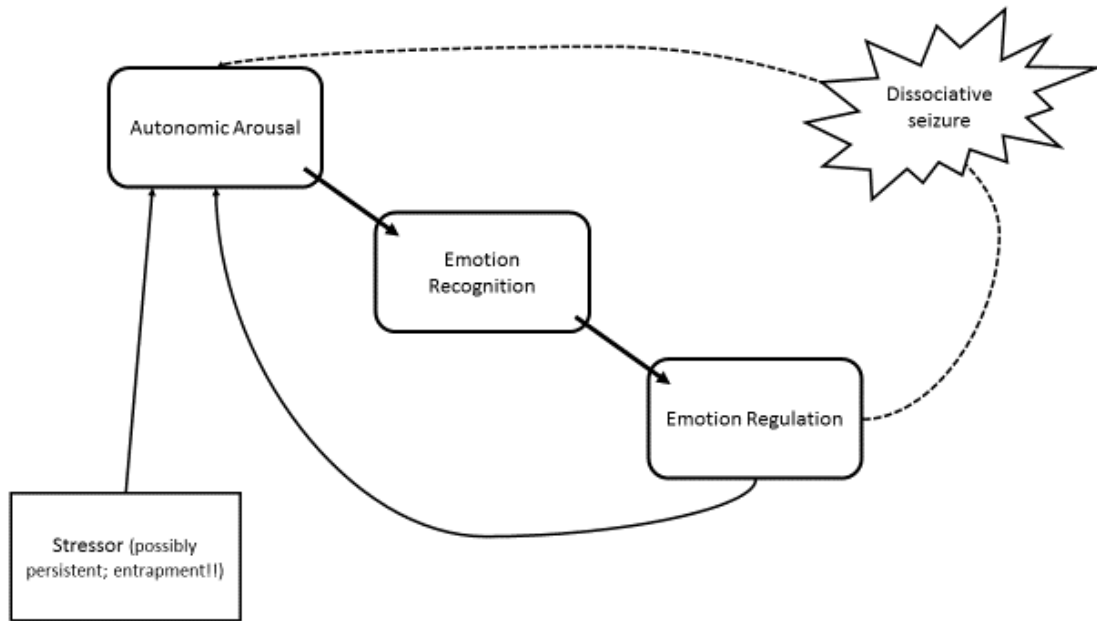
Figure 1: Representation of emotional processing in the maintenance of non-epileptic seizures. Figure by Graham (2016), reproduced with permission.

Figure 1 shows a simplified version of the components of emotion processing, and how this may be affected in NES. In response to a stressor, the body becomes physiologically aroused, and then one becomes aware of an emotional response. For example, trembling hands and shallow breathing is subsequently recognised as anxiety. Given the human predisposition to return to a state of homeostasis, one is then motivated to respond by using strategies to regulate this emotion, for example, using self-talk, or slowing and deepening breathing. However, for those with NES, there is an understanding that this process is altered at one or more stages. This means that emotion is not successfully regulated, leading to the occurrence of non-epileptic seizures either as a way of dissociating, i.e., to separate oneself from the presence of the stimuli causing the emotion (Roberts & Reuber, 2014), or as a learned response to alleviate the discomfort of prolonged autonomic arousal (Stone & Carson, 2013).

Studies have shown that a subgroup of individuals with NES struggle with accessing adaptive regulatory strategies for difficult emotions, selecting goal-directed behaviours and being in control of their feelings and actions (Brown et al., 2013). Novakova, Howlett, Baker, and Reuber (2015) found under-regulation and over-suppression of emotions using self-report measures, substantiating the concept that avoidance of emotional experience is a problem for those with NES. Psychological flexibility is theoretically connected to these concepts of emotion processing and regulation, defined as "the capacity to persist or to change behavior in a way that (a) includes conscious and open contact with thoughts and feelings, (b) appreciates what the situation affords,

and (c) is guided by one's goals and values" (McCracken & Morley, 2014, p. 225). Increasing psychological flexibility is a central aim of ACT, and there is a promising evidence base for ACT as a psychological treatment for medically unexplained symptoms including FND (Graham, O'Hara, & Kemp, 2018; Hann & McCracken, 2014; Westin et al., 2011). Although so far there has been limited experimental investigation into the connection between psychological flexibility and NES, evidence has shown experiential avoidance (demonstrating a lack of one aspect of psychological flexibility) to be correlated with anxiety in NES (Dimarco, Dawson, Roberts, Brown, Moghaddam, & Reuber, 2014). This presents emerging evidence for the role of psychological flexibility as an important factor in NES.

There also is substantial evidence for emotional recognition deficits in NES. For example, Myers, Matzner, Lancman, Perrine, & Lancman (2013) showed a high prevalence of alexithymia, which involves difficulty identifying and labelling feelings, in individuals with NES. Alexithymia can be understood as top-down emotional processing, whilst also fundamental to emotion recognition is the bottom-up ability to detect and appraise bodily signals, known as interoception. Interoceptive accuracy refers to the ability to accurately detect bodily sensations, and can be assessed objectively using experimental paradigms such as a heartbeat detection task (Schandry, 1981). This task is a well-validated measure of interoception, sensitive to individual differences (Ainley, Tajadura-Jimenez, Fotopoulou, & Tsakiris, 2012; Domschke, Stevens, Pfleiderer, & Gerlach, 2010). It involves participants attempting to connect with their beating heart, and count or guess how many heartbeats they experience within a set timeframe. Simultaneously, actual heart rate is objectively recorded using electrocardiogram (ECG), allowing the counted figure (subjective detection) to be compared with the recorded (actual) number of beats (Schandry, 1981). Interoceptive accuracy is therefore operationally defined as the discrepancy (error) between these figures.

Despite the evidence to suggest impairment of emotional processing in NES, interoception has not yet been measured objectively in this group. This is an important omission because interoception is a primary process in emotion processing, on which all other aspects of emotion identification, appraisal and regulation depend (Farb et al., 2015). It therefore may be that this is a central deficit in NES. The initial aim of this research project was to investigate the process of detection and regulation of emotion in people with NES. To test the hypothesis that interoception is impaired in NES compared to controls, the aim was to undertake group comparisons on a heartbeat detection task (Schandry, 1981) between people with NES (*N*=30) and non-clinical controls (*N*=30). Further objectives included the exploration of differences between these groups in

alexithymia, psychological flexibility, interoceptive sensibility and emotion regulation. Questionnaire measures were selected to investigate these variables.

Unfortunately, due to the changes in NHS service parameters it proved impractical to recruit a clinical sample within the timeframe of this thesis. At this stage a non-clinical group had been recruited and tested ($N =30$) and it was thought that there were interesting and unanswered questions within this group, particularly whether interoception correlated with psychological flexibility in a way suggested by the ACT model. Therefore, the focus of the project shifted to explore the relationships between detection and regulation of emotion, and psychological flexibility. The ACT model (outlined in detail in the following section) has made clear suggestions pertaining to the capacity and willingness to notice and appraise bodily sensation and this is inherent within the construct of psychological flexibility (Harris, 2009). However, the relationship between psychological flexibility and the elemental aspects of emotion processing such as interoceptive accuracy have not yet been assessed. Therefore, it was felt that this was a significant area for further examination of the theories underlying ACT. It was agreed that recruitment to the clinical group would be ceased, and instead recruitment of the current sample would be extended. Given that small effect sizes were expected, prior to undertaking any statistical analysis the decision was made to extend the sample to another thirty participants (total $N=60$).

Jan - April 2016
- Met with supervisor Dr Chris Graham and commenced initial discussions around area of research; interoception and non-epileptic seizures (NES).
- Dr Donna Lloyd joined team as supervisor; research contract and training plan completed.
- Research question, title and paradigm finalised: An examination of interoceptive processes in non-epileptic seizures.

Dec 2016
- Made contact with Lead Neurologist and research nurse in local NHS Trust regarding becoming a field supervisor and collaborator, by supporting recruitment of patients with NES.
- Received ethical approval for control group testing from School of Psychology Research Ethics Committee (SOPREC), and commenced recruitment.

Apr - Aug 2017
- April 2017 submitted ethical application to IRAS Research Ethics Committee.
- Received approval July 2017 and opened recruitment via neurology team.
- No referrals for recruitment received; started to develop ideas for alternate research directions, should recruitment be unsuccessful by Jan 2018.

Jan 2018
- By January no participants had been referred to researcher.
- Decision made to instead extend the control group up to 60 participants by March 2018, as it was felt that there were unanswered questions within this non-clinical sample, which may also inform future NES research.
- Decided to instead focus on psychological flexibility and detection and regulation of emotion.
- Submitted amendment to SOPREC to extend control testing and recommenced testing once approved.

Figure 2: Brief outline of events and changes throughout the current project.

2. Literature Review

The aim of the current research is to investigate the relationship between psychological flexibility and the detection and regulation of emotion in a non-clinical sample, in order to test the theory underpinning the ACT model. The ensuing chapter will start by describing and outlining current literature contextualizing the key areas under investigation within the project. This will include a brief examination of theories of emotion, going on to connect this to the psychological flexibility model, and finally to ACT, as a tool for the development of psychological flexibility. The chapter will conclude by summarising the background research and stating the aims and hypotheses of the current project.

2.2 Emotion

2.2.1 Theories of Emotion

Emotion is widely accepted as a key part of psychological therapy, common across the full range of therapeutic approaches and theoretical models. For example, in ACT, the process of allowing emotion to be noticed and fully experienced, without defence, in the current moment is a central component of therapeutic work (Blackledge & Hayes, 2001). Within many CBT models, identifying one's feelings in a particular situation is often a key component of understanding what is driving and reinforcing maladaptive beliefs as well as behaviour (Greenberg, 2008). In intensive short term dynamic psychotherapy, experiential emotion processing is crucial in recognising, confronting and ultimately overcoming maladaptive psychological defences in order to resolve intrapsychic conflict (Davanloo, 1979). Physical sensations in the body are highlighted as being a strong indicator of different emotions in all of these examples.

It has been asserted as early as the 19th century by the James-Lange theory of emotion that physiological experiences are primary to emotion processing (James, 1884). Following Charles Darwin's (1872) evolutionary theories of emotion as an adaptive response to the environment, William James proposed, controversially at the time, that our emotional responses occur following direct physiological responses to our environment (Dalgleish, 2004). James (1884), and subsequently physiologist Carl Lange (1885) posited that, whilst our physiology directly and automatically responds to a stimulus, our emotions are dependent upon our interpretation of those bodily reactions. For example, standing up to give a public speech may cause symptoms of anxiety in the body, such as shaking hands, dry mouth, racing heart, etc. According to the James-Lange theory, the observation and interpretation of this bodily response is what leads one to understand that they feel anxiety, or fear. "I am trembling, therefore I feel afraid" (James, 1884).

Hence, the capacity to notice and evaluate bodily sensations is theorised to be central to our ability to recognise, label and regulate emotion. Even the word 'feeling' itself implies bodily sensation. The specific role of the body in sensing and identifying emotion has been open to debate over the years. However, the centrality of physiology to emotional experience is now widely accepted and has been evidenced in experimental research into perception of bodily state, often referred to as interoception (Domschke et al., 2010; Füstös, Gramann, Herbert, & Pollatos, 2012; Hanley, Mehling & Garland, 2017; Pratt, 2014).

2.2.2 Bottom-up Emotion Processing: Interoception

Drawing on these early theories of emotion, interoception has come to be understood as a key factor in emotion processing (Füstös et al., 2012). It has been defined by Farb et al. (2015) as "an iterative process, requiring the interplay between perception of body states and cognitive appraisal of these states to inform response selection" (p. 1). Despite James' early postulation of interoceptive processes being central to the experience of emotion (James, 1890), it has taken experimental psychology some time to catch up to characterising and observing interoceptive ability, and the study of interoception is currently experiencing a resurgence (Murphy, Catmur & Bird, 2018). As outlined below (Box 1), interoception is a multi-faceted concept. Interoceptive processes involve both the detection of physiological states in the body – 'bottom-up' emotional processing – and the 'top-down' associated cognitive awareness and analysis of these signals (Hanley, Mehling & Garland, 2017). Figure 3 illustrates the role of interoception within the wider emotional processing loop presented earlier (in Fig. 1).
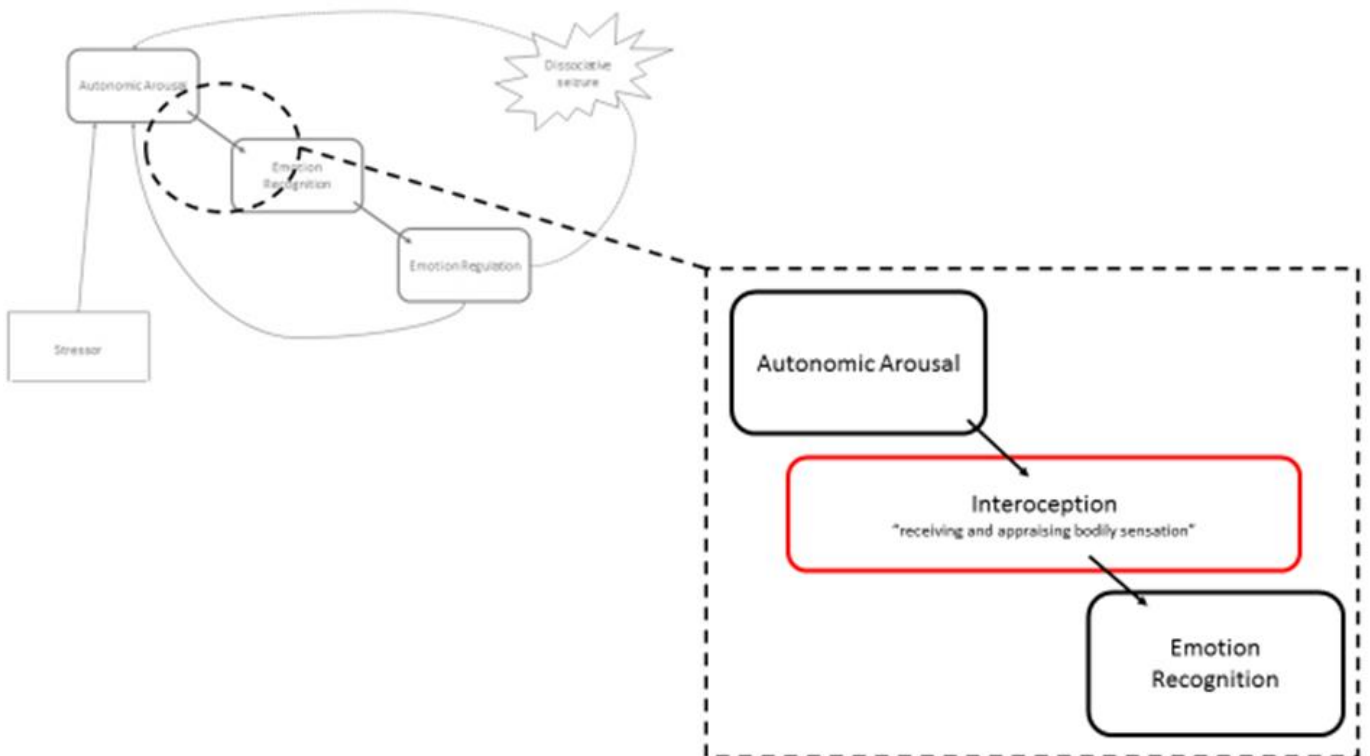
Figure 3: Representation of the role of interoception in emotional processing. Figure by Graham (2016) reproduced with permission.

