Interoception: An embodied mechanism of resilience

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Keywords: embodiment, interoception, power, homeostasis, resilience, emotion.

Abstract word count: 258

Main body word count: 6313

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Acknowledgements

1. Donné van der Westhuizen for her unconditional support and encouragement throughout the whole process of this research, from start to finish. Lucid thinker.
2. Dr Lester John for assisting with technical issues related to the heart rate monitor.
3. Prof. Mark Solms for the allocation of funding.
4. The Department of Psychology for the years of research methods courses that have been put to use during the course of this project.
5. Last but not least: significant friends and family who have allowed me to talk out the various obstacles I've encountered along the way.

Abstract

Background and aims: Embodied theories of emotion point toward an integral role for interoception, the awareness of internal bodily signals such as heartbeat, in emotional awareness. Greater interoceptive accuracy (IA) may promote emotional resilience. However, the modulation of interoception by emotional states and vice versa is not well established. The aim of this study is therefore to

Method: A double-blind 2x2 factorial experimental design was used. Participants (N=20) were randomly assigned to either a high (n=10) or a low (n=10) power condition. Interoceptive accuracy was measured before and after the administration of a novel power manipulation task. Resilience (Connor-Davidson Resilience Scale) and relevant personality variables were also collected.

Results: Analyses of variance (ANOVA) were used to test effects of power and median-split resilience on change in interoceptive accuracy (IA-change), and absolute IA-change. The effect of power on IA-change was statistically significant (p = .044). The power main effect was qualified by a significant disordinal interaction effect between power and resilience on IA-change (p = .026), indicating that low-resilience individuals in the low power condition experienced a significant drop in interoceptive accuracy. There was a significant effect for resilience on *absolute* IA-change (p = .047), with low resilience resulting in greater absolute IA-change. Trait anger was strongly and negatively correlated with baseline interoceptive accuracy (r = -.59, p < .01).

Discussion: Direction of IA change was consistent with hypotheses: high power increased, while low power decreased IA. Individuals with low resilience were less able to cope with the emotional threat presented in the low power condition, resulting in reduced IA.

Interoception: An embodied mechanism of resilience

We are, fundamentally, embodied beings and this impacts how we can make sense of our subjective experiences as we interact with the world (Craig, 2009; Gallese & Sinigaglia, 2010; van der Westhuizen, Solms, & van Honk, 2015). The notion that elementary sensorimotor processing is fundamental to higher-order cognition and emotion has garnered increasing interest and support in recent decades, although the idea that emotions are intimately linked to physiological states has been around for some time (Wilson, 2002; Herbert & Pollatos, 2012). The James-Lange (James, 1884; Lange, 1885) theory and, more recently, Damasio's (1996) somatic marker hypothesis are two notable theories making claims to that effect. A cornerstone of this view is that awareness of internal bodily sensations (i.e. interoception) is necessary for emotional experience (Craig 2002; Craig 2003).

For physiological states to influence the mind, they must be represented in the brain. There are, in fact, numerous representations – and re-representations – of the body in the brain (Herbert & Pollatos, 2012; Serino et al., 2015; Tsakiris, 2010). The most commonly referenced bodily representations are those mapped by the sensorimotor cortices. For example, sensory information from the exterior surface of the body, primarily associated with the modality of touch, is mapped onto the somatosensory cortex (Banich & Compton, 2011). One instance of representation of the body in the brain that has received increasing attention in recent years is the mapping of the physiological state of the entire body, which is maintained primarily by the insular cortex (Cameron, 2001; Craig, 2002; Herbert & Pollatos, 2012). This kind of mapping is referred to as interoception and gives rise to an awareness of fluctuating visceral states, such as the beating of one's heart.

Despite the accumulation of neuroscientific evidence supporting the notion of embodied emotion, especially the role of interoception in emotional awareness (Craig 2002; Damasio et al., 2000; Pistoia et al., 2015; Terasawa, Fukushima, & Umeda, 2013), investigation into the modulation of interoceptive ability by particular emotional states and vice versa is not well established (Durlik, Brown, & Tsakiris, 2013; Durlik & Tsakiris, 2015; Kunstman et al. 2016). Although early accounts emphasized the role of interoception in the visceral experience of anxiety and panic (Domschke, Stevens, Pfleiderer, & Gerlach, 2010; Zoellner & Craske, 1999), it is unlikely that accuracy in interoceptive mapping relates to any one particular emotional state (Panksepp & Biven, 2012). Instead, mounting evidence points to a role for interoceptive ability

in emotional resilience (Haase et al., 2016). Thus one might ask questions such as: how does interoception support emotional resilience, and how is it related to other emotional states that may support resilience? We suggest that psychological experiences of power increase interoceptive accuracy, and that higher levels of interoceptive accuracy facilitate coping.

Exploring the links between interoception, resilience, and power

Interoception, simply put, is the awareness of internal bodily signals (Craig, 2002). These internal bodily signals have been linked to activity of the autonomic nervous system (Craig, 2002; Craig, 2003; Damasio et al., 2000), and include hunger, thirst, sensual touch and visceral and respiratory sensations amongst others and together constitute one aspect of bodily representation (Craig, 2002; Craig, 2009). However, while an individual may experience internal bodily sensations and thus have interoceptive awareness, for maximal utility these signals should accurately predict the state of the body (interoceptive accuracy). Arguably, the primary utility of having such a representation is its role in maintaining homeostasis (Craig, 2002; Craig, 2013; Damasio et al, 2000). Homeostasis can be thought of as a relatively stable internal state in which the body can function optimally, typically maintained within certain parameters (e.g. an acceptable internal body temperature; Banich & Compton, 2011). Homeostasis is maintained on an automatic physiological level (e.g. autonomic hormone regulation), as well as behaviourally. Awareness of internal states relevant to survival is necessary if an organism is to execute appropriate behaviours in order to fulfil those needs brought about by homeostatic dysregulation, such as hunger. Thus, one of the contributions of interoception is in linking information about the internal state of the body to goal-directed behaviour aimed at restoring homeostatic equilibrium (Craig, 2002; Herbert & Pollatos, 2012; Paulus, Tapert, & Schulteis, 2009).

For instance, one way in which awareness of internal bodily signals can translate into coping behaviour is through alliesthesia, the notion that the experience of an external stimulus or event as either pleasant or unpleasant depends on the internal state of the body (Paulus et al., 2009). For example, whether a source of heat is experienced as pleasant or unpleasant (and thus whether an organism seeks out or avoids the source of heat) depends on the organism's core body temperature (Craig, 2002; Paulus et al., 2009). Alternatively, behavioural passivity may arise when internal states remain unknown. Extending this notion, given that emotional experience and interoception share a common neural correlate (the insular cortex; Zaki, Davis, & Ochsner, 2012), emotions can be thought of as a proxy for the particular state of the body: they

are positively and negatively valenced experiences with unique physiological profiles that influence behaviour in response to homeostatic perturbations.