2.2.2.1 Measurement of Interoception

Interoception has been primarily experimentally assessed by measuring the sensitivity to noticing cardiac signals (i.e., awareness of the heart beating). One's heartbeat is an internally perceptible interoceptive event, as well as being externally measurable using non-invasive means,

making it a functional way to assess interoception (Herbert, Muth, Pollatos & Herbert, 2012). The heartbeat detection task involves a comparison between a participant's internal count of their own heart beating and an objectively recorded number of heartbeats during a short timeframe of between twenty-five and forty-five seconds (Schandry, 1981). This is repeated across six time periods, and participants must use interoceptive signals and mental tracking rather than exteroceptive cues such as pulse checking (Pratt et al., 2011). This discrepancy between subjective (counted) and objective (recorded) heartbeats is calculated to give an interoceptive accuracy score between zero and one. A higher score indicates that one's tracked estimate of heartbeats is closer to the objective number recorded, i.e., less error, therefore better accuracy (Pollatos et al., 2008). This method has been evidenced as a reliable and valid indication of an individual's general interoceptive awareness (Tsakiris, Tajadura-Jiménez, & Constantini, 2011). Cardiac awareness has also been demonstrated to be correlated with the capacity to notice changes in other organs of the body, indicating that heartbeat awareness is representative of broader interoception (Herbert et al., 2012; Whitehead & Drescher, 1980).

Box 1. Some measurable facets of interoception, adapted from Farb et al. (2015) and Garfinkel et al. (2015)

1. Interoceptive accuracy: the convergence between subjective (reported) and objective (measured) bodily states –e.g., heart rate, temperature. Often measured using heartbeat detection (tracking) task (Schandry, 1981), where participants count their own perceived heartbeats, which is compared against an objective (recorded) number of heartbeats in a given timeframe, and/or heartbeat discrimination task (Katkin, Reed, & Deroo, 1983), during which participants assess whether a tone sounded is synchronous or asynchronous with their heart beating.

2. Interoceptive awareness: metacognitive insight into the accuracy of one's own accuracy in perceiving bodily changes, for example, confidence in one's own accuracy of interoceptive responses on heartbeat detection tasks (Garfinkel et al., 2015).

3. Interoceptive sensibility: an individual's subjective ability to describe his or her own emotional state. This can be measured with questionnaires, for example, the Scale of Bodily Connection (SBC) (Price & Thompson, 2007).

2.2.2.2 Studies Measuring Interoception in Mental Health Conditions

Research exploring various mental health difficulties has highlighted the complex role of interoception in emotion within these conditions. Dunn et al. (2010) explored interoceptive accuracy using a heartbeat detection task described earlier (Schandry, 1981) in those experiencing anxiety and depression. Findings supported the hypothesis that interoceptive accuracy - the ability

to accurately count the number of heartbeats within a given timeframe as compared to actual recorded heartbeats increased significantly with anxiety-specific arousal symptoms. However, this relationship was moderated by anhedonia symptoms: as anhedonia increased, the association between arousal and superior interoception became less marked. In other studies, a positive association has also been found between interoceptive awareness and trait anxiety in healthy individuals (Pollatos et al., 2007), and in clinical samples with a range of anxiety disorders including social anxiety, panic disorder and generalised anxiety disorder (Domschke, Stevens, Pfleiderer, & Gerlach, 2010; Ehlers & Breuer, 1996; Pineles & Mineka, 2005).

In a review of the literature on the relationship between anxiety and heightened interoceptive awareness, Domschke et al. (2010) concluded that this sensitivity to feared bodily responses and resultant reactivity to the perception of threat to self may contribute to the development and perpetuation of anxiety symptoms. However, the authors also criticised some of the limited research for an over-reliance on self-report questionnaire measures, given that, without objective physiological assessment, true accuracy cannot be determined (only subjective beliefs around interoceptive ability). This highlights the importance of further research using objective measures of interoception such as heartbeat detection or discrimination, to deepen our understanding of the mechanisms involved. Furthermore, in a more recent study using a heartbeat-tracking task to compare interoceptive accuracy in individuals with body dysmorphic disorder (BDD), anxiety, and non-clinical controls, interoceptive accuracy was not heightened in people with anxiety compared to the other two groups (Pratt, 2011). Given the reported reliability and validity of heartbeat detection as a measure of interoceptive accuracy (Ainley et al., 2012; Domschke et al., 2010), the variation in methods of assessment and over-reliance on subjective measures in studies of anxiety may partly explain the disparity in findings (Domschke et al., 2010; Pratt, 2011).

Interoceptive accuracy is reduced in some eating disorders, including anorexia nervosa (Pollatos et al., 2008). This effect was also found in a group of individuals with BDD who performed significantly worse on a heartbeat detection task than non-clinical controls (although not significantly poorer than those with anxiety; Pratt, 2014). The effect was further emphasised when the participants completed the same task in front of a mirror to explore the impact of self-focussed attention during interoceptive processing. Whilst use of a mirror has been previously shown to enhance interoceptive accuracy in individuals with normally lower accuracy levels by improving self-focussed attention (Ainley et al., 2012), this was actually detrimental for those with BDD as compared to both other groups (Pratt, 2014). This interesting finding points to the complex and

malleable nature of interoception as a multidimensional construct, which may be manipulated differently on various levels in different individuals.

2.2.3 Top-down Emotion Processing: Alexithymia

Another component of emotion processing is concerned with the cognitive identification and appraisal of feelings. Alexithymia is a multifaceted construct incorporating: difficulties with identifying, labelling and describing the experience of emotion; differentiating bodily sensations of emotion; limited imaginative thinking, and; a tendency towards a stimulus bound, externally-oriented thinking style (Taylor, Bagby & Parker, 2003). It therefore impacts upon various levels of emotional processing; primarily 'top-down' appraisal, as well as psychological mindedness, social attachments and interpersonal relating. The concept of alexithymia, in keeping with the James-Lange theory of emotion, refers to the difficulties in noticing, identifying and appraising visceral sensations as emotional experiences, following physiological arousal in response to stimuli. The opposite of alexithymia is referred to as emotional literacy, denoting a greater ability in identifying, labelling and describing feelings using language. This is also conceptually a key element of psychological flexibility, requiring the ability and willingness to notice and remain in contact with private events, including emotional feelings.

Various studies have demonstrated a relationship between alexithymia and impaired interoceptive accuracy across different interoceptive domains aside from cardiac perception, such as taste, muscular effort, respiratory awareness and cardiac perception (Murphy, Brewer, Catmur & Bird, 2017; Murphy, Catmur & Bird, 2018; Shah et al., 2016). Low alexithymia has been also shown to support better psychosocial and psychological functioning and better quality of life in the general population (Beroccal et al., 2009; Modesti, Furrer & Malti, 2009). This relationship has been suggested as evidencing atypical interoception as an underlying 'common factor' across psychopathology or pervasive distress generally, in a dimensional rather than categorical or diagnostic context (Murphy et al., 2017).

Shah, Hall, Catmur and Bird (2016) conducted a similar interoceptive accuracy study to that of Garfinkel et al. (2015) on people with autism spectrum condition but assessed and controlled for alexithymia using the 20-item Toronto Alexithymia Scale (TAS-20; Bagby, Parker & Taylor, 1994). They found that there was no difference between those with autism and controls when groups were matched on alexithymia, suggesting that alexithymia, not autism, is associated with poorer interoceptive accuracy. In addition, in a recent study involving novel tests of interoception, high alexithymia was found to be associated with reduced accuracy in utilising interoceptive cues

in three different domains; on a respiratory task, a task of muscular exertion, and on a taste task (Murphy, Catmur & Bird, 2018), regardless of presentation of autism, anxiety or low mood.

'Difficulty Identifying Feelings' and 'Difficulty Describing Feelings' refer to two well-validated subscales (DIF and DDF, respectively) of the TAS-20 (Bagby, Parker & Taylor, 1994) and as constructs, form a major component of alexithymia. Research into difficulty identifying and describing feelings (DIDF) suggests that distress is related to the way in which an individual chooses to approach and respond to adversity, rather than the adverse circumstances themselves (Landstra, Ciarocchi, Deane, Botes & Hillman, 2013). This suggests that alexithymia informs one's behaviour in how one approaches and copes with the impact of hardship. Once an individual is able to appraise distress as an emotional response to such hardship, they are better equipped to explore ways to manage, or 'regulate' emotion.

2.2.4 Emotion Regulation

Whilst interoception and emotional literacy refer to key aspects of emotional processing, the next step of emotional experience is concerned with how one then chooses to manage, or regulate emotion. Emotional regulation refers to the process by which an individual employs strategies in order to manage the fluctuation of emotion in response to internal or external stressors (Thompson, 1994). Gross and John (2003) conducted a study into the functionality of two well-defined emotion regulation strategies. The first, Cognitive Reappraisal, indicates the attempt to reinterpret one's situation or emotions, "with its emphasis on controlling the personal meaning that events have for the individual" (p. 361), and secondly, Expressive Suppression refers to the attempt to suppress emotions "with its emphasis on controlling one's behavioral responses to these events" (p. 361, Gross & John, 2003). Reappraisal is associated with greater experience and expression of positive emotion and less expression of negative emotions. It is also related to greater wellbeing and interpersonal functioning. In contrast, those who tend to employ suppression experience and express lesser positive and increased negative feelings. Suppression is also associated with poorer interpersonal functioning and wellbeing (Gross & John, 2003).

The choice of specific strategy of regulation and the evaluation of how useful they are is a highly individual matter, influenced by personality, experiences and learning throughout life (Gross & John, 2003). Different therapies approach the regulation of emotion in slightly different ways. For example, CBT approaches often advocate cognitive reappraisal and restructuring. 'Thought records' are a popular way of taking note of frequently experienced negative and automatic thoughts, examining the emotional impact of them, and appraising the 'evidence' for and

against the thought being supported by 'fact', such as past experience. One is then supported to explore alternative or more balanced thoughts, and then rate the emotional impact again (Rupke, Blecke, & Renfrow, 2006). In contrast, an ACT approach to emotion regulation is to simply select those strategies which work for the individual in enabling them to live life in congruence with their values (Hayes et al., 2006). However, inflexible use of suppression as a strategy would be inconsistent with the psychological flexibility model, given that the model emphasises openness to experience feelings and thoughts. In contrast, the process of cognitive reappraisal involves deciding how to respond to thoughts, which necessitates observing cognition at a distance as encouraged in ACT, in order to reframe (Gross & John, 2003).

2.3 The Psychological Flexibility Model and ACT

The current section aims to provide a detailed overview of key components of the psychological flexibility model, on which the ACT approach is based. Contextual examples will be outlined of how these qualities function, overlap and feature in people's emotional lives. Links will be drawn between sub-processes of psychological flexibility and emotional processes, including bodily perception (interoception), linguistically identifying and describing emotion (alexithymia) and regulation. Designed as the vehicle with which to improve psychological flexibility, ACT will be described and linked to emotion processing. Finally, the concluding section will summarise the connections between all variables, leading into the aims and hypotheses of the current study.

2.3.1 Psychological Flexibility

Psychological flexibility describes the ability to make open and conscious contact with the current moment, and to adapt or persist in behaviour in order to serve personal valued ends (Hayes et al., 2006). The psychological flexibility model acknowledges two core sources of information or influence, which interact in order to contribute towards the selection of behaviour patterns (McCracken & Morley, 2014). The first, direct experience, refers to the way in which one takes in information about the self and the world through bodily senses and feelings directly. The second set of influences is understood as more cognitive in nature, incorporating language and verbal-based means of comprehension, appraisal and mental analysis. As such the model "fully integrates cognitive and environmental influence as the core process of both healthy and problem behaviour" (McCracken & Morley, 2014, p. 9).

The model proposes that psychological flexibility is a key behavioural process which helps to explain wellbeing and distress in humans. Kashdan and Rottenberg (2010) refer to psychological flexibility as a "fundamental aspect of health", and there is a large body of research emphasising

the fundamental role of psychological flexibility in psychological wellbeing in a range of psychological presentations. Indeed conversely, psychological inflexibility has been shown to be indicative of increased psychological distress (A-tjak, et al., 2015; González-Fernández et al., 2017; Fledderus, Bohlmeijer, Smit, & Westerhof, 2010; Kashdan & Rottenberg, 2010; Levin et al., 2012; McCracken & Gutiérrez-Martínez, 2011; Merwin et al., 2011; Wicksell, Olsson & Hayes, 2010). Psychological flexibility includes several converging sub-processes (summarised in Table 1).

Acceptance within the context of psychological flexibility is understood as an "active and aware embrace of those private events occasioned by one's history", including cognitions and emotions, without making attempts to moderate or avoid them (Hayes et al., 2006, p. 7). Experiential avoidance, as the opposing position, occurs when an individual is unwilling or unable to remain connected to certain (often unpleasant) private events, such as feelings, physiological sensations, thoughts, memories, and so on, and instead makes attempts to alter the form of frequency of such events and/or the contexts in which they occur. Often, this avoidance will result in a behavioural or affective cost, if not in the short term, then in the form of longer-term psychological harm. For example, an individual who becomes anxious in social situations might find themselves start to experience bodily signs of anxiety when approaching a social event. Unpleasant, anxious thoughts and memories related to their social performance in the present or past may also be activated. A person who has a greater tendency towards experiential avoidance may block or avoid contact with these unpleasant experiences in a number of ways, for example, by deciding very early on that they will not consider attending, or perhaps by using substances to limit the experience of anxiety. This alleviates the immediate threat of experiencing anxious thoughts and feelings, but may have a number of unintended consequences. By attempting to keep thoughts and feelings at a controlled distance it increases the tendency to predict one's feelings prior to actual experience, and potentially make judgements about one's (in)ability to cope and subsequent behavioural response or strategy based on inaccurate predictions (González-Fernández et al., 2017). In a review of the evidence, Chawla and Ostafin concluded that experiential avoidance has been shown to play a significant role in the development and maintenance of various forms of poorer psychological functioning; including substance misuse relapse, severity of symptoms in specific difficulties such as phobias, and mediating the relationship between trauma and psychological distress (2007).

Table 1: A taxonomy of the six sub-processes of psychological flexibility.

Acceptance	Being open to allow experiences (pleasant and unpleasant) to come and go. Making room for thoughts and feelings rather than resisting or avoiding.
Cognitive defusion	Taking a position of stepping back and recognising that thoughts are separate from the events that they describe.
Contact with the present moment	Being present in the current moment; fully conscious of the here and now, e.g. mindfulness.
Self-as-context	Taking the position of the 'observing' self, in order to notice what is being experienced in one's inner and outer world; 'meta-awareness', or 'pure awareness'.
Values	Central to ACT is identifying meaningful values for living; our own judgement of what comprises our 'chosen life direction'.
Committed action	This involves "doing what it takes" to live congruently with our identified values.

Acceptance, which etymologically comes from the verb, to take, is an alternative to this pattern of experiential avoidance (Blackledge & Hayes, 2006). It actively allows space for feelings and other private events to be received or taken, and be felt exactly as they are until they pass. This requires a kind of curiosity, to tune in to the body and mind and notice what is being felt, whilst recognising the context in order to make sense of the experience. This is a central process of ACT, where the therapy goal is often shifted from feeling *better* to *feeling* better; that is, increasing one's capacity to make full contact with what is being felt, rather than to try and resist or transform those feelings. Again, within the concept of acceptance as an important process in psychological flexibility, importance is placed upon one's ability to connect with and accurately notice one's interoceptive experiences, which has not yet been objectively measured.

According to Relational Frame Theory (RFT) which underpins ACT, language plays a significant role in the ways in which individuals come to understand, contextualise and relate to their private experiences (Hayes et al., 2006). One element of psychological inflexibility emerges from a rigidity and literality of the application of language and cognition to direct contingencies, resulting in an impaired ability to adapt or persevere with behaviours in a way consistent with valued ends. In other words, the language attributed to cognitive events is interpreted literally and

factually without question, and therefore maybe permitted to guide behaviour in an inflexible and potentially unhelpful manner, irrespective of the environmental context. This concept is coined cognitive fusion, referring to the fixed way in which one might be inexorably attached, or fused, to the unquestioned 'truth' of their thoughts. Cognitive fusion sustains experiential avoidance, keeping one seemingly 'safe' from unpleasant private events. Returning to the previous example, the social avoider might think to themselves "I am rubbish in social situations; I can't help but embarrass myself". Being fused to this statement, believing unquestionably in its reality, understandably leads one to physically or experientially avoid the situation, seeking strategies to reduce contact with unpleasant feelings.

However, cognitive defusion, as developed in ACT, allows one to create space and more objective questioning of thoughts and predictions such as these. Taking a position of recognising that a thought is merely a thought, and may or may not be true enables the individual to be more critical of the content, and also to acknowledge the feelings associated with having that thought. "I am having a thought that I am rubbish and that I won't be able to help but embarrass myself" infers more distance between oneself and one's thoughts, and gives space to recognise the feeling – fear and anxiety – that is embedded within the thought. It is no longer certain and fixed truth, but an unresolved feeling, which requires validation, care and regulation. One can take a step away from the preoccupation or 'stuckness' with one's thoughts, and pay attention to other influences and sources of information, such as the bodily experience of emotion. There is a move away from 'overthinking' and relying on language-based conceptualisations of self, past and future, which are often negative and cautionary, leading individuals to disconnect from what it is they want and value in life, beyond respite from psychological suffering (Hayes et al., 2006).

Contact with the present moment is self-explanatory and as referred to previously, represents the importance of flexibly connecting to the current time, the here-and-now, rather than allowing one's focus to drift disproportionately to ruminating on the past or worrying about one's future (Hayes et al., 2006). It is similar to the moment-by-moment non-judgemental awareness of mindfulness meditation, interacting with the other processes of psychological flexibility to allow open and conscious engagement with psychological events as they occur (Hayes et al., 2006). Significance is placed on noticing what is actually there, without prediction or judgement, which again emphasises the need for interoceptive processes to be available and relatively accurate.

Self-as-context, or self-as-observer, embodies a perspective in which one is able to notice private events such as feelings and thoughts without being either defined by or directly harmed by

being in contact with them (McCracken & Morley, 2014). This position effectively requires flexible present focus and fosters both acceptance and defusion (Hayes et al., 2006).

The two final processes core to ACT and psychological flexibility are connected to one's ability to identify their own individual life direction or values, and the ways in which they can commit to action, which will propel them towards valued ends (Harris, 2009). The former psychological flexibility sub-processes described are not intrinsic end goals; acceptance, defusion, present moment focus and self-as-observer are processes which serve to equip one to move effectively towards identifying personal values and ultimately to act in a way which is consistent with them living a meaningful, values-congruent life (Hayes et al., 2006). Values may consist of life directions such as friendship, family, work – or anything considered of importance to the individual – whereas committed action refers to smaller or larger steps or goals to action which support values-based living. The approach differs to more problem-focussed therapies by developing what is valued by the individual and how they can make this part of life bigger, rather than trying to reduce the frequency, form or impact of the symptoms or problem directly (Harris, 2009).
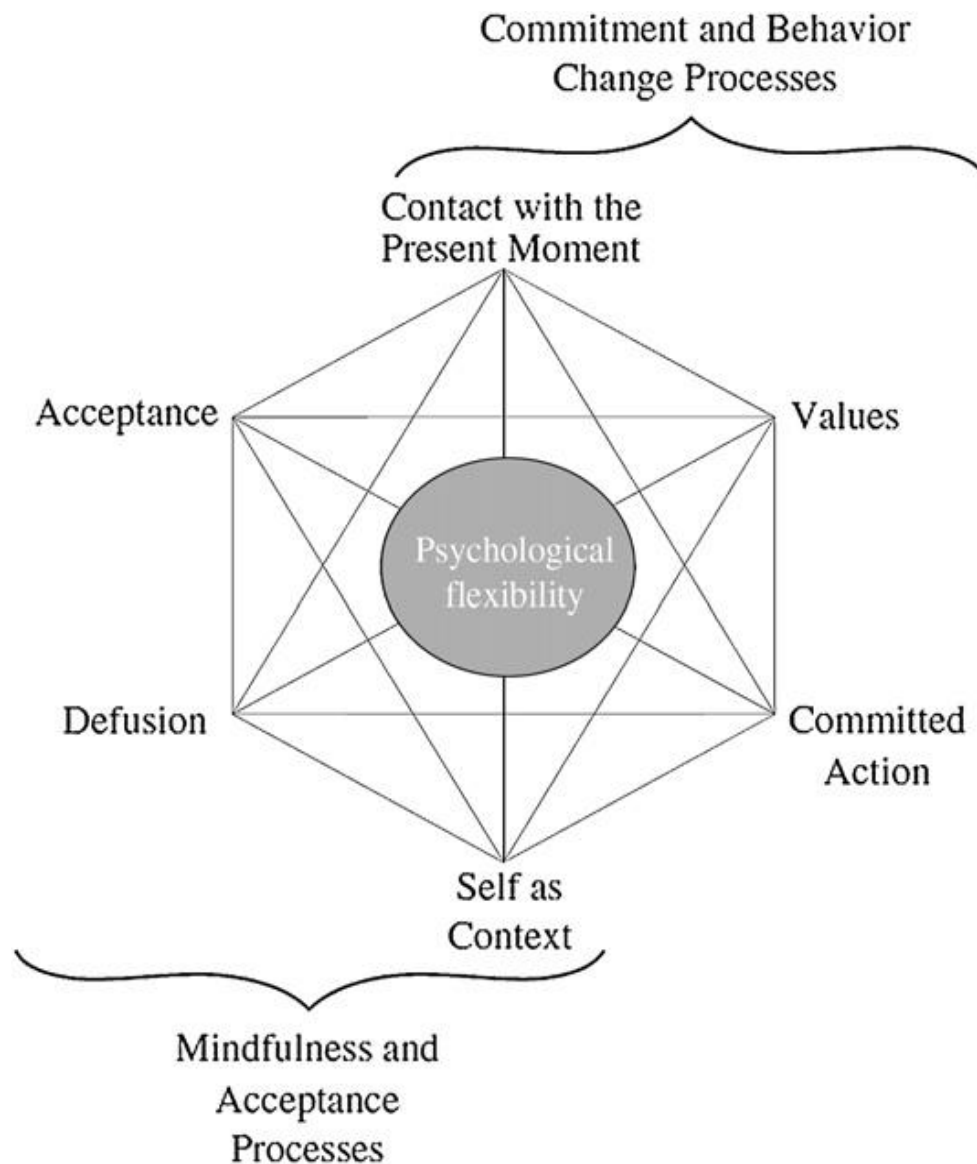
Figure 4: The ACT 'Hexaflex', from Hayes et al. (2006).

There is a body of evidence for each of the six aspects of psychological flexibility contributing to overall wellbeing (Levin et al., 2012). These aspects are often presented in the form of a 'hexaflex' (Fig. 4), which demonstrates the interlinking connections of the six core processes (Harris, 2009). As shown in Figure 4, these processes can be grouped into two different clusters; those concerned with mindfulness and acceptance, and those involved in commitment and behaviour change (Hayes et al., 2006). The current study is concerned with the first set of processes; specifically acceptance, defusion, present moment focus and self-as-observer. This is because these most clearly relate to emotion processing; more specifically, they describe an individual's abilities in remaining open to, objectively noticing and accepting their thoughts and feelings in the moment. 'Thoughts' in this context refer to all manner of cognitive experiences, and 'feelings' encompasses all aspects of the experience of emotion including physiological sensations

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(interoception). Given that psychological flexibility involves first noticing and detecting emotional states, detection of bodily state is considered a fundamental component of psychological flexibility (McCracken & Morley, 2014). The current research aims to investigate this assertion by using an objective measure of interoception.

2.3.2 Acceptance and Commitment Therapy (ACT)

ACT is a psychotherapy based on the psychological flexibility model, aiming to improve an individual's psychological flexibility. ACT is focussed on encouraging the development of the six core sub-processes (Table 1) described in detail above, which enable the individual to accept and cope with the pain of life and instead redirect energy into 'values-congruent living', (i.e., living in line with one's values; Harris, 2008; Hayes et al., 2006). ACT is often termed a 'third wave' therapy, which refers to its position within the wider context of the historical development of cognitive and behavioural therapies.

The first generation or 'first wave' of behaviour therapy focussed on changing behaviour via simple reinforcement and conditioning. The development of Cognitive Behaviour Therapy (CBT) shifted attention onto changing thoughts and cognition (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). However, despite the popularity of 'second wave' CBT, it has been postulated that effective treatment may not need to focus primarily on actively challenging or changing cognition and that some problems are less suited to this approach (Longmore & Worrell, 2007; Worrell & Longmore, 2008). Arguably, CBT focuses on helping an individual to challenge and change the content of their thoughts rather than the relationship they have with these thoughts, concentrating on *what* rather than *how* a person is thinking and approaching thoughts (Ciarrochi & Bailey, 2008; Gaudiano, 2008). The development of 'third wave' therapies saw a return to more radical behaviourist approaches, in the form of functional behavioural analysis with a contextual basis (Hayes et al., 2006), but this time applied to thoughts and thinking, rather than just overt behaviours. ACT is a well-researched and utilised example of such third wave therapies, and evidence for efficacy of ACT is promising in treating many psychological and mental health difficulties (Hayes et al., 2006; Levin, Hildebrandt, Lillis & Hayes, 2012).