One explanation of how bodily representations subserve homeostatic regulation is that they model predictions about expected internal state and surroundings. For instance, this entails the notion that perception reflects the dynamic process of the matching between sensory information and prior beliefs or prediction, approximating Bayesian inference (Friston, 2014; Moutoussis, Fearon, El-Deredy, Dolan, & Friston, 2005). In line with an account of the brain as a processor of approximate Bayesian inference, is the notion, as Tsakiris, Tajadura-Jiménez and Constantini (2011) have argued, that monitoring both interoceptive *and* exteroceptive signals, rather than primarily relying on exteroceptive signals, is characteristic of individuals with high levels of interoceptive awareness, and this may facilitate optimisation of the body's internal predictive models.

In support of this, Paulus and colleagues (2009) have recently proposed that optimal neural performance can be characterized by the minimization of body prediction errors, that is, the experienced difference between predicted interoceptive states and actual interoceptive states. From a Bayesian-brain perspective, being a good predictor, regardless of whether those predictions have to do with good or bad outcomes, enables more efficient coping. This is because, according to this theoretical framework, what the brain tries to overcome in its management of the body in the environment, is unpredictability and not, for instance, feelings of discomfort (Moutoussis et al., 2014). Therefore, optimal performers may demonstrate adaptive coping by generating more efficient body prediction errors, and this may depend, in a large part, on interoceptive accuracy.

Interoception's role in facilitating homeostasis may therefore enable emotional resilience, which is the ability to cope efficiently and adaptively in the face of adversity (Haase et al., 2016; Luthar, Cicchetti, & Becker, 2000). Many accounts of resilience describe this attribute in terms of a proactive behavioural style, or an 'approach' orientation that is associated with better self-regulatory skills, higher self-esteem and greater feelings of control (Alvord & Grados, 2005; Buckner, Mezzacappa, & Beardslee, 2003; Diehl & Hay, 2010). In support of the link between the accessibility of internal states and proactive coping, Haase et al. (2016) found that individuals who were identified as having low resilience had poorer interoceptive awareness than individuals with high resilience when confronted with a threat to homeostasis, namely a loaded inspiration

breathing task (i.e. inhalation was made challenging). Low resilience individuals also had to recruit increased neurocognitive resources in order to deal with the stressors (Haase et al., 2016). Corroborating this finding, several studies have shown that people with superior interoceptive accuracy are better able to regulate their emotions in response to social ostracism and are as such less adversely affected by the experience (Füstös, Gramann, Herbert, & Pollatos, 2012; Kever, Pollatos, Vermeulen, & Grynberg, 2015; Pollatos, Matthias, and Keller, 2015). Hence, more precise interoceptive awareness may facilitate proactive coping with stress by optimizing predictive models of the self in action.

The concept of resilience by way of predictive models may help to explain the cognitive and behavioural styles that have been associated with the evolutionarily advantageous experience of social power. Although definitions of power vary, the notion of control is central, whether it is of the outcomes of others, or feelings within oneself (Guinote 2007a). In terms of cognition and behaviour, power has been associated with increased goal-directed activity and approach behaviour (Anderson, Keltner, & Kring, 2001; Anderson & Galinsky, 2006; Galinsky, Gruenfeld, & Magee, 2003; Keltner, Gruenfeld, & Anderson, 2003; Kilduff & Galinsky, 2013). Being in power may also encourage positive perceptions of the self, including increased optimism, and reduce negative self-appraisal (Anderson & Galinsky, 2006; Kilduff & Galinsky, 2013; Kunstman et al., 2016). Finally, many of the advantages of being powerful have been associated with an attunement to personal, internally directed goals (Kunstman et al., 2016), and greater selectively in processing relevant information about a situation in order to efficiently meet situational demands (Guinote 2007a, 2007b). These findings support the idea that high power individuals are able to minimise their body prediction errors, and thus are suggestive of a facilitative role for interoception in power.

Corroborating this, Durlik and Tsakiris (2015) found that after being subjected to social ostracism through a Cyberball social ostracism task, which can be seen as a reduction of social power, participants' levels of interoceptive accuracy dropped. Directly in support of the link between power and interoceptive ability, Kunstman et al. (2016) recently showed that inducing powerful feelings in individuals with body dysmorphic disorder (BDD) temporarily increased interoceptive accuracy, which itself was associated with milder BDD symptoms. Self-objectification, which is primarily an exteroceptive or externally-based perception of the self, is closely mirrored by a low-power profile in terms of greater negative affect and reduced cognitive

performance, as well as reduced interoception (Ainley & Tsakiris, 2013; Frederickson & Roberts, 1997). Indeed, low interoceptive ability has also been linked with a variety of psychological illnesses. Examples include body dysmorphic disorder (Kunstman et al., 2016), anorexia nervosa (Pollatos et al., 2008), and depression (Avery et al., 2014; Terhaar, Viola, Bär, & Debener, 2012).

The ability to control or regulate distressing emotions and maintain a functional sense of control, whether or not it is proportionate to actual possession of control (Anderson & Galinsky, 2006; Fast, Gruenfeld, Sivanathan, & Galinsky, 2009), has in fact been linked to the psychological experience of power. Van der Westhuizen, Solms, et al. (2015) argue that, at the most basic level, power is reducible to feeling in control. In support of this view, recent findings have shown that by decreasing the experience of power via a recall-induced priming task, participants' experience of sensory-motor control decreased (Obhi, Swiderski, & Brubacher 2012). On the other hand, people prone to feeling rage, an emotional state often linked to disinhibition, (i.e. a loss of control) have been found to have lower interoceptive accuracy (van der Westhuizen, Reid, van Honk & Solms, 2015). These findings underscore the important role of embodied mechanisms in higher-order experiences of control and power. Corroborating this view, the hormone testosterone, a major physiological substrate of social power (Eisenegger, Haushofer, & Fehr, 2011), not only increases the tendency to attribute events in the environment to the self, that is, the sense of agency (van der Westhuizen, Solms, Moore, & van Honk, 2016), but also increases interoceptive accuracy (van der Westhuizen, Reid, et al., 2015). Hence, power appears to be intimately linked to the experience of control and awareness of the body, and the links between power and resilience suggest that interoceptive ability may operate as an important embodied mechanism in this regard. That is, interoceptive awareness may help to facilitate the same psychological processes that operate during experiences of power.

Thus, to conclude, interoceptive processing plays an integral role in mediating emotional reactions to homeostatic dysregulation. In doing so, interoception interacts with other embodiment functions, such as the sense of agency and the way in which the self is represented in relation to the other, to influence emotion, cognition, and behaviour. Together, these interacting processes constitute our subjective experiences (Herbert & Pollatos, 2012; van der Westhuizen, Solms, et al., 2015). Whilst some studies have found increased interoceptive awareness to be a function of anxiety (e.g. Paulus & Stein, 2006), more recent work provides compelling support for the role of interoception in emotion regulation and resilience. However,

literature documenting direct changes in interoceptive accuracy by emotional manipulation is lacking.

Research aims and hypotheses

The psychological state linked to subjective experiences of power may offer a unique window into exploring the proposed link between interoceptive awareness and emotional resilience and has to date not been investigated. The aim of the current research is therefore to address this gap, namely that there has been little empirical work done to investigate whether or not experiences of power are in fact sustained, at least in part, by interoceptive processing. Using an emotion-priming paradigm, we therefore aimed to test the effects of power and powerlessness, two emotional states argued to be on opposite ends on a spectrum of control, on interoceptive accuracy. We hypothesised that interoceptive accuracy would increase relative to baseline in situations where an increased sense of power has been elicited, and secondly, that a reduced sense of power would cause a temporary drop in interoceptive accuracy.

Method

Design and Setting

We used a pre-post 2 x 2 factorial experimental design including both within- and between-subjects variables. We also included relevant correlational variables, such as resilience and personality traits (see materials).

Independent variable 1. Emotional-priming (2 levels; between-subjects) high power, and low power; between groups (task described under measures).

Independent variable 2. Time (2 levels; within-subjects) interoceptive accuracy, measured before and after completing the priming task.

Dependent variable. Interoceptive accuracy, as measured by a heartbeat-tracking task (described under materials).

Setting. The experiment was carried out in a temporary laboratory in Botha's Hill, Kwa-Zulu Natal.

Participants

A total of 22 females were recruited via convenience and snowball sampling using social media and the Student Research and Participation Programme (SRPP), a platform specific to UCT psychology students (Appendix A). However, two participants were excluded: one on the

basis of a confounding medical condition, the other on the basis of having a BMI > 30. Participants in the final sample ($N = 20$) were randomly assigned to a high ($n = 10$) or low ($n = 10$) power condition. The randomisation schedule was calculated via randomization.com, and the researcher was kept blind to the condition of the participant while data was being collected.

*Table * Participant characteristics (N = 20)*

	M(SD)	Minimum	Maximum
Age	22.90 (5.61)	18.00	37.00
BMI	21.12 (2.27)	17.19	26.22

Inclusion criteria. Healthy, right-handed women, aged 18-30, with any ethnic background. We specified handedness due to possible lateralisation on interoceptive functions in the insular cortex (Lake & Bryden, 1976).

Exclusion criteria. In order to control for possible confounding interactions, individuals with history of head trauma or psychiatric illness, or those currently taking any psychiatric medication, were exluded, as there is evidence that interoception is altered in clinical populations (e.g. Pollatos et al., 2008; Terhaar et al., 2012). Individuals with a BMI over 30 (classified as obese) were also excluded, since previous research has shown that BMI is a potential confound (Herbert & Pollatos, 2014). Finally, due to potential hemispheric lateralisation of interoceptive processing (Lake & Bryden, 1976), non-right-handed individuals were also excluded.

Materials

Self-report measures.

The Affective Neuroscience Personality Scales – Short Version (ANPS-S). The ANPS-S (Pingault, Falissard, Côté, & Berthoz, 2012) is a shortened version of a physiologically-grounded measure of affective personality traits based on Panksepp's (2005) six primary subcortical emotion systems in the brain (Davis, Panksepp, & Normansell, 2003; Davis & Panksepp, 2011). These systems include playfulness, seeking, caring, fear, rage, and sadness. Of relevance to the current study, the ANPS anger scale has been shown to be significantly negatively correlated with interoceptive accuracy (van der Westhuizen, Reid, et al. 2015).

Construct validity for the original ANPS has been established by Davis et al. (2003) and Davis and Panksepp (2011), who have shown that the ANPS correlates with another widely used measure of personality, namely the Five-Factor Model (FFM; Goldberg, 1990). The ANPS-S

consists of 36 4-point Likert-type items (scored from 0 = “Strongly disagree”, to 3, “Strongly agree”) drawn from the original scale. Reliability for the ANPS-S administered in French and Canadian samples was acceptable with Cronbach’s alpha values ranging between .60 and .79 per subscale (Pingault et al., 2012). However, in our sample reliability of the subscales deviated from the range observed by Pingault and colleagues (see results).

Connor-Davidson Resilience Scale (CD-RISC). The CD-RISC is a widely used measure of resilience with good psychometric properties. The 25-item scale has 5-point Likert-type items ranging from 0 (“not at all true”) to 4 (“true almost all of the time”) (Connor & Davidson, 2003). The CD-RISC has been shown to have high internal consistency in a South African samples, with Cronbach’s alpha values typically 0.92 or above (Fincham, Altes, Stein, & Seedat, 2009; Jørgensen & Seedat, 2008). This is in keeping with good reliability values reported internationally (Connor & Davidson, 2003). Cronbach’s alpha for our sample was similar to values reported in previous literature at $\alpha = 0.90$. The CD-RISC has also been used as a predictor of interoceptive awareness (Haase et al., 2016).

Emotion-priming task. Two versions of a priming task were created, corresponding to each level of the emotion-priming independent variable (high power, and low power; Appendix D). The task consists a short written scenario, describing a high-stakes interview in which power dynamics are at play, followed by writing prompts (varied by condition), intended to elicit a particular affective experience. The structure of the task and the content of the scenario are based on similar tasks that successfully elicit power (e.g. Galinsky et al., 2003; Kunstman et al., 2016; Obhi et al., 2012). However, the written scenario replaces the autobiographical memory component of previous tasks. The participant is instructed read the scenario, and then write a response to it as though she is a particular character in the scenario. The participant is provided with some optional prompts, such as “What feelings would you experience during the interview?”

***Manipulation check*.** To assess whether the emotion-priming task is successful, participants were asked what emotions they had imagined their assigned character feeling, and what emotions they themselves had experienced while writing their responses. They were also asked to rate how intense they imagined their character’s emotions were, how difficult they found it to imagine themselves as their character, and how intense their own emotions had been

while they were writing on 6-point scale ranging from 0 (*not at all intense*) to 5 (*very intense*; see Appendix E).