ACT is based on the premise that the experience of emotion – both pleasant and distressing – is a normal and expected part of human life, but that this experience can be distorted and enhanced by normal cognitive processes. This may ultimately lead individuals to engage in problematic behaviours in the pursuit of avoiding or attenuating those unpleasant emotions (Blackledge & Hayes, 2001; Harris, 2006). In contrast to the more traditional medical model that mental 'illness'

is caused by psychopathology that must be cured, the philosophy in ACT is that individuals are all subject to context. As such, when faced with the inevitable trials and tribulations of human life, the way in which one responds can either enable them to manage psychological pain, or cause more pain and suffering (McCracken & Morley, 2014). ACT asserts that whilst pain is an inevitable and functional part of human existence, it is the struggle to resist, diminish and rid oneself of this pain that brings about lasting suffering (Blackledge & Hayes, 2001; Harris, 2009). ACT is a transdiagnostic approach. Thus, the underlying theory is designed to be applicable across all individuals by aiming to explain the processes underlying psychological wellbeing as well as distress (Hayes et al., 2006).

When examining the efficacy of a particular psychotherapeutic approach, it is important to consider the cogency of its underlying theoretical model (Levin et al., 2012). In ACT, this has been frequently embarked upon via laboratory-based investigations of components of the psychological flexibility model. Extending treatment outcome research, these studies allow further examination of the process of change, exploring "whether changes in outcome are functionally related to changes in theoretical processes" (p.742, Levin et al., 2012). In a meta-analysis of 66 such studies, Levin et al. (2012) reported significant positive effect sizes for acceptance, present moment focus, values, and mindfulness conditions over inactive conditions. This offers support for the utility and theoretical coherence for treatment components proposed by the psychological flexibility model. The authors also observed significantly larger effect sizes when treatment conditions incorporated experiential methods, for example, exercises or metaphors, than in those conditions employing a more didactic approach. This empirical support for the principles underlying ACT is significant; however, there is a gap in the research of psychological flexibility studies incorporating objective measures of bodily or emotional awareness such as the heartbeat detection task.

Given their roots in behavioural science, cognitive and behavioural approaches have always valued clear outcome measures in assessing baseline (or pre-therapy) functioning and post-intervention changes. In order to measure psychological flexibility, the Acceptance and Action Questionnaire was developed (Bond et al., 2011). The second version (AAQ-II) has since been developed to improve upon on its psychometric properties and is predictive of a range of outcomes including depression, substance misuse, anxiety and stress (Bond et al., 2011). The AAQ-II has been criticised for neglecting certain aspects of psychological flexibility such as committed action, instead foregrounding statements focussing on experiential avoidance/acceptance, and fusion (Francis, Dawson, & Golijani-Moghaddam, 2016). However, as described previously in this chapter, the current study is most concerned with acceptance, fusion, present awareness and self-

as-observer as relating to noticing and appraising bodily emotion, of which the AAQ-II is an appropriate measure. Additionally, the AAQ-II is the most frequently used measure of psychological flexibility clinically and in research, allowing greater opportunity for comparison with other findings.

2.3.3 The Role of Emotional Processing and Interoception within Psychological Flexibility and ACT

ACT is a third wave contextual behavioural therapy, which is growing in popularity and developing a promising evidence base for a range of psychological and health difficulties (Hayes et al., 2006; Levin at al., 2012). The goal of therapy is to develop a client's psychological flexibility. Reflecting back on the definition of this term as "the capacity to persist or to change behaviour in a way that includes **(a) conscious and open contact with thoughts and feelings**, (b) appreciates what the situation affords, and (c) serves one's goals and values" (McCracken & Morley, 2014, p. 225), the key premise under investigation in this study is the clause (a) highlighted in bold. So a central assumption in the psychological flexibility model and thus, ACT, is that greater psychological flexibility requires the ability to notice and use feelings for information (Hayes et al., 2006). Emotional events are respected as being a natural and inevitable part of human experience, to be noticed and accepted in the context in which they arise, without judgement or avoidance. Within ACT, one's ability to notice emotional events as they occur without defence plays a key role in being able to make thoughtful decisions on how to act, in a way which appreciates the contextual limitations and serves one's values effectively (Blackledge & Hayes, 2001; Harris, 2008). The psychological flexibility model asserts that two distinct set of influences impact on behavioural responses; direct, 'bottom-up' experience through bodily senses and feelings, and 'top-down' cognitive and linguistics means of appraisal and analysis. The process by which individuals detect and appraise emotion within the body is known as interoception (Farb et al., 2015). With direct experience of physiological sensations and bodily emotion at the centre of the way behaviour is coordinated, conceptually it follows that it would be advantageous, if not crucial, for information arising from this direct experience to be accessible when needed as well as accurate in the present moment.

A central tenet of the psychological flexibility model is that the ways in which humans naturally develop verbal constructions of events can actually keep them separate from the events themselves. If one is kept insulated or distanced from experiencing events directly, it becomes impossible to persist or change appropriately to act in a way that is truly responsive to the context

external to these verbal and mental processes (McCracken & Morley, 2014). The human mind is a complex and powerful tool, capable of manipulating the experience of emotion, which can serve as a proxy for emotion itself. If trusted upon too much to analyse all events and experiences through language, past memories, etc., however, it is unreliable. Therefore, the capacity to connect to and accurately perceive experiences directly within the body – interoception – is asserted to be an important and intrinsic part of psychological flexibility. Despite these assertions, and the centrality of 'noticing experience' in psychological flexibility and in ACT, as yet, there has been no objective assessment of whether there is a relationship between interoception and psychological flexibility. This relationship has not yet been investigated experimentally, using an objective measure of interoception such as cardiac perception, currently the most commonly used method (Domschke et al., 2010).

Garfinkel et al. (2015) found that in a sample of people with autism spectrum conditions, there was a discrepancy between objective interoceptive accuracy on a heartbeat tracking task (in which the autism group performed significantly poorer) and subjective interoceptive sensibility as shown by scores on the awareness section of Porges' Body Perception questionnaire. In other words, those with autism demonstrated an over-inflated perception of their own interoceptive ability, in contrast to the objective accuracy measure. This discrepancy, between poorer interoceptive accuracy and subjective over-confidence, was associated with deficits in emotion sensitivity and anxiety symptoms. From an ACT perspective, this impact on psychological wellbeing would be consistent with what might be expected from an overreliance on predictions or judgements about perceived bodily emotion over actual and direct experience with sensation. Conceptually, psychological flexibility might be indicated as playing a role within this relationship; however, this was not measured within the study.

Mindfulness practice is commonly used within ACT as a technique to acquaint one with the capacity to slow down, notice and defuse from thoughts and emotions. Relatively short mindfulness courses have been shown to offer some utility in improving subjective interoceptive ability (Parkin et al., 2014). Furthermore, evidence suggests that interoceptive awareness and dispositional mindfulness – a key skill developed within ACT – are strongly correlated and share considerable variance, and both constructs are associated with increased psychological wellbeing (Hanley, Mehling & Garland, 2017). These findings were based on self-report measures alone and therefore warrant further exploration using objective measures of interoceptive accuracy.

Alexithymia, referring to difficulties identifying and describing feelings, has previously been found to be associated with reduced interoceptive accuracy (Shah et al., 2016; Murphy, Catmur &

Bird, 2018). However, little is known about the specific role – if any – of psychological flexibility in interoceptive accuracy and subjective sensibility. The model would suggest that increased psychological flexibility should be associated with less error between subjective confidence in interoceptive ability, and actual interoceptive accuracy (i.e., smaller interoceptive state prediction error (ISPE)). That is, those who are more open to experiencing embodied emotion might be predicted to have greater insight into their capacity to accurately detect bodily sensation. However, the relationships between these concepts are as yet unclear, as are the specific roles they may play in emotional detection and regulation.

The range of often conflicting findings on interoception in psychological wellbeing (and conversely, distress) described here and earlier in this chapter suggests more complexity than a simple one-dimensional relationship between the two. This conclusion is worthy of note; particularly in the context of psychological flexibility given its attempts in providing an explanation not for distress itself but for how one understands and approaches distress and wellbeing. That is, an individual can be high in psychological flexibility and still experience anxiety, distress, low mood, and so on. In fact, the model would assert not that one can, but that one certainly will experience the full range of emotions, and that this is not intrinsically good or bad, healthy or pathological (Hayes et al., 2006). However, psychological flexibility involves the ability to notice embodied processes as they arise, suggesting that good enough interoceptive accuracy is a prerequisite for developing psychological flexibility.

Findings from Landstra et al. (2013) offer some insight into the relationship between alexithymia, psychological flexibility and psychological wellbeing. In a large study of men who were HIV positive and undergoing anal cancer screening, both psychological flexibility (assessed using the AAQ-II) and difficulty identifying and describing feelings (assessed via those subscales of TAS-20) were reliable predictors of depression, anxiety, stress and health related quality of life (Landstra et al., 2013). Psychological flexibility and alexithymia were highly negatively correlated, suggesting overlap between the two variables (Landstra et al., 2013), and the effect of psychological flexibility on mental health was fully mediated by alexithymia. This suggests that identifying and describing feelings from a cognitive, top-down perspective plays an important role in how psychological flexibility impacts on overall psychological wellbeing. However, there was no examination within the study of bottom-up emotional processing (interoception) and how this, alongside alexithymia, may interact with psychological flexibility and mental wellbeing.

A key aspect of emotion processing relates to the choices an individual makes in regulating their emotions. The importance of successful interoceptive awareness has been implicated in

selecting successful regulation strategies. Füstös, Gramann, Herbert, and Pollatos (2012) showed that the better one's interoceptive accuracy is, the more successful they were at applying an emotion regulation strategy (i.e., reappraisal) in response to negative emotion. In order for an individual to make thoughtful choices about how best to regulate their emotion, they must first have the interoceptive abilities necessary to both receive accurate information about their embodied feelings, and to make well-balanced evaluations about their emotional state in context.

This is not to say that it is therefore necessary, or even optimal, for an individual to be focussed on their interoceptive processes at all times. ACT takes a pragmatic approach to wellbeing (i.e. 'do what works'), and as such, emphasis is placed on having the capacity to tune into and receive accurate interoceptive information as and when it is needed. Just as it is not possible or necessary to maintain constant mindfulness, interoceptive accuracy can be conceptualised as a useful source of information about one's emotional state; utilising one's ability to notice events. This 'tuning in' is utilised by the heartbeat detection task (Schandry, 1980), which requires participants to selectively attend to interoception for short periods at a time. This 'noticing' is an important component of psychological flexibility; using in-the-moment awareness of feelings, as opposed to a reliance on cognitively predicting or judging what emotion might be experienced (Hayes et al., 2006). Interoception is proposed as a way of noticing and experiencing emotion as it occurs in the body, and so it follows that it should be important for this information to be accurate in order to provide a good basis on which to make responsive decisions on how to act in line with one's values. However, there is currently a gap in the research investigating links between psychological flexibility and the bodily experience of emotion.

3. Aims and Hypotheses

The aim of the current research is to explore the relationship between psychological flexibility and the detection and regulation of emotion in a non-clinical sample in order to test the theoretical basis of ACT. A central assumption in the psychological flexibility model and thus, ACT, is that greater psychological flexibility requires the ability to notice experiences, including one's feelings and thoughts (Hayes et al., 2006; McCracken & Morley, 2014). Given that psychological flexibility includes the ability to notice emotion, we aimed to test this theory using an objective measurement of interoceptive accuracy. Further aims included understanding the relationships between interoception and psychological flexibility with other processes involved in emotion and the ability to identify and describe feelings and strategies in regulating emotion. It would provide further validation of the ACT model if widely understood emotion regulation strategies (cognitive

reappraisal and expressive suppression) correlate with psychological flexibility in theoretically consistent ways.

3.1 Primary Hypothesis

1. Individuals higher in psychological flexibility (as evidenced by a lower score on the AAQ-II) will be more accurate on a heartbeat detection task as shown by a higher interoceptive accuracy score (Schandry, 1981).

3.2 Secondary Hypotheses

1. Individuals higher in psychological flexibility will show less discrepancy between objective interoceptive accuracy on a heartbeat detection task and associated confidence ratings, i.e., lower Interoceptive State Prediction Error (ISPE).

2. Individuals higher in psychological flexibility will score higher on the Scale of Bodily Connection on the Body Awareness Scale and lower on the Dissociation Scale, indicating higher trait interoceptive sensibility.

3. The relationship between interoceptive accuracy and psychological flexibility will be mediated by scores on the Difficulty Identifying and Describing Feelings (DIDF) subscales of the 20-item Toronto Alexithymia Scale (TAS-20).

4. Individuals higher in psychological flexibility will score lower on the expressive suppression subscale of the Emotion Regulation Questionnaire (ERQ).

5. Individuals higher in psychological flexibility will score higher on the cognitive reappraisal subscale of the ERQ.

METHOD

1. Design

A within-subjects correlational design was used to examine the relationship between the detection (interoception) and regulation of emotion, and psychological flexibility in a non-clinical, adult population.

2. Ethical Clearance

Ethical approval was granted by the School of Psychology Research Ethics Committee (SoPREC) (see Appendix A).

3. Participants and Recruitment

A power calculation (using G*Power; Faul, Erdfelder, Lang, & Buchner, 2007) was conducted prior to data collection to establish the necessary sample size required to detect an effect. However, the current study was novel, as no previous studies have investigated interoception and psychological flexibility. Therefore, power was calculated using a previous study which shared the most similar methodology available and also investigated interoception and alexithymia (Shah et al. (2016). The authors reported a medium effect size (r=0.36) between interoception and alexithymia. For an alpha level of 0.05 and power of 0.80 it was estimated that 46 participants would be required to detect an effect of this size in the current study.