Heartbeat tracking task. A custom-made optical heart rate sensor, developed by Dr. Lester John (Biomedical Engineering Department, UCT), was used to monitor participants' heartbeats. Following standard protocol (Tsakiris et al., 2011), the sensor was attached to the tip of the index finger of the participants' non-dominant hand (in this case, the left hand, since we are only including right-handed individuals). The sensor was connected to a physiological data unit (NI-USB 6000, National Instruments) that sampled at a rate of 1 kHz. The participant received audiovisual prompts from a computer program to guide her through the heartbeat tracking portions of the experiment. Following collection and processing of the data[1], interoceptive accuracy was calculated using the following formula (Tsakiris, Tajadura-Jiménez, & Costantini, 2011):

$$\frac{1}{3}\sum\left(1-\left[\frac{objective\ count\ -\ subjective\ count}{objective\ count}\right]\right)$$

Procedure

Screening and booking a slot. Online platforms were used for screening purposes. Google Forms was used to collect demographics and screen potential participants (Appendix F), as well as to administer the ANPS-S electronically. Doodle (doodle.com) was used for scheduling experimental sessions with participants who met the inclusion criteria.

Experimental session. An overview of what the study entailed (excluding the research hypotheses) was provided at the beginning of the session. Before commencing the experiment, the participant was given an informed consent form to read and sign, and an opportunity to ask questions.

The CD-RISC measure was administered electronically, followed by a baseline measurement of interoceptive accuracy (heartbeat tracking task). The participant was instructed not to monitor her pulse during this task. The heart rate sensor was attached to the participant's left index finger. The participant followed audiovisual computerised prompts to count her

[1]The recorded heartbeat data were saved as text coordinates for a graph of a participants' heartbeats per interval, requiring manual recreation of the graph for counting and checking a participant's heartbeats for each trial. Given the inefficiency of this method, the researcher coded a Microsoft Excel macro to automatically count the heartbeats and produce the graphs to check for abnormalities in the recorded heartbeat data.

heartbeats during four trials of varying lengths, beginning with a brief practice trial. Three test trials of 30, 35, and 45 seconds commenced in a random order, and were counterbalanced between participants. The participant's objective heartbeat was recorded during these intervals and was later compared to the participant's subjective heartbeat count to generate an interoceptive accuracy score (Tsakiris et al., 2011). No performance feedback was given.

Following the baseline interoceptive accuracy measurement, the priming task commenced. To keep the researcher blind to the condition of the participant, the was given a folded piece of paper (prepared by a research assistant) with either a letter "X" or a letter "Y" written inside it. The participant was then instructed to open the PDF file that matched the letter inside their folded piece of paper from a list of files labelled Q, R, X and Y. The dummy files ("Q" and "R") were used to make it less likely for participants to guess the hypothesis based on the task scenario which involved only two characters. The PDF contained the instructions for the appropriate priming task, depending on group allocation (high power or low power). Participants were provided with a pen and paper to complete the written aspect of the task.

Immediately following completion, interoceptive accuracy was measured again. The order of the trials was matched to the order of the trials at baseline. The manipulation check questionnaire was then administered. Thereafter, weight and height measurements was taken in order to check BMI. Finally, participants were given an opportunity to voice questions or concerns. They were emailed a debriefing letter on conclusion of data collection (Appendix G).

Results

Predicting interoceptive accuracy

Before commencing analyses, the data were examined for outliers and missing and illegal values. An inspection of means and standard deviations for interoceptive accuracy at baseline revealed a comparatively large gap between high power (M= 0.52, SD=0.18) and low power (M= 0.73, SD=0.19). However, the change in mean interoceptive accuracy scores from baseline to post-manipulation was in the expected direction: the mean interoceptive accuracy of the high power group increased to 0.58 (SD=0.21) and the mean IA of the low power group decreased to 0.66 (SD=0.16). The standard deviations at different levels were roughly comparable, with the largest difference being between post-manipulation high-power IA, and post-manipulation low-power IA.

Table 1 Means and standard deviations for IA measures by Power

	Low Power	High Power
Measurement	*M* (SD)	*M* (SD)
Baseline IA	0.73 (0.19)	0.52 (0.18)
Post-manipulation IA	0.66 (0.16)	0.58 (0.21)
IA-change	-0.07 (.17)	0.06 (0.17)

Note. $n = 10$

An independent samples *t*-test indicated that the difference observed between the IA pre-manipulation (i.e. baseline) means between groups was significant, which suggests that our groups were not equivalent to start with. Therefore, in order to control for between-group differences in baseline IA, a new variable, "IA-change", was computed. IA-change was calculated by subtracting baseline IA from post-manipulation IA, such that a positive IA-change value represents an increase in IA and a negative IA-change value represents a decrease in IA. However, the effect of power on IA-change was not significant, although it approached significance $t(18) = -1.91$, $p = .073$. Subsequently, power and resilience were entered into a two-way factorial analysis of variance (ANOVA).

Table 2. Means and standard deviations for IA-change by Power and Resilience

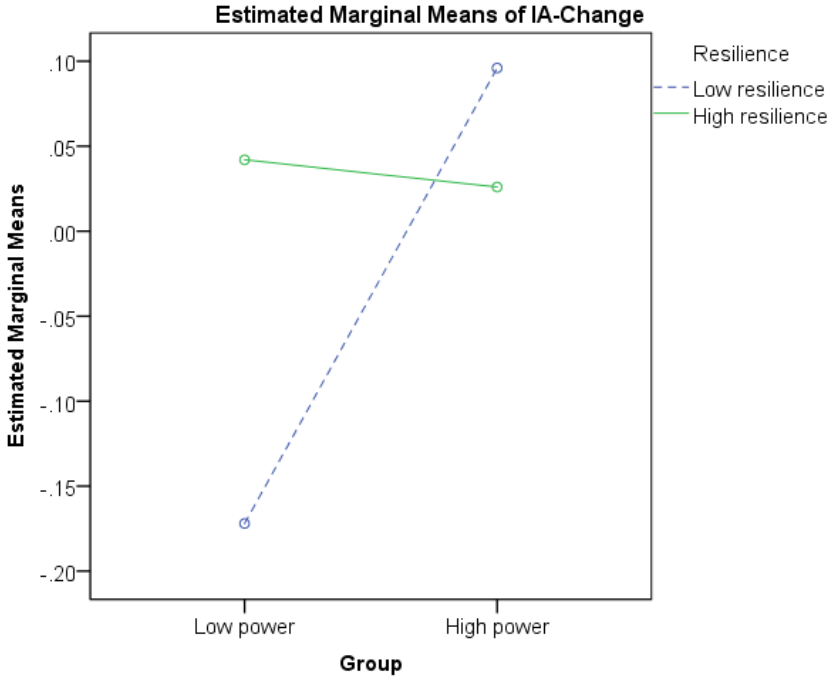
	Low resilience (n = 5)	High resilience (n = 5)	Power Totals (n =10)
Group	*M* (SD)	*M* (SD)	*M* (SD)
Low power	-.17 (.13)	.04 (.13)	-.07 (.17)
High power	.10 (.17)	.03 (.05)	.06 (.12)
Resilience Totals (n = 10)	-.04 (.20)	.03 (.09)	