Non-clinical ('healthy') adults (N =60) were recruited from the University of Leeds. They were recruited using the School of Psychology participant pool, the Leeds psychology voluntary participation email list (PSYCLEEDS-VOL list) (see Appendix B), and via posters on campus (see Appendix C). The participant pool included undergraduate and postgraduate students, university staff, researchers and alumni, from various departments and schools. The participants self-selected from a list of inclusion and exclusion criteria (below) and contacted the researcher to sign up for the study. Participants all received either 4 participant pool credits or a £5 Love2Shop voucher as recompense for their time.

Inclusion criteria

Aged between 18-70 years old.

Exclusion criteria

Those with any of the following:

1. A diagnosis of a neurological condition, which may affect emotional processing, interoception or understanding (e.g., epilepsy, a dementia) or functional neurological condition such as NES.

2. Diagnosis of an illness that may cause peripheral neuropathy (e.g., multiple sclerosis, diabetes).

3. A diagnosis of learning disability.

4. Unable to speak and understand English language.

5. Presence of skin allergies likely to be irritated by the electrodes (e.g., contact dermatitis, eczema). This is to avoid the risk of any harm to participants caused by the electrodes.

Criteria one to three were set as a result of the initial research question, to select a healthy control group in contrast to the NES group and to exclude any condition/medical diagnoses that could affect their performance in the study. Criterion four was included as there are not well-validated translated versions of the psychometric questionnaires.

4. Measures

A psychophysiological heartbeat detection task was carried out as an objective measure of interoceptive accuracy. Participants also rated their confidence in accurately detecting their heartbeats on each trial, in order to indicate error between perceived (subjective) and actual (objective) interoceptive ability. Paper questionnaire measures were used to explore participants' mood, psychological flexibility, emotional identification and regulation. All measures are described in more detail below.

4.1 Initial demographic data gathering

1. Age (date of birth subtracted from date of testing).

2. Gender.

3. Body Mass Index (BMI) – calculated from weight and height measurement (BMI $= kg/m^2$).

4.2 Psychophysiological tasks

4.2.1 Heartbeat detection task (HBDT) (Schandry, 1981)

The heartbeat detection task (Garfinkel et al., 2015; Schandry, 1981) is frequently used to investigate interoceptive accuracy and awareness (Farb et al., 2015). Here, participants are asked to focus on the experience of their heart beating within their bodies. Just before starting the test, participants are asked to sit quietly, close their eyes and focus internally to detect their heart beating. Electrodes are attached to the right wrist and both ankles to record the number of

heartbeats using electrocardiography (ECG; BIOPAC Systems, Inc). Participants are given the following instructions, *"without manually checking, please silently count the heart beats you feel in your body from the time that I say 'start' until I say 'stop'"*. Participants complete a time interval of 25, 35, and 45 seconds twice in a random order, completing 6 intervals overall. The participant reports the number of counted heartbeats at the end of each trial, which is recorded by the researcher onto an Excel data spreadsheet on the University desktop computer in the lab, as well as the number of actual heartbeats in the given timeframe recorded by the BIOPAC system, which was not shared with the participant, in order to prevent them from correcting performance or guessing on the basis of feedback.

Analysis: Interoceptive accuracy is calculated for each participant as the mean score across the six HBDT trials using the formula:

$$Accuracy = \frac{1}{6}\sum\left(1 - \frac{[\text{recorded beats} - \text{counted beats}]}{\text{recorded beats}}\right)$$

This provides a heartbeat detection score from 0 to 1, with high scores indicating small amounts of error. Mean scores for non-clinical groups have been reported as between 0.6-0.7 (Garfinkel et al., 2015), 0.73 (SD 0.13) (Pratt, 2011), and 0.69 (SD 19.78) (Shah et al., 2016).

4.2.2 Interoceptive State Prediction Error (ISPE)

The ISPE was defined operationally as the difference between objective interoceptive accuracy on the HBDT, and subjective interoceptive awareness in the form of confidence ratings given during the task. At the end of each interval, participants were asked to mark a cross on a paper version of a visual analogue scale of 10cm to indicate their confidence in accurately detecting their heartbeat (see Appendix F). The scale ranged from 'total guess' (0cm), indicating no heartbeat awareness, and 'complete confidence' (10cm), indicating full perception of heart beat (Garfinkel et al., 2015). Scores were averaged over six trials for each participant to give an overall mean confidence rating. These scores were converted into z-scores using the formula:

$$Z = \frac{x - \mu}{\sigma}$$ Interoceptive error scores were calculated for each participant as the average difference between total counted and recorded scores across all six intervals on the heartbeat detection task. The same formula was used to standardise interoceptive error z-scores (described above). In order to enable direct comparison to the confidence z-scores, the error scores were defined operationally as accuracy scores, i.e. the lower the error, the higher the accuracy. Therefore, these were inverted to calculate accuracy.

The z-scores of interoceptive accuracy were subtracted from the standardised confidence scores, resulting in ISPE scores, demonstrating the discrepancy between subjective belief about accuracy (confidence), and actual accuracy scores. A negative number indicates under confidence compared to actual accuracy performance, whereas a positive score shows overconfidence compared to actual performance, as in Garfinkel et al. (2015). Scores closest to zero indicate least error between assumed and actual accuracy performance. Additionally, a further calculation made all ISPE scores positive, so that general error could be investigated without accounting for valence of under- or overconfidence. All scores therefore were above zero, with lower scores indicating less error.

4.3 Questionnaire measures

4.3.1 Scale of Bodily Connection (SBC) (Price & Thompson, 2007)

The SBC (see Appendix G) is a 20-item questionnaire, which measures trait interoceptive sensibility (Farb et al., 2015). It consists of two sub-scales, assessing body awareness (BA) and body dissociation (BD). For example, "If there is tension in my body, I am aware of the tension" looking at body awareness, and "My body feels frozen, as though numb, during uncomfortable situations" indicating body dissociation. Items are scored on a 5-point scale, ranging from 0, "not at all", to 4, "all of the time." The two subscales are uncorrelated, and outcomes are calculated by averaging the scores on each to give a score of 0-4, with higher BA scores indicating higher bodily awareness, and higher BD scores indicating high bodily dissociation. Mean scores in a non-clinical population have been reported as 3.36 (SD 0.66) for BA and 2.07 (SD 0.63) for BD (Price & Thompson, 2007). Internal consistency of the items in the current sample was calculated for BA (α=.82) and BD (α=.52). This questionnaire was administered immediately following the initial demographic data measurements and prior to the HBDT, to prevent any influence of the task. All subsequent questionnaires were administered following the HBDT. In selecting this measure for the current study, various subscales of the Porges' Body Perception questionnaire (Porges, 1993) were also considered, but the SBC was favoured for a number of reasons. The Porges' questionnaire was considered to have less face validity in representing interoception, given that the many items refer to exteroceptive experiences rather than interoceptive, such as noticing watering eyes and hearing digestive noises. The SBC was considered to be more relevant to interoception in more general emotional experiences rather than being limited to stress (anxiety) only and is shorter, therefore bearing less participant load.

4.3.2 Generalized Anxiety Disorder-7 item scale (GAD-7) (Spitzer, Kroenke, Williams, & Lowe, 2006).

The GAD-7 is a 7-item questionnaire, which measures current anxiety symptoms (see Appendix K). Participants rate the extent to which they have been "bothered by" 7 common anxiety symptoms over the preceding 2 weeks, for example, "feeling nervous, anxious or on edge", or "becoming easily annoyed or irritable". Answers range on a 4-point frequency scale, from 0 (not at all) to 3 (nearly every day), and total scores range from 0 to 21. Severity of anxiety is indicated by 0-5 (minimal/non-clinical), 6-10 (mild), 11-15 (moderate) and 16-21 (severe) (Kroenke et al., 2010). The GAD-7 is a well-validated and efficient tool for assessing generalized anxiety (Kroenke et al., 2010; Spitzer et al., 2006), and has been adopted by the Improving Access to Psychological Therapies (IAPT) initiative in services nationwide. Internal consistency of the items in the current sample was calculated (α=.83). It was important to capture participants' anxiety levels to enable categorisation of the sample (e.g., as being "non-clinical").

4.3.3 Patient Health Questionnaire-9 item scale (PHQ-9) (Kroenke, Spitzer, & Williams, 2001)

The PHQ-9 is a 9-item questionnaire measuring current symptoms of low mood and depression (see Appendix K). Participants rate the extent to which they are bothered by 9 common depressive symptoms over the preceding 2 weeks, including "little interest or pleasure in doing things" and "feeling down, depressed or hopeless". Answers range on a 4-point scale indicating frequency, from 0 (not at all) to 3 (nearly every day), and total scores ranging from 0 to 27. Severity of depressive symptoms is indicated by 0-5 (minimal/non-clinical), 6-10 (mild), 11-15 (moderate) and 16-27 (severe) (Kroenke et al., 2010). The PHQ-9 is a well-validated and efficient tool for assessing depression (Kroenke et al., 2010), and has also been adopted by the Improving Access to Psychological Therapies (IAPT) initiative in services nationwide alongside the GAD-7 for anxiety. Internal consistency of the items in the current sample was calculated (α=.74). As with the GAD-7 above, it was essential to capture participants' depression levels to accurately enable categorisation of the sample's psychological wellbeing generally.

4.3.4 Acceptance and Action Questionnaire – II (AAQ-II) (Bond et al., 2011)

The AAQ-II is a 7-item questionnaire which measures psychological flexibility inclusive of experiential avoidance (see Appendix H) with good reliability and validity: the mean Cronbach's α coefficient is .84 (.78–.88), and 3- and 12-month test–retest reliability is 0.81 and 0.79, respectively (Bond et al., 2011). Participants are asked to rate how true each of 7 statements are for them on a 7-

point scale from 1 (never true) to 7 (always true), for example, "my painful experiences and memories make it difficult for me to live a life that I would value" and "I'm afraid of my feelings". Higher scores indicate lower levels of psychological flexibility, and previous research has indicated a significant correlation between higher scores on the AAQ-II and psychological distress, thought suppression and work absences. Mean scores in a non-clinical population have been reported as 18.51 (SD 7.05), and 28.3 (SD) in a clinical population of substance misusers, whilst scores of > 24-28 suggest a current clinical level of distress (Bond et al., 2011). Internal consistency of the items in the current sample was calculated (α=.88). Several widely-used ACT-focussed measures are specific to treatment of a particular clinical presentation (e.g. chronic pain), and thus not appropriate for the current sample. The Comprehensive assessment of ACT processes (CompACT; Francis, Dawson, & Golijani-Moghaddam, 2016) was considered as an alternative to the AAQ-II. Whilst this would be a useful alternative measure and certainly an option for replication of the current study, the AAQ-II remains the most widely used, gold standard of psychological flexibility assessment at the current time. This allows greater opportunity for comparison with existing research.

4.3.5 Toronto Alexithymia Scale-20 (TAS-20) (Difficulty Identifying Feelings and Difficulty Describing Emotions subscales) (Taylor, Bagby, & Luminet, 2000)

The TAS-20 measures three aspects of emotion recognition: Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking (EOT). The DIF and DDF sub-scales (see Appendix I) were administered but the EOT was excluded because it has shown poor psychometric properties in previous studies (Brown et al., 2013; Haviland, 1996). This also reduced the participant burden, as the questionnaire involved just 12 items. Participants are asked to indicate the extent to which they agree with a statement on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree), for example, "I am often confused about what emotion I am feeling", "I have feelings that I can't quite identify" (DIF), and "it is difficult for me to find the right words for my feelings", "people tell me to describe my feelings more" (DDF). One item is reverse scored, and summing scores results in a score from 5 to 35 for DIF and 5 to 25 for DDF, where higher scores indicate higher difficulty. Mean scores in a non-clinical population have been reported as 14.38 (SD 5.21) for DIF and 12.50 (SD 4.20) for DDF (Parker, Taylor & Bagby, 2003). In order to form one score for DIDF, the scores were then combined as in Landstra et al. (2013), where Cronbach's alpha for the 12-item DIDF scale was reported $\alpha = 0.88$. Internal consistency of DIDF scales in the current sample was calculated (α=.68).

4.3.6 Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003)

The ERQ is a 10-item questionnaire, which records the extent to which people use two types of strategies to regulate their emotions: Cognitive Reappraisal and Expressive Suppression (see Appendix J). Participants are asked to indicate the extent to which they engage with each of the regulation strategies by responding to 10 statements on a 7-point scale from 1 (strongly disagree) to 5 (strongly agree), for example, "When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*" (reappraisal), and "I control my emotions by *not expressing them*" (suppression). Calculating mean item scores for each subscale results in overall scores for reappraisal and suppression, with higher scores indicating greater use of the strategy. Males are likely to engage in suppression more than females: mean cognitive suppression scores in a non-clinical population were 3.64 (SD 1.11) for men and 3.14 (SD 1.18) for women. Males and females score similarly for reappraisal, with a mean of 4.60 (SD 0.94) for men and 4.61 (SD 1.02) for women (Gross & John, 2003). Internal consistency of the items in the current sample was calculated for reappraisal (α=.80) and suppression (α=.74).

5. Procedure

Participants were allocated a one-hour testing slot in the Senses Laboratory within the School of Psychology, UoL. The lab is a small, quiet ground floor room, to allow participants to focus on the task. They were then asked to read the information sheet (see Appendix E) and consent form (see Appendix D), and had an opportunity to ask the researcher any questions before committing to participate. After signing the consent form, participants' height and weight was measured, and their gender and date of birth recorded by the researcher. They were then asked to complete the interoceptive sensibility questionnaire (SBC). They then completed the heartbeat detection task (described above), with output from the ECG recorded via the BIOPAC program onto the lab desktop computer with the monitor facing away from participants. Participants rated their confidence at the end of each trial on a 10cm visual analogue scale. They then completed paper questionnaires related to mood (GAD-7, PHQ-9), labelling and regulation of emotion (TAS-20, ERQ), and an assessment of their psychological flexibility (AAQ-II). Individual responses were recorded onto the Excel data spreadsheet on the lab computer by the researcher. Finally, participants were debriefed on the purpose of the study, and thanked for their participation.

6. Data Analysis

Data is presented quantitatively in format, and after anonymisation, analysed using Statistical Package for Social Sciences (SPSS) version 21 on a university desktop. It was tested for

assumptions of normality using Kolmogorov-Smirnov tests to determine whether parametric or non-parametric tests are most appropriate. Zero-order correlation-coefficients were calculated and reported in order to present overall observed relationships between focal variables.

One-tailed correlational analysis was carried out between interoceptive accuracy and scores on the AAQ-II, in order to test for a significant positive relationship between interoception and psychological flexibility as predicted by the primary hypothesis. Given the unknown relationships between these variables, two-tailed analysis was considered, but one-tailed was ultimately selected due to the aims in testing the relationships predicted by the psychological flexibility model. Moving onto the secondary hypotheses, further one-tailed correlational analyses were conducted to test for the predicted relationships between psychological flexibility (AAQ-II scores) and ISPE (calculated as described in section 4.2.2), interoceptive sensibility (scores on body awareness and body dissociation scales of the SBC), alexithymia (TAS-20 scores), and both strategies of emotion regulation (ERQ). If significant relationships are shown between all three variables of psychological flexibility, alexithymia and interoception, a mediation analysis will be conducted to investigate whether the relationship between psychological flexibility and interoception is mediated by alexithymia, as predicated by the fourth secondary hypothesis.

RESULTS

1.Descriptive Statistics and Tests of Normality

Prior to analysis, one participant was removed due to having an improbable interoceptive accuracy score, likely due to administration or measurement error. Table 2 shows the whole sample descriptive statistics.

The sample ($N =59$) was checked for parametric assumptions, which indicated non-normal distributions for the following tests: GAD-7, PHQ-9, AAQ-II, TAS-20 DIDF subscales and body dissociation subscale of the SBC, which all yielded significant values on Kolmogorov-Smirnov tests ($p<0.05$). For this non-clinical sample, a negatively skewed distribution was seen due to their function in assessing a large range of subclinical to severe clinical presentation of which our population were at the predominantly subclinical end. Therefore, non-parametric tests were considered most appropriate for analysis.

Table 2: Descriptive statistics for the whole sample on all measures and comparison norms from a different non-clinical population.

	Sample Mean (*SD*) (N=59)	Sample Range	Population Norm Mean* (*SD*)
Age	30.6 (12.8)	18.6-69.5	
BMI (kg/m^2)	22.8 (4.5)	16.3-43.1	
Accuracy Score	0.65 (0.17)	0.37-1.0	0.73 (0.13)
Mean Confidence Rating	4.1 (2.5)	0.0-8.4	
GAD-7	5.9 (4.0)	0-18	0-5 Non-clinical, 6-10 Mild
PHQ-9	4.6 (3.3)	0-15	0-5 Non-clinical
AAQ-II	17.2 (7.0)	7-40	18.51 (7.05)
ERQ Reappraisal	5.1 (0.9)	2.7-7.0	Male =4.60 (0.94) Female =4.61 (1.02)
ERQ Suppression	3.1 (1.2)	1.0-5.8	Male =3.64 (1.11) Female =3.14 (1.18)
TAS DIF	13.2 (3.9)	7-24	14.38 (5.21)
TAS DDF	10.8 (6.1)	5-47	12.5 (4.20)
SBC Body awareness	2.5 (0.6)	0.9-3.6	3.36 (0.66)
SBC Body dissociation	0.9 (0.5)	0.1-3.6	2.07 (0.63)

* NB 'Population Norms' shown in final column have been taken from other papers as detailed under measures used, in the section 4 of the methods chapter.

Table 3: Spearman's Rho correlation-coefficient matrix for all focal variables.

	Accuracy Score	GAD-7	PHQ-9	AAQ-II	ERQ Reappraisal	ERQ Suppression	TAS DIDF	SBC Body awareness	SBC Body dissociation
Accuracy Score	-	0.119	0.106	-0.178	0.167	0.096	-.001	0.054	0.117
GAD-7	0.119	-	0.558**	0.511**	-0.059	0.186	0.514**	0.076	0.337**
PHQ-9	0.106	0.558**	-	0.477**	-0.089	0.339**	0.364**	0.055	0.369**
AAQ-II	-0.178	0.511**	0.477**	-	-0.309**	0.238*	0.434**	-0.022	0.305**
ERQ Reappraisal	0.167	-0.059	-0.089	-0.309**	-	0.134	-0.005	0.323**	0.157
ERQ Suppression	0.096	0.186	0.339**	0.238*	0.134	-	0.372**	0.006	0.255*
TAS DIDF	-.001	0.514**	0.364**	0.434**	-0.005	0.372**	-	-0.061	0.381**
SBC Body awareness	0.054	0.076	0.055	-0.022	0.323**	0.006	-0.061	-	0.271*
SBC Body dissociation	0.117	0.337**	0.369**	0.305**	0.157	0.255*	0.381**	0.271*	-

*Denotes correlation is significant at the $p < 0.05$ level, **denotes correlation is significant at the $p < 0.01$ level.*

2. Primary Hypothesis: Interoceptive Accuracy

Spearman's Rho correlation analysis revealed no significant relationship between interoceptive accuracy and AAQ-II scores (rho = -0.178, p=0.089). There was a weak negative correlation between the two variables. As lower AAQ-II scores represent higher psychological flexibility, this indicated that as psychological flexibility increased, interoceptive accuracy became better, but this was not a significant effect. Therefore, the primary hypothesis was rejected.

3. Secondary Hypotheses

3.1 Interoceptive State Prediction Error (adapted from Garfinkel et al., 2015).

Interoceptive state prediction error (ISPE) was calculated as defined in section 4.2.2 of the methods chapter. A similar metric was used as that of Garfinkel et al.'s (2015) calculation of Interoceptive Trait Prediction Error (ITPE). ISPE ranged from negative scores, indicating under-confidence in beliefs about performance during the heartbeat detection task compared to actual accuracy scores, and positive, representing over confidence compared to actual accuracy. The secondary hypothesis stated that individuals higher in psychological flexibility would show lower ISPE. Spearman's rho was used to analyse the relationship between ISPE and psychological flexibility (AAQ-II), which revealed no significant correlation (rho = 0.145, p=0.137).

Secondly, the ISPE scores were made positive, in order to represent overall error from zero upwards, i.e., the total error whether over or under-confident. There was no correlation between ISPE and psychological flexibility (AAQ-II) (rho = -0.068, p=0.306). Therefore, the secondary hypothesis was rejected: no relationship was found between interoceptive state prediction error and psychological flexibility.

3.2 Interoceptive Sensibility

There was no significant relationship between Body Awareness (BA) and psychological flexibility (rho = -0.022, p=0.435). However, the Body Dissociation (BD) score was significantly positively correlated with scores on the AAQ-II (rho = 0.305, p=0.009), indicating that body dissociation increases as psychological flexibility decreases. Therefore, the third hypothesis that individuals lower in psychological flexibility would score lower on BA and higher on BD subscales was partially supported.

3.3 Alexithymia

In order to test the hypothesis that the relationship between psychological flexibility and interoception was mediated by alexithymia, a correlation analysis was first carried out to explore the relationship between psychological flexibility, interoceptive accuracy and alexithymia (DIDF). A significant positive relationship was found between alexithymia and AAQ-II scores (rho = 0.434, $p<0.001$). This indicated that as psychological flexibility increased, difficulties in identifying and describing feelings reduced.

However, there was no significant relationship between alexithymia and interoceptive accuracy (rho = -0.001, $p=0.498$) in addition to the non-significant correlation between psychological flexibility and interoceptive accuracy, as stated above. Therefore, alexithymia did not mediate the relationship between psychological flexibility and interoceptive accuracy, and the fourth hypothesis was rejected.

3.4 Emotion Regulation: Expressive Suppression

There was a significant positive relationship revealed between the suppression subscale of the ERQ and scores on the AAQ-II (rho = 0.238, $p=0.035$). This indicated that those higher in psychological flexibility scored lower in expressive suppression, supporting the fifth hypothesis.

3.5 Emotion Regulation: Cognitive Reappraisal

A significant negative relationship was shown between the reappraisal subscale of the ERQ and AAQ-II scores (rho = -0.309, $p=0.009$). Therefore, individuals higher in psychological flexibility scored higher in cognitive reappraisal, and the sixth hypothesis was accepted.

DISCUSSION

The following chapter summarises the research project, and presents the results in relation to the hypotheses outlined in the introductory chapter. Strengths, limitations and possible areas of future replication and research are outlined and findings are discussed in the context of previous research.

1. Discussion of Main Findings

The aim of the current research was to explore the relationship between psychological flexibility and the detection and regulation of emotion in a non-clinical sample in order to test the model underlying ACT. The model suggests that a vital component of psychological flexibility is the ability to maintain "conscious and open contact with thoughts and feelings" (McCracken & Morley, 2014, p. 225). Therefore, the current aim was to test this theory using an objective measurement of interoceptive accuracy. Further aims included understanding the relationships between interoception and psychological flexibility with other processes involved in emotion, such as alexithymia, and strategies in regulating emotion.

Correlation analysis revealed no significant relationship between interoceptive accuracy and scores on the AAQ-II, and the primary hypothesis was therefore rejected. This finding does not provide support for the underlying premise of the psychological flexibility model, which emphasises the importance of the connection to the body in being open and accepting of experiences including emotions, and mindful of one's responses including those within the body (Harris, 2009; Hayes et al., 2006). However, though non-significant, there was a trend towards a correlation in the direction predicted in that, as psychological flexibility increased, interoceptive accuracy improved. There are a number of considerations to be made in interpreting this null finding.

Interoception is difficult to operationalise for the purposes of research. Whilst cardiac perception has been the most frequently used methodology and is advantageous in lending itself to objective measurability and subjective perception, it is not without criticism (Desmedt, Luminet, & Corneille, 2018). Findings on the relationship between heartbeat detection and psychological wellbeing have been mixed, perhaps suggesting that improved ability to detect heart rate accurately can relate differentially to emotional experience and is not intrinsically good or bad. The current study used a well validated method of cardiac perception (Ainley et al., 2012; Garfinkel et al., 2015). The task procedure dictated that participants were relaxed and comfortable in order to count heartbeats at their resting rate as

the method dictates. However, in the context of measuring psychological flexibility and the workability aspect of this trait, it may have been more relevant to assess interoceptive accuracy at a point at which it would be functionally useful to notice one's internal emotional state, for example, when anxious. It may be that someone high in psychological flexibility becomes more aware of and connected to internal bodily changes such as heart rate only when there is a salient emotional event to be noticed, depending on the context they find themselves in. This explanation could fit with the contradicting evidence presented in the literature thus far (see section 2.2.2.2 of the introductory chapter), and highlights the unique ethical and methodological challenges to further research into this aspect of the model. However, it may offer a possible ACT-consistent explanation for the null finding within the current design.

Furthermore, a recently published paper investigating the validity of the heartbeat detection task has invited caution when using the task to draw conclusions about interoceptive accuracy (Desmedt, Luminet, & Corneille, 2018). The authors found that accuracy greatly reduced when the task was repeated in an adapted way by asking participants to only report those heartbeats that they definitely experienced interoceptively, rather than using non-interoceptive cues, e.g. estimation of resting heart rate. They argued that even this second method is not reliable in terms of interoceptive accuracy, due to potentially confounding individual differences in decision thresholds for reporting detected heartbeats. Therefore, despite the advantages of conducting objective interoceptive accuracy assessment over questionnaire measures (Ainley et al., 2012; Garfinkel et al., 2015; Schandry, 1981), the present study used only one method examining interoception - cardiac detection - that could, like the AAQ-II as a measure of psychological flexibility, be criticised regarding its validity. Recent developments have been made in assessment of other interoceptive domains of ability and dimensions of measurement, such as taste sensitivity, muscular effort and respiratory output (Murphy et al., 2017). This presents exciting opportunities for further exploration of the relationship between psychological flexibility and multi-domain interoception.

In addition, there is evidence to suggest that knowledge and beliefs about heart rate can impact on cardiac interoceptive accuracy (Ring, Brener, Knapp, & Mailloux, 2015). For this reason, there was no feedback given to participants throughout the study about their actual heart rate or their accuracy in counting to limit the opportunity for self-correction. There were six intervals of various time periods presented in a randomised order, and the participants

were not given any indication of how long each interval lasted to minimise the possibility of guessing the number of expected heartbeats within the time allotted. However, there was no way to control for participants' pre-existing knowledge and beliefs about heart rate, which may be a potential unmeasured confound. Individuals who track their heart rate, e.g., whilst exercising, may have performed differently to those who had no prior knowledge. In future research using the heartbeat detection task it would be recommended for this to be controlled for. One suggestion to minimise this would be by incorporating an assessment of a different domain of interoception, such as taste, muscular exertion, or respiratory awareness (Murphy, Catmur, & Bird, 2018).

Furthermore, the measurement of psychological flexibility presents certain challenges to research design. Despite the popularity and usability of the AAQ-II in a large body of research as well as in clinical settings, there are obvious limitations to using a self-report measure, particularly to assess a relatively esoteric and contextual trait as psychological flexibility. The nature of reporting one's own flexibility (or lack thereof) in itself requires a level of self-awareness, and any self-report measure is subject to personal bias. That is, one must be aware of the relationship they are having with thoughts and feelings, and fully understand the impact that this is having in their lives, in order accurately to assess that this is a problem for them. The questionnaire necessitates a level of insight into problems that someone low in psychological flexibility would be assumed not to have. Issues of construct validity have also been raised with the AAQ-II in terms of the overlap with the measurement of psychological wellbeing (Wolgast, 2014), and the authors concluded that a primary problem of attempting to measure psychological flexibility is in capturing "a dynamic and shifting psychological process with a static and global self-report measure" (p. 838).