Change in interoceptive accuracy was largest for individuals in the low power condition who were also low in resilience (M= -.17, SD= .13). Of interest: the low power, low resilience group was the only group for whom the direction of change in IA did not change within a single standard deviation. The second largest IA-change mean was for low resilience individuals in the high power condition (M= .10, SD= .17). However, the standard deviation for this group was the largest single cell standard deviation, and was particularly striking in comparison to the much smaller standard deviation of the high power, high resilience group (M= 0.03, SD= 0.05). Overall, the smallest IA-change was observed in the high resilience group (M= 0.03, SD= 0.09).

Despite the noticeable difference in the size of standard deviations in the high power condition, assumptions were met for a two-way independent ANOVA, testing the effects of resilience and power on change in interoceptive accuracy (see APPENDIX*). CD-RISC scores were median-split to create a categorical high-low resilience variable. There was a significant main effect for power on IA-change, $F(1, 16) = 4.78$, $p = .044$, $\eta_P^2 = .23$, indicating that, all other things being equal, power significantly influenced the direction of change in IA. There was no statistically significant main effect for resilience on IA-change, $F(1, 16) = 1.56$, $p = .230$, $\eta_P^2 = .09$. However, the main effect of power on IA-change should be interpreted cautiously since there was a statistically significant disordinal interaction between power and resilience, $F(1, 16) = 6.06$, $p = .026$, $\eta_P^2 = .28$. This can be observed in the means plots displayed in Figure 1.

Specifically, an inspection of a pairwise comparisons for the interaction revealed that the for individuals low in resilience, the difference between mean change in IA observed between the high power group and the low power group was significant ($M_{high\ power} - M_{low\ power} = .27$, $SE = .08$), $F(1, 16) = 10.80$, $p = .005$, $\eta_P^2 = .40$, but not individuals with high resilience ($M_{high\ power} - M_{low\ power} = -0.02$, $SE = .08$, $p = .847$). Because the variable IA-change carries information about the direction of the change in interoceptive accuracy as well the size of the change, it is particularly important to look at the means themselves in order to interpret the mean differences (refer to Table 2). The preceding mean difference should therefore be taken to indicate that individuals who had low resilience experienced a significant drop in IA after undergoing the low power manipulation, whilst this there was no significant change for high resilience individuals. However, there was also a significant difference between high resilience and low resilience mean

IA-change for individuals the low power condition ($M_{high\ power} - M_{low\ power} = 0.21$, $SE = .08$), $F(1, 16) = 6.89$, $p = .018$, $\eta_P^2 = .30$, but not for individuals in the high power condition ($M_{high\ power} - M_{low\ power} = 0.07$, $SE = .08$, $p = .403$). In other words, the significance of the power-resilience interaction emanates from the low power condition (but not the high power condition) and for participants who were low in resilience (but not those who were high in resilience).



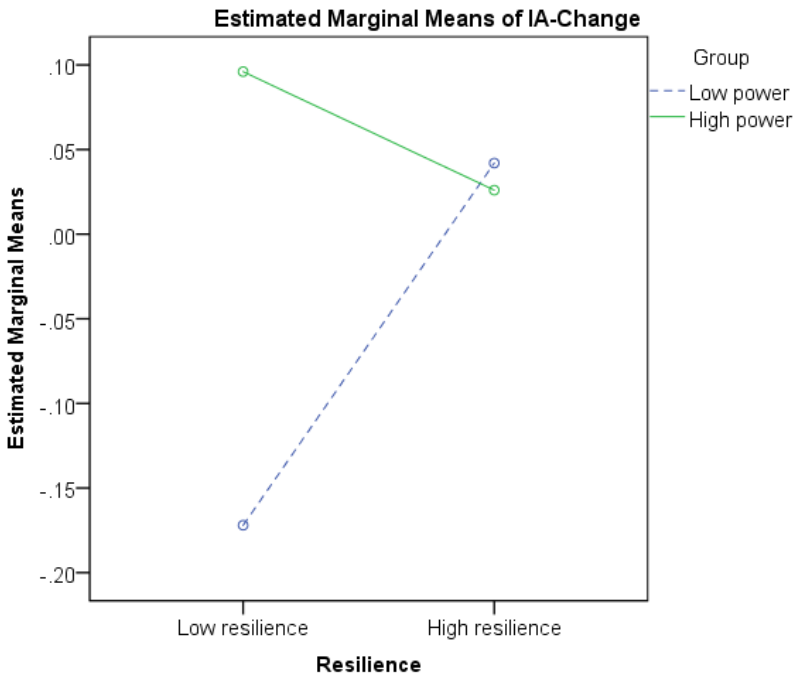


Figure 1. Estimated marginal mean plots for the interaction effect of resilience and power on IA-change.

We also tested whether resilience and power predicted "absolute IA-change" (i.e. the amount, but not direction, if change in interoceptive accuracy). Again, assumptions were met for a two-way ANOVA (APPENDIX*). Looking at the means and standard deviations in Table 3, the mean change observed for low resilience seems consistently higher than the change observed for high resilience, regardless of the power condition. This was confirmed by a significant main effect for resilience on absolute IA-change $F(1, 16) = 4.65$, $p = .047$, $\eta_P^2 = .23$. There were no other significant effects for this test.

Table 3. Descriptive statistics for Absolute IA-change x Group x Resilience

Group	Resilience	Mean	Std. Deviation	N
Low power	Low resilience	.17	.13	5
	High resilience	.11	.07	5
	Total	.14	.10	10
High power	Low resilience	.16	.10	5

	High resilience	.04	.03	5
	Total	.10	.09	10
Total	Low resilience	.16	.11	10
	High resilience	.08	.06	10
	Total	.12	.10	20

Table Shapiro-Wilk normality test for Absolute IA-change x Group x Resilience*

			Shapiro-Wilk		
	Group	Resilience	Statistic	df	Sig.
Absolute IA-change	Low power	Low resilience	.948	5	.725
		High resilience	.923	5	.547
	High power	Low resilience	.978	5	.922
		High resilience	.984	5	.955

Manipulation check: participants' emotional responses

New variables were computed in order to understand and compare the (imagined) emotional response of the character, and the participant's own emotional response (see Table 3). Power-level Congruence (Yes, No, Mixed) refers to the congruence between the emotions listed in the two open-ended response questions in the manipulation check and the participant's Power-level. The same questions were also coded to produce an emotional Valence variable (Positive = 1, Negative = -1, or Mixed = 0). Emotional Response was calculated by multiplying Valence by emotion intensity ratings provided by participants in the manipulation check questionnaire (i.e. Emotional Response = Valence*Intensity). As displayed in Table 4, Power-level Congruence high for the imagined emotional responses of the character, suggesting that participants' interpretations of the high-stakes scenario were consistent with their power condition. In general, Low-Power Congruence was higher than the corresponding High-Power Congruence, for both character and participant, which may suggest that the low-power prime was more effective at inducing predictable, group-consistent emotional responses. Character Emotional responses were imagined to be more intense than participants' own emotions, and, from the standard deviations of participants' own emotional responses and their Power-level Congruence, participants' own emotional responses showed greater variation, particularly in the high power condition.

Table 4. Descriptive statistics for emotional responses for character, and participant

	Character Emotion			Participant Emotion	
Group	Power-level Congruence	Response *M* (SD)	Task Difficulty *M* (SD)	Power-level Congruence	Response *M* (SD)
Low power	90% (10%)	-4.00 (1.70)	3.60 (1.17)	70% (10%)	-1.70 (2.45)
High power	80% (20%)	2.6 (1.65)	2.20 (1.40)	40% (20%)	0.00 (2.49)

Note. Percentage of responses with mixed congruence are listed in parentheses.

Correlation of interoceptive accuracy with personality variables

Prior to assessing correlation between baseline interoceptive accuracy and ANPS-S personality variables, descriptive statistics and reliability were calculated for ANPS-S subscales (Table 5).

Table 5. Means, standard deviations, and Cronbach's alpha for ANPS-S subscales

Subscale	*M* (*SD*)	Cronbach's α
Playfulness	12.15 (2.87)	.72
Seeking	12.85 (2.68)	.81
Caring	13.10 (2.22)	.51
Fear	9.65 (3.22)	.84
Rage	6.65 (2.21)	.68
Sadness	8.95 (2.09)	.26

Due to the poor reliability of the Caring and Sadness subscales, they were omitted from the correlation analysis with baseline interoceptive accuracy (Table 6).

Table 6. Pearson correlations between baseline interoceptive accuracy and ANPS-S subscales

	Baseline IA	Playfulness	Seeking	Anger	Fear
Baseline IA	1.00	.15	.21	-.59**	-.38
Playfulness	.15	1.00	.45*	.20	-.50*
Seeking	.21	.45*	1.00	-.34	-.36

Anger	-.59**	.20	-.34	1.00	.09
Fear	-.38	-.50*	-.36	.09	1.00

Of the ANPS-S subscales included the correlation analysis with baseline interoceptive accuracy, the only subscale to correlate significantly with baseline interoceptive accuracy was Anger. By Cohen's conventions (Cohen, 1988), anger was strongly and negatively correlated with baseline interoceptive accuracy (r = -.59, p < .01), indicating that higher levels of trait anger were associated with lower levels of baseline interoceptive accuracy.

Ethics

This study was granted ethical approval (Appendix H) and conducted in line with the UCT guidelines for human research subjects. Signed informed consent (Appendix I) was obtained from each participant prior to their participation in the study. It was emphasised that participation was voluntary and that participants were free to withdraw at any point, and that their data would remain confidential.

This study involved some possible sources of psychological discomfort. For some participants, measuring height and weight may have been a sensitive issue. Additionally, participants who completed the low-power prime may have experienced discomfort. We therefore included UCT's Student Wellness Service contact details, as well as some additional possibilities for non-students, in a debriefing email in order to make sure that assistance was available, should any participant have needed it.

All participants were entered into a draw to win R300 cash prize. Additionally, UCT psychology students were compensated with 2 SRPP points for their time. Participants benefited from insight into psychological research and had an opportunity to learn more about emerging theories on the embodiment of cognition and emotion.

Discussion

Interoceptive accuracy may facilitate coping with adversity by optimizing the brain's predictive models through a reduction of the difference between predicted and observed internal states (Moutoussis, Fearon, El-Deredy, Dolan, & Friston, 2014; Tsakiris et al., 2011). Coping in

the face of adversity, in other words “resilience”, may therefore be supported by higher levels of interoceptive accuracy, and the psychobehavioural profile associated with resilience (goal-directed and approach oriented behaviour, increased sense of self-esteem and control) closely matches cognitive and behavioural styles associated with possession of social power. The aim of the current research, therefore, was to explore the relationship between interoceptive accuracy and psychological states associated with power and powerlessness, as they relate to emotional resilience. Accordingly, we hypothesized that experimentally manipulating participants’ experiences of power would increase interoceptive accuracy for the high power condition, and decrease interoceptive accuracy for the low power condition.

Interoceptive accuracy changes in the expected direction, consistent with participants’ assigned power condition, supporting our hypotheses. However, since our high power and low power groups differed significantly in interoceptive accuracy at baseline, we computed an IA-change variable (the difference between post-manipulation and baseline interoceptive accuracy) to measure the direction and size of the change in interoceptive accuracy in response to the power manipulation. We found that there was a significant main effect for power on change in interoceptive accuracy, however, this finding is qualified by the significant disordinal interaction effect for resilience and power. Interestingly, this interaction effect indicates that it is only when vulnerability (i.e. low resilience) is combined with threat (low power) that there is a significant drop in interoceptive accuracy. This finding is consistent with Haase et al. (2016) who found that interoceptive accuracy was reduced in response to threat for individuals with low resilience (vs. those with high resilience).

Interestingly, in a separate analysis, we found that resilience, but not power, significantly predicted the amount of change observed in interoceptive accuracy, as measured by the absolute IA-change variable (i.e. excluding the direction of the change). Specifically, high resilience was associated with significantly less absolute change in interoceptive accuracy. One of the things that this finding might suggest is that stability in interoceptive accuracy (and not just the degree of accuracy) may be important for resilience.

The importance of stability in interoceptive accuracy for resilience could be explained by drawing on Bayesian inference. If optimal neural performance can be characterized by minimizing body prediction errors (Moutoussis et al., 2014; Paulus, Tapert, & Schulteis, 2009), then not only would higher levels of interoceptive accuracy facilitate optimal performance, but

so too would stability of the level of interoceptive accuracy. Fluctuation in interoceptive accuracy may lead to "surprising" incoming information about the state of the body (Friston, 2011; Moutoussis et al., 2014), and thus increase body prediction errors.