2. Discussion of Secondary Findings

Interoceptive state prediction error was calculated in a way similar to the method designed by Garfinkel et al. (2015), who developed an interoceptive trait predictive error as a trait (rather than state) measure of interoceptive sensibility. The authors presented only the error values ranging from negative values (indicating under-estimation by the participant of their objective accuracy) to positive values (an over-estimation of accuracy). Although this was replicated in the current study, using a state measure of confidence relating to the specific task itself, there was no significant relationship of this measure with psychological flexibility. Arguably, the more valid operational definition of prediction error was determined as absolute error, where the negative scores are inverted to give a measure of prediction error

without the scale of under or over-confidence. Again, there was no significant relationship between psychological flexibility and absolute interoceptive state prediction error, indicating that error may not be an important factor in psychological flexibility as measured by the AAQ-II. However, again this may be interpreted with caution due to the limited range of the non-clinical sample and methodological considerations aforementioned. It may be that for those with larger prediction error, or across a larger, more diverse sample, an effect might have emerged.

Trait interoceptive sensibility was assessed using the Scale of Bodily Connection. Whilst body awareness was not significantly correlated with psychological flexibility, body dissociation was significantly positively correlated with AAQ-II scores, indicating that as psychological flexibility improves, body dissociation decreases. The body awareness subscale was designed to assess sensory awareness, the capacity to identify and experience bodily states and sensations (Price & Thompson, 2007). Given the overlap between the concepts of body awareness and psychological flexibility, the null finding is interesting. Mean scores on both body awareness and body dissociation subscales in this sample were notably different to those previously reported, even in a non-clinical population (Price & Thompson, 2007). The sample presents as being lower in body awareness and lower in body dissociation than comparable populations. Anecdotally, comments and questions from the participants during the process of completing this questionnaire indicated that there may have been some confusion about the meaning of the items. Reflecting back on the items of the body awareness scale, whilst the Cronbach's alpha coefficient demonstrated good internal consistency, some of the items may assess constructs slightly adrift of pure internal bodily awareness. Some items may be seen as referring to more external bodily sensation (exteroception), for example, "I am aware of internal sensation during sexual activity", or to the way in which one responds to or regulates emotion; "I distract myself from feelings of physical discomfort" rather than one's subjective beliefs about interoceptive ability (sensibility). This result is consistent with that found between AAQ-II scores and objective interoceptive accuracy, and as such the aforementioned difficulties with the AAQ-II may have also contributed to the null finding, in not adequately touching upon those aspects of psychological flexibility pertaining to bodily awareness (Wolgast, 2014).

The body dissociation subscale is concerned with assessing the process by which internal bodily experiences are blocked and avoided, as well as the functional separation of mind from body, particularly with regard to painful or traumatic experiences (Price & Thompson,

2007). Improved psychological flexibility has previously been shown to reduce expressive suppression and dissociative symptoms of post-traumatic stress disorder (Dick, Niles, Street, DiMartino & Mitchell, 2014). Whilst this finding is supportive of previous research, it might be that this questionnaire focussed more on the overall concept of dissociation than avoidance within the body specifically, assessing something slightly different from the intended concept of interoceptive sensibility. As discussed, Wolgast (2014) suggests that the AAQ-II largely measures distress, and it could be argued that the body dissociation scale of the SoBC also measures a kind of embodied distress. Therefore, the significant correlation may be simply the result of both tapping into a latent distress process. In addition to this, the Cronbach's alpha coefficient for the body dissociation scale indicated that internal consistency of the items was relatively low, suggesting a lack of correlation between variables and a lack of clarity around the construct being measured. These findings should therefore be interpreted with caution.

Landstra et al., (2013) found that both alexithymia and psychological flexibility, which were significantly negatively correlated, were reliable predictors of depression, anxiety, stress and health related quality of life. The current study replicated the finding that psychological flexibility was negatively associated with difficulties identifying and describing feelings. This finding suggests overlap between these two constructs. For example, both appear to involve awareness of emotion. However, in contrast to previous studies (Murphy et al., 2017; Murphy, Catmur & Bird, 2018; Shah et al., 2016), there was no significant relationship between alexithymia and interoceptive accuracy. There may be several methodological and theoretical reasons for this finding, part of which has already been touched upon in terms of the limitations of the heartbeat detection task as a means for assessing interoception. In addition, the current sample was a non-clinical group, scoring lower on the difficulty identifying and describing feelings subscales than even the non-clinical population norms previously presented (Bond et al., 2011). Therefore, it would be reasonable to conclude that the present sample were relatively low in alexithymia and not representative of a large range of scores. It might be that this connection to interoceptive accuracy only becomes apparent for more clinical levels of alexithymia.

In support of hypotheses four and five, both emotion regulation strategies were significantly correlated with psychological flexibility in the predicted directions. Firstly, those higher in psychological flexibility scored lower on the expression suppression subscale of the ERQ, indicating that they tended away from suppressing the expression of their

emotion. This is supportive of the psychological flexibility model underlying ACT, which advocates for the open experience of emotion (Harris, 2009). According to the model, it is important for one to be openly aware and accepting of emotional experiences in order to live in a values-consistent way, responding flexibly according to context (Hayes et al., 2006). It therefore follows that in order to do this, it would necessitate a willingness to express rather than suppress emotions in the way described on the subscale, either privately or otherwise.

Those scoring higher in psychological flexibility on the AAQ-II also scored higher on the cognitive reappraisal subscale of the ERQ. Reappraisal as a skill draws on some aspects of psychological flexibility, in that one must first notice thoughts as thoughts before choosing whether to reframe them, for example, as more positive. Therefore, the model would predict that higher psychological flexibility would improve one's ability to step back, notice and potentially choose to flexibly reappraise a thought or belief. In contrast to more traditional CBT, where one could argue that the idea of cognitive restructuring often involves re-evaluating the content of thoughts to better align cognition with an external 'truth' or reality, ACT encourages metacognitive skills such as reappraising the utility of engaging with a thought; "does engaging with this particular thought move me towards or away from my values?" The ERQ cognitive reappraisal subscale includes both of these elements in a way that is difficult to tease out individually, for example in the statements "when I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm", and "when I want to feel more *positive* emotion, I *change the way I'm thinking* about the situation". However, the strategy requires cognitive defusion as a starting point, and therefore the relationship with psychological flexibility was as predicted.

3. Additional Limitations and Recommendations for Future Research

As discussed, there are limitations to the current design and as such caution is advised in the interpretation of the current findings. A number of the measures in the current study were trait self-report questionnaires, which as described earlier are limited in capacity to assess constructs which are experiential and contextual in nature, and reliant upon awareness. There is scope for further research using alternate and emerging measures of psychological flexibility and interoception outside of cardiac perception, including a psychological flexibility measure focussing on awareness.

There are also some limitations to be considered about the sample in this study. Although the sample included mixed gender, it was predominantly female. This is important because

gender differences have been acknowledged in some aspects of emotion processing. For example, in emotion regulation, different norms are presented for males than females for both clinical and non-clinical samples (Price & Thompson, 2011). There are also observed neurological sex differences in emotion processing (Hamann & Canli, 2004; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008; Wrase et al., 2003). Therefore the current sample might be considered somewhat heterogenous in an important sense. There may have been important unmeasured confounding variables in the sample, such as level of education, socioeconomic background, cultural differences, etc.

The sample was also limited to a non-clinical population. This is a valid choice in terms of the psychological flexibility model, which considers that psychological processes are common to all, rather than discrete categories of 'psychopathological' or 'healthy', individuals are on a continuum that changes with one's situation. Nonetheless, it may be that there was not sufficient variability across the measures such as alexithymia, etc., to show significant relationships, particularly where effect sizes are small. Therefore, replication on a broader population and with clinical groups is suggested.

The ACT approach to regulation of emotion is to advocate the flexible use of strategies which work well for the individual in practice, rather than to be directive on what is objectively considered 'bad' or 'good' (Hayes et al., 2006). Therefore, within the model, it is not so much that reappraisal or suppression as a strategy is inflexible in itself, rather that the inflexible use of any response would be observed to be unhelpful. For example, if an individual was suddenly to find herself hit by a wave of emotion, such as grief, in a socially precarious situation such as in a professional meeting, it might be most helpful for her to suppress such feelings until such a point that she feels psychologically safe to express and explore them. However, if she continued to suppress these feelings regardless of the context and refuse to accept or experience them (i.e., experiential avoidance), it would be expected that this might start to cause her more distress and difficulty in the long term. Indeed, this finding perhaps highlights a difficulty in assessing the psychological flexibility model using observational designs. The inflexible overuse of one particular strategy in all or most situations, regardless of its workability, goes against the idea of psychological flexibility. A more psychologically flexible approach would involve thinking about responding to the context in a way which serves one's values (Hayes et al., 2006). Therefore, as with psychological flexibility itself, it is difficult to assess this esoteric concept accurately, as the

model is more concerned not so much with emotion regulation strategies themselves, but the flexibility with which they are applied.

ACT emphasises the power of experience and embodiment within the therapy room, moving away from the intellectualising cognitive approaches of traditional CBT (Hayes et al., 2006). Whilst the current findings were not significant, the relationship between interoception and psychological flexibility followed the direction predicted, and there are a number of possibilities discussed here as to why the current method may not have revealed a significant correlation supportive of the underlying model. Perhaps the clearest way of improving interoceptive accuracy may be via mindfulness techniques, although there has previously been a mixed picture of the efficacy in mindfulness alone for increasing objective interoceptive accuracy. Parkin et al (2014) showed that an intensive experiential mindfulness course (either an 8 week Mindfulness Based Cognitive Therapy or Mindfulness Based Stress Reduction course), whilst not showing an objective improvement, significantly increased confidence in cardiac perception. Hanley, Mehling and Garland (2017) presented evidence of the correlation between interoceptive awareness and dispositional mindfulness, although used only self-report measures. Whilst the evidence shows that a mindfulness intervention alone might struggle to improve objective interoceptive accuracy, further research is needed to determine whether a more comprehensive ACT intervention, with its goal in increasing psychological flexibility, could improve interoceptive ability. In this sense, mindfulness alone could be considered a relatively narrow approach, but a more multifaceted ACT approach, inclusive of all aspects of psychological flexibility, may reveal whether there is a relationship with interoception at all, and if so, whether it is accuracy that is important or some other component, such as confidence. This would offer a useful test of the hypothesised link between interoception and psychological flexibility.

4. Non-Epileptic Seizures

In terms of non-epileptic seizures, the current study presents findings that would be useful to explore within a clinical sample. One study has demonstrated that experiential avoidance – a key element of psychological flexibility – is correlated with anxiety in NES (DiMarco et al., 2014). Given the substantial evidence for emotional recognition deficits in NES, the question of how interoception may feature in this pathway remains pertinent. Research has shown a high prevalence of alexithymia in NES (Myers et al., 2013) which, based on the current findings, may also correlate with limited psychological flexibility in this

group. Further research on this population is needed to develop an understanding of the key areas of emotion processing difficulties.

5. Conclusion

Although support was shown for the position of the psychological flexibility model towards emotion regulation, the current study did not find evidence to support the primary idea under study: that a crucial part of psychological flexibility involves the ability to accurately notice experiences including in the body (interoception). However, there are clear limitations in the methodology of this novel study and therefore further operationalisation and investigation into these concepts is warranted. Future replications should focus on developing and utilising various means of assessing interoception and psychological flexibility, increasing sample size, and broadening the sample population to include clinical groups such as those experiencing non-epileptic seizures.

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APPENDICES

Appendix A: Ethics Approval Email Screenshot

Dear Ekaterini Klepousniotou,

Re your ethics application, Investigating interoception using the heartbeat detection task in a heathy population , ethics reference number: PSC-259.

I am pleased to inform you that the above research application has been reviewed by the School of Psychology Research Ethics Committee and has been approved.

If the reviewers have left any comments they will appear below.

Primary reviewer comments (if applicable) Jean-Francois Delvenne:

Secondary reviewer comments (if applicable) :

Please note that this approval only relates to the particular version of documentation supplied in this specific application (ethics ref no: PSC-259).

If you wish to make any amendments to the approved documentation, please note that all changes require ethical approval prior to implementation.

Please note: You are expected to keep a record of all your approved documentation, as well as documents such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes.

You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

Yours sincerely,

School of Psychology Research Ethics Committee

Appendix B: Recruitment Email to Participant Pool

Appendix C: Recruitment Poster

UNIVERSITY OF LEEDS

Volunteers wanted for a study investigating emotional processing and heart beat perception

The experiment will take place in LG.28, in the School of Psychology at the University of Leeds and total participation time is approximately 1 hour. Undergraduate psychology students can receive 4 credits for taking part, and staff members or students will be offered a £5 Love2Shop voucher.

For more information or to request a participant information sheet please contact Charlotte Gaukroger (researcher): ps08cg@leeds.ac.uk
The supervisor of this research is Dr Donna Lloyd: d.m.lloyd@leeds.ac.uk; tel: 0113 343 7247

This study was given a favourable ethical opinion for conduct by SoPREC (ref no: XXXX; date approved: XXXX) and is led by The University of Leeds.