Tsakiris et al. (2011) have argued that the combined monitoring of interoceptive and exteroceptive signals, rather than overreliance on exteroceptive signals, optimizes predictive capacity. In relation to our findings, it may be that low resilience is characterized by an oversensitivity to exteroceptive signals, which then produces larger fluctuations in internal states in response to a perceived threat. This interpretation would be consistent with findings that link overreliance on exteroceptive self-perception with a low power profile: increased negative affect, and reduced interoceptive accuracy (Ainley & Tsakiris, 2013; Fredrickson & Roberts, 1997).

Further evidence for an association of reduced interoceptive accuracy with negative affect in the current study was provided by the significant negative correlation between trait anger and baseline interoceptive accuracy (consistent with the findings of van der Westhuizen, Reid, Solms, and van Honk, 2015). Trait anger may also represent reduced feelings of control, which may also explain its association with reduced interoceptive accuracy. Participants in the low power condition also reported imagining their power-manipulation characters experiencing intense and negative emotion. Thus overall there is support for the link between reduced interoceptive accuracy and negatively valenced emotional experiences, especially those associated with reduced control.

One limitation of the current study its small sample size, which places constraints on the generalizability of the findings, and the appropriateness of certain statistical tools (e.g. multiple regression). Based on the effect sizes we found for our results, we used G*Power (3.1.9.2) to perform an a priori sample size calculation to determine an appropriate sample size for a replication of the current study with the aim of achieving a power of .95. We recommend a sample of 52 or more. However, despite our small sample size, many of our findings are consistent with prior research.

While previous literature has focused on the accuracy of interoception, given our findings on the negative correlation between the amount of change in interoceptive accuracy and resilience, future research should also explore the contribution of the stability of interoceptive accuracy to psychological well-being and coping with adversity. Whilst our findings have lent support to the notion that emotional experiences of power affect interoceptive accuracy,

questions remain about the effects of inducing other emotions. Given our replication of van der Westhuizen, Reid, Solms, and van Honk's (2015) finding that trait anger is significantly negatively correlated with baseline interoceptive accuracy, the effects of inducing state anger on interoceptive accuracy may be a promising avenue to explore.

Embodied cognition is a steadily growing field (Herbert & Pollatos, 2012). The current study contributes to improving our understanding of interoception, as an embodied mechanism of emotional experience. Specifically, research investigating the effect of emotion manipulation on interoception is limited, and this study seeks to address that gap. Insights into embodied mechanisms of emotion may pave the way for new methods of therapy focussed on developing resilience, especially those that encourage awareness of bodily sensations and mindfulness (Tops, Boksem, Quirin, IJzerman, & Koole, 2014).

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Appendix A

Recruitment advertisement email

Subject: Research Invitation: Embodied Emotion Study

You are invited to participate in a study investigating emotional experience and perception of the body. This study forms part of an Honours project and is in being conducted by researchers in the Department of Psychology, UCT.

Who can participate?

We are looking females who are right-handed and between the ages of 18-30, and who do not have a history of psychiatric illness or head injury.

What does participation involve?

You will need to complete a screening survey to determine whether you are eligible to participate. During the experimental session you will be asked to complete some questionnaires about aspects of your personality and emotional feelings. You will also be asked to track a bodily process and perform a memory-recall task. Your weight and height will also be measured. The duration of the experimental session will be under an hour.

All participants will be entered into a draw to win a R300 cash prize. UCT psychology students will also receive **2 SRPP** points for participating.

How to sign up: If you think you might be interested in participating, please copy and paste the link below into your browser window and complete the survey. If you eligible to participate, you will be contacted by the researcher and will be able to pick a slot to come into the lab for an experimental session.

If you have any questions about the study, please feel free to contact the primary researcher, Freda Swan, at swnfre004@myuct.ac.za.

Appendix B

ANPS-D

Affective Neuroscience Personality Scale 2.4	Strongly Disagree (0)	Disagree (1)	Agree (2)	Strongly Agree (3)
1. Almost any little problem or puzzle stimulates my interest.				
2. People who know me well would say I am an anxious person.				
3. I often feel a strong need to take care of others.				
4. When I am frustrated, I usually get angry.				
5. I am a person who is easily amused and laughs a lot.				
6. I often feel sad.				
8. When I want something I usually go all-out to get it				
9. I do not get much pleasure out of looking forward to special events.				
10. I am not frequently jittery and nervous.				
11. I think it is ridiculous the way some people carry on around baby animals.				
12. I never stay irritated at anyone for very long.				
13. My friends would probably describe me as being too serious.				
14. I seem to be affected very little by personal rejection.				
16. I prefer to watch and observe than take the lead in group work				
17. I will gossip a little at times.				
18. I really enjoy looking forward to new experiences.				
19. I often think of what I should have done after the opportunity has passed.				
20. I like taking care of children.				
21. My friends would probably describe me as hotheaded.				
22. I am known as one who keeps work fun.				
23. I often have the feeling that I am going to cry.				
25. I go out of my way to get things I want				
26. I am usually not highly curious.				
27. I would not describe myself as a worrier.				
28. Caring for a sick person would be a burden for me.				
29. I cannot remember a time when I became so angry that I wanted to break something.				
30. I generally do not like vigorous games which require physical contact.				
31. I rarely become sad.				
33. Striving to be better than my peers is not important to me				
34. I always tell the truth.				
35. Seeking an answer is as enjoyable as finding the solution.				
36. I often cannot fall right to sleep because something is troubling me.				
37. I love being around baby animals.				
38. When I get angry, I often feel like swearing.				
39. I like to joke around with other people.				
40. I often feel lonely.				
42. When I go after something I use a ‘no holds barred’ approach				
43. I usually feel little eagerness or anticipation.				
44. I have very few fears in my life.				
45. I do not especially like being around children.				
46. When I am frustrated, I rarely become angry.				
47. I dislike humor that gets really silly.				
48. I never become homesick.				
50. I usually avoid activities in which I would be the center of attention				
51. Sometimes I feel like swearing.				
52. I enjoy anticipating and working towards a goal almost as much as achieving it.				
53. I sometimes cannot stop worrying about my problems.				
54. I feel softhearted towards stray animals.				
55. When someone makes me angry, I tend to remain fired up for a long time.				
56. People who know me would say I am a very fun-loving person.				
57. I often think about people I have loved who are no longer with me.				
59. If I see a chance to get something I want I move on it right away				
60. I am usually not interested in solving problems and puzzles just for the sake of solving them.				
61. My friends would say that it takes a lot to frighten me.				
62. I would generally consider pets in my home to be more trouble than they are worth.				

63. People who know me well would say I almost never become angry.				
64. I do not particularly enjoy kidding around and exchanging "wisecracks."				
65. It does not particularly sadden me when friends or family members are disapproving of me.				
67. I seldom feel agitated when I do not win				
68. I have never "played sick" to get out of something.				
69. My curiosity often drives me to do things.				
70. I often worry about the future.				
71. I feel sorry for the homeless.				
72. I tend to get irritated if someone tries to stop me from doing what I want to do.				
73. I am very playful.				
74. I tend to think about losing loved ones often.				
76. When I see an opportunity for something I like I get excited right away				
77. I rarely feel the need just to get out and explore things.				
78. There are very few things that make me anxious.				
79. I do not like to feel "needed" by other people.				
80. I rarely get angry enough to want to hit someone.				
81. I do not tend to see the humor in things many people consider funny.				
82. I rarely have the feeling that I am close to tears.				
84. I do not find it satisfying being in a position of leadership				
85. There have been times in my life when I was afraid of the dark.				
86. Whenever I am in a new place, I like to explore the area and get a better feel for my surroundings.				
87. I often worry about whether I am making the correct decision.				
88. I am the kind of person that likes to touch and hug people.				
89. When things do not work out the way I want, I sometimes feel like kicking or hitting something.				
90. I like all kinds of games including those with physical contact.				
91. I frequently feel downhearted when I cannot be with my friends or loved ones.				
93. When working on a project, I like having authority over others				
94. I am not the kind of person that likes probing and investigating problems.				
95. I rarely worry about my future.				

96. I do not especially want people to be emotionally close to me.				
97. I hardly ever become so angry at someone that I feel like yelling at them.				
98. I do not frequently ask other people to join me for fun activities.				
99. I rarely think about people or relationships I have lost.				
101. I do not like to be the one in a group making decision				
102. I have never intentionally told a lie.				
103. I often feel like I could accomplish almost anything.				
104. I often feel nervous and have difficulty relaxing.				
105. I am a person who strongly feels the pain of other people.				
106. Sometimes little quirky things people do really annoy me.				
107. I see life as being full of opportunities to have fun.				
108. I am a person who strongly feels the pain from my personal losses.				
110. People who know me well would say that I have a powerful character				
111. I am not an extremely inquisitive person.				
112. I almost never lose sleep worrying about things.				
113. I am not particularly affectionate.				
114. When people irritate me, I rarely feel the urge to say nasty things to them.				
115. Playing games with other people is not especially enjoyable for me.				
116. It would not bother me to spend the holidays away from family and friends.				
118. I do not compete in challenges to win				

Appendix D

Emotional priming task[2]

Novel Narrative Power-Priming Task[3]

Please read the following scenario and then respond to the prompt below by writing on the page provided. You will not be required to show anyone what you have written and there is no right or wrong response.

Scenario: a high-stakes interview

Thembelihle is the high-powered CEO of a large company. Her career developed rapidly because of her sharp business mind, dedication and hard work, which earned her many promotions and the respect of her colleagues. She has a clear vision of what she wants for her company. She expects a lot from her employees and rewards those who she believes deserve it, but she doesn't hesitate to express it if she feels that an employee is not meeting her vision of the company's standards.

Mary is a recent graduate and has been struggling to find employment. She has admired Thembelihle since she saw Thembelihle giving a presentation on her company at a career fair in Mary's first year at university. Mary applied for a position in Thembelihle's company but she thinks that she only landed an interview because Thembelihle owes her uncle a favour.

When Mary enters the board room for her interview, Thembelihle looks confident and in control, sitting in her high-backed chair behind a large, polished desk. Instead of returning Mary's smile, Thembelihle silently scrutinises Mary for a moment, frowning, and then says, "If you want

[2] Note: Only the general instructions and a single prompt (dependent on group) will appear on the task given to the participant. They are grouped here for the sake of space and ease of comparison. The remainder of the page was for the participant to write on

[3] I have attached the original task (following the new task) to make comparison easier. I also added some notes on relevant literature after that.

to work in my company you will have to stop wearing clothes like *that*. This is a professional environment."

Mary feels embarrassed and is worried that she has made a bad first impression, but Thembelihle then smiles, and says, while glancing down over Mary's CV, "We all have things to learn. We have reviewed your CV and we think you have some potential, but there were also significant gaps, so we want to see you in action. Our colleague, will play the role of a client, and you will have to respond. We will be making notes and evaluating your performance throughout the role-play. Begin."

Thembelihle's evaluation of Mary will determine whether Mary has a place in the company or not.

High-power

Please take a moment to imagine, as vividly as possible, that **you are Thembelihle** in the situation above. You have power over Mary. By power, we mean that you control the ability of another person (Mary) to get something she wants (a job in your company), and you are in a position to evaluate her. Please describe this situation in which you have power over Mary in as much detail as possible, including how you would act, and how you would feel.

For example, what impression do you think Mary has of you?

What kind of influence do you have over Mary?

How might your decision about the job affect Mary's life?

What feelings would you experience during the interview?

What does it feel like to be you?

Etc…

Low-power

Please take a moment to imagine, as vividly as possible, that **you are Mary** in the situation above. Thembelihle has power over you. By power, we mean a situation in which someone else (Thembelihle) controls your ability to get something you want (a job in the company you've always wanted to work for), and she is going to evaluate you. Please describe this situation in which Thembelihle has power over you in as much detail as possible, including how you would act, and how you would feel etc.

For example, what impression do you think Thembelihle has of you?

What kind of influence does Thembelihle have over you?

How might Thembelihle's decision about the job affect your life?

What feelings would you experience during the interview?

What does it feel like to be you?

Etc…

Appendix E

Manipulation check

Carefully read the questions below and then answer as accurately as possible.

Please note, **there is no wrong or right answer**.

1) Think about how you were feeling when the situation you recalled was taking place.

What emotion/s were you experiencing at the time?

_____

How intense were your emotions?

Not at all intense Very intense

0	1	2	3	4	5

2) Think about how you were feeling when you wrote about your memory just now.

Did you find it difficult to properly re-experience the event?

Very difficult It was easy

0	1	2	3	4	5

What emotion/s were you experiencing while you were writing?

_____

When you were writing, how intense were your emotions?

Not at all intense Very intense

0	1	2	3	4	5

Appendix F

Online screening and demographics

Informed consent

Why is this research being done – what is it trying to find out?
This research is being done to find out more about how certain emotions influence perceptions of the body.

Why are you being invited to take part?
You are being invited to take this screening survey because you have expressed an interest to participate.

What procedures, drugs or other treatments are involved in this research?
If you meet the eligibility criteria for this study, you will be invited to participate in an experimental session. During the experimental session you will be requested to fill in several questionnaires that will ask you about aspects of your personality and emotional feelings. We will also assess your ability to monitor bodily processes, and ask you to perform