Poster v1 25/11/16

Appendix D: Consent Form

UNIVERSITY OF LEEDS

Consent to take part in 'Investigating interoception using a heartbeat detection task in a healthy population'

	Initial here if you agree to the statement to the left
I confirm that I have read and understand the participant information sheet (ref no: 16-0361; date approved: 08-Dec-2016) explaining the above research project and I have had the opportunity to ask questions about the project.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. Data that has already been provided can be removed following withdrawal from the study by contacting the lead researcher Charlotte Gaukroger (ps08cg@leeds.ac.uk) up until 15 days after I have taken part in the study.	
I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research. I understand that my responses will be kept strictly confidential.	
I agree for the data collected from me to be used in relevant future research in an anonymised form.	
I confirm that I do not have any skin allergies likely to be irritated by the electrodes (e.g., contact dermatitis, eczema).	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	
Name of participant:	
Participant's signature:	
Date:	
Name of Researcher:	
Researcher's signature:	
Date*:	

*To be signed and dated in the presence of the participant. Once this has been signed by all parties the participant should receive a copy of the information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be kept with the project's main documents which must be kept in a secure location.

Appendix E: Participant Information Sheet

Participant Information Sheet

Investigating interoception using a heartbeat detection task in a healthy population.

You are being invited to take part in a research study. Before you decide whether or not you want to take part it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish or ask the lead researcher (Charlotte Gaukroger) if there is anything that is not clear and you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?
The purpose of this study is to investigate what relationship there is between an individual's ability to notice what is happening in their body (i.e., their heart beating), and the way they process and cope with their emotions. To do this, we are asking healthy volunteers to undertake a heartbeat perception task and fill out 6 questionnaires, relating to mood, emotional processing and coping (please see further details below).

The experiment will take approximately 1 hour to complete in total. Undergraduate psychology students can receive 4 credits for taking part, and non-undergraduate students and staff will receive a £5 love2shop voucher as recompense for your time.

Why have I been chosen?
You have been asked to participate in this study because you are healthy with no skin allergies, no diagnosis of a neurological condition which may affect emotional processing, interoception or understanding (e.g. epilepsy, a dementia) and no diagnosis of an illness that may cause peripheral neuropathy (e.g. multiple sclerosis, diabetes).

Do I have to take part?
Taking part in this research is entirely voluntary. It is up to you to decide whether or not to take part. If you do, you will be given this information sheet to keep and be asked to sign a consent form (which you will be given a copy of to keep). If you decide to take part and then change your mind, you can do so without giving a reason. Even if you take part in the experiment, and later decide that you do not want us to analyse your data, you can let us know within 15 days from participating in the study and we will remove it from the study.

What will happen to me if I take part and what do I have to do?
If you decide to take part you will be asked to come to room LG.28 in the School of Psychology for one testing session. After signing the consent form and confirming that you have no skin allergies or diagnoses as mentioned above, the researcher will measure your height and weight in order to generate BMI (body mass index). This is because BMI has been shown to be associated with interoception. You will then be asked to place a recording electrode on your right wrist and the ankles of your right and left feet in order to record your heart rate. We will then ask you to count how

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many times you can detect your heart beat within a set time period of less than a minute each time, giving you feedback after each trial on how you are doing. After this, we will ask you how confident you felt that you were able to count your heart beating accurately.

Finally, we will ask you to complete 6 questionnaires:

1. Generalized Anxiety Disorder-7 item scale (GAD-7) – this asks about 7 common anxiety symptoms
2. Patient Health Questionnaire-9 item scale (PHQ-9) – this asks about 9 common symptoms of low mood
3. Toronto Alexithymia Scale-20 (TAS-20) (Difficulty Identifying Feelings and Difficulty Describing Emotions subscales) – 12 items will look at your ability to name and describe emotions
4. Emotion Regulation Questionnaire (ERQ) – this has 10 items and asks about the ways you regulate your emotions
5. Acceptance and Action Questionnaire – II (AAQ-II) – this has 7 items, and looks at how you manage your emotions
6. Scale of Bodily Connection (SBC) – this asks about your bodily awareness.

We will then debrief you about the experiment and answer any questions you might have about the process. The experiment will take no longer than 1 hour including consent taking and debriefing.

What are the possible disadvantages and risks of taking part?
There are no disadvantages or risks from taking part in this study. The electrodes have been used several times before in similar research but you must state in the consent form that you do not have a skin allergy (such as contact dermatitis or eczema) before we can apply them. The questionnaires being used in the study are used frequently in clinical and research settings, and some of the questions ask about potentially sensitive topics such as your mood. If you find this upsetting at any point please feel free to discuss this with the experimenter.

What are the possible benefits of taking part?
Whilst there are no immediate benefits for those people participating in the project, it is hoped that that the information we get from studying healthy participants could help us to better understand the relationship between being connected to one's own bodily experiences and emotional processing. You may also find that your own awareness of bodily state and emotional wellbeing is slightly improved.

Will my taking part in this project be kept confidential?
All the information that we collect about you during the course of the research will be kept strictly confidential. When the study is over, the data we get will be analysed by the lead researcher. Your data will be given a Participant Identity Number (PIN), so it will not be possible for anyone to identify your data. Only the lead researcher will have access to your personal information, which will be stored separately from your data. If you would like to receive a summary of the findings, we will be happy to send this to you when it is available. However, we will not be able to give you any specific

information about your own data, as the data of all the participants who take part in the study will be analysed as a group and you will not be able to be identified in any reports or publications.

What will happen to the results of the research project?
The results of this research will be published in peer-reviewed scientific journals, which will be freely available on-line or you can request a copy of the published results from the lead researcher (Charlotte Gaukroger). The data collected during the course of the project might be used for additional or subsequent research; however, you will not be identified in any report or publication.

Who is organising/ funding the research?
This research is being carried out as part of a Doctorate in Clinical Psychology qualification, and as such is funded by the Leeds Teaching Hospitals NHS Trust.

Contact for further information
Thank you for taking the time to read through the information. If you have any questions or would like further information you can contact the lead researchers by e-mail or telephone:
The supervisor of this research is Dr Donna Lloyd: d.m.lloyd@leeds.ac.uk; tel: 0113 343 7247
You may also contact Charlotte Gaukroger (lead researcher): ps08cg@leeds.ac.uk

If you have been affected by the content of the questionnares
Please feel free to discuss this with the researcher, or alternatively the following contacts may be helpful for you:

Samaritans: www.samaritans.org or Freephone 116 123
University staff counselling and psychological support service: staffcounselling@leeds.ac.uk or 0113 343 3694
University student counselling service: scc@leeds.ac.uk or 0113 343 4107

This study was given a favourable ethical opinion for conduct by SoPREC (ref: XXXXX, date approved XX/XX/2015) and is led by The University of Leeds.

Thank you for taking time to read this sheet and for considering taking part in the study.

Appendix F: Interoceptive Confidence Visual Analogue Scale*

*N.B. 10cm line was added by hand and photocopied to ensure consistency.

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

On the line below, please draw a small cross (x) to indicate how confident you felt in counting your heartbeats.

Total Guess
(No heartbeat awareness)

Complete Confidence
(Full perception of heartbeat)

Appendix G: Scale of Bodily Connection (Price & Thompson, 2007)

S B C

Study Number: _____   Date: _____

Instructions:

This questionnaire asks about your body awareness and your response to body awareness.
For each statement please check the box that best answers the way you generally feel.
There are no right answers, please answer as truthfully as you can.
There are two questions about sexual activity, please consider all sexual activity including self-stimulation. If you do not engage in sexual activity, please leave these questions blank.
Please consider the past two months as the time frame for your response.

	Not at all 0	A little bit 1	Some of the time 2	Most of the time 3	All of the time 4
1. If there is tension in my body, I am aware of the tension					
2. It is difficult for me to identify my emotions					
3. I notice that my breathing becomes shallow when I am nervous					
4. I notice my emotional response to caring touch					
5. My body feels frozen, as though numb, during uncomfortable situations					
6. I notice how my body changes when I am angry					
7. I feel like I am looking at my body from outside of my body					
8. I am aware of internal sensation during sexual activity					
9. I can feel my breath travel through my body when I exhale deeply					
10. I feel separated from my body					
11. It is hard for me to express certain emotions					
12. I take cues from my body to help me understand how I feel					
13. When I am physically uncomfortable, I think about what might have caused the discomfort					
14. I listen for information from my body about my emotional state					
15. When I am stressed, I notice the stress in my body					
16. I distract myself from feelings of physical discomfort					
17. When I am tense, I take note of where the tension is located in my body					
18. I notice that my body feels different after a peaceful experience					
19. I feel separated from my body when I am engaged in sexual activity					
20. It is difficult for me to pay attention to my emotions					

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Appendix H: Acceptance and Action Questionnaire II (Bond et al., 2011)

AAQ-II

Below you will find a list of statements. Please rate how true each statement is for you by circling a number next to it. Use the scale below to make your choice.

1	2	3	4	5	6	7
never true	very seldom true	seldom true	sometimes true	frequently true	almost always true	always true

1. My painful experiences and memories make it difficult for me to live a life that I would value.	1　2　3　4　5　6　7
2. I'm afraid of my feelings.	1　2　3　4　5　6　7
3. I worry about not being able to control my worries and feelings.	1　2　3　4　5　6　7
4. My painful memories prevent me from having a fulfilling life.	1　2　3　4　5　6　7
5. Emotions cause problems in my life.	1　2　3　4　5　6　7
6. It seems like most people are handling their lives better than I am.	1　2　3　4　5　6　7
7. Worries get in the way of my success.	1　2　3　4　5　6　7

This is a one-factor measure of psychological inflexibility, or experiential avoidance. Score the scale by summing the seven items. Higher scores equal greater levels of psychological inflexibility.

Bond, F. W., Hayes, S. C., Baer, R. A., Carpenter, K. M., Guenole, N., Orcutt, H. K., Waltz, T., & Zettle, R. D. (in press). Preliminary psychometric properties of the Acceptance and Action Questionnaire – II: A revised measure of psychological inflexibility and experiential avoidance. *Behavior Therapy.*

Appendix I: DIDF Subscales of TAS-20 (Taylor, Bagby, & Luminet, 2000)

Date: ID#:

T A S – 20

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by circling the corresponding number. Give only one answer for each statement.

Circle 1 if you STRONGLY DISAGREE
Circle 2 if you MODERATELY DISAGREE
Circle 3 if you NEITHER DISAGREE NOR AGREE
Circle 4 if you MODERATELY AGREE
Circle 5 if you STRONGLY AGREE

	STRONGLY DISAGREE	MODERATELY DISAGREE	NEITHER DISAGREE NOR AGREE	MODERATELY AGREE	STRONGLY AGREE
1. I am often confused about what emotion I am feeling.	1	2	3	4	5
2.* It is difficult for me to find the right words for my feelings.	1	2	3	4	5
3. I have physical sensations that even doctors don't understand.	1	2	3	4	5
^4.* I am able to describe my feelings easily.	1	2	3	4	5
6. When I am upset, I don't know if I am sad, frightened, or angry.	1	2	3	4	5
7. I am often puzzled by sensations in my body.	1	2	3	4	5
9. I have feelings that I can't quite identify.	1	2	3	4	5
11.* I find it hard to describe how I feel about people.	1	2	3	4	5
12.* People tell me to describe my feelings more.	1	2	3	4	5
13. I don't know what's going on inside me.	1	2	3	4	5
14. I often don't know why I am angry.	1	2	3	4	5
17.* It is difficult for me to reveal my innermost feelings, even to close friends.	1	2	3	4	5

Appendix J: Emotion Regulation Questionnaire (Gross & John, 2003)

Emotion Regulation Questionnaire (ERQ)
Gross & John
9/03

The <u>Emotion Regulation Questionnaire</u> is designed to assess individual differences in the habitual use of two emotion regulation strategies: cognitive reappraisal and expressive suppression.

Citation

Gross, J.J., & John, O.P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. <u>Journal of Personality and Social Psychology, 85</u>, 348-362.

Instructions and Items

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your <u>emotional experience</u>, or what you feel like inside. The other is your <u>emotional expression</u>, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1————2————3————4————5————6————7
strongly   neutral   strongly
<u>disagree</u>   <u>agree</u>

1. ____ When I want to feel more *positive* emotion (such as joy or amusement), I *change what I'm thinking about*.

2. ____ I keep my emotions to myself.

3. ____ When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*.

4. ____ When I am feeling *positive* emotions, I am careful not to express them.

5. ____ When I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm.

6. ____ I control my emotions by *not expressing them*.

7. ____ When I want to feel more *positive* emotion, I *change the way I'm thinking* about the situation.

8. ____ I control my emotions by *changing the way I think* about the situation I'm in.

9. ____ When I am feeling *negative* emotions, I make sure not to express them.

10. ____ When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation.

Note

Do not change item order, as items 1 and 3 at the beginning of the questionnaire define the terms "positive emotion" and "negative emotion".

Scoring (no reversals)

Reappraisal Items: 1, 3, 5, 7, 8, 10; Suppression Items: 2, 4, 6, 9.

Appendix K: PHQ-9 and GAD-7 (Kroenke, Spitzer, & Williams, 2001; (Spitzer et al., 2006)

Participant ID: Date:

GAD-7

Over the last 2 weeks, how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every Day
1 Feeling nervous, anxious or on edge	0	1	2	3
2 NOT being able to stop or control worrying	0	1	2	3
3 Worrying too much about different things	0	1	2	3
4 Trouble relaxing	0	1	2	3
5 Being so restless that it is hard to sit still	0	1	2	3
6 Becoming easily annoyed or irritable	0	1	2	3
7 Feeling afraid as if something awful might happen	0	1	2	3

A12 – GAD7 total score

PHQ-9

Over the last 2 weeks, how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every Day
1 Little interest or pleasure in doing things	0	1	2	3
2 Feeling down, depressed or hopeless	0	1	2	3
3 Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4 Feeling tired or having little energy	0	1	2	3
5 Poor appetite or overeating	0	1	2	3
6 Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
7 Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8 Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9 Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

A11 – PHQ9 total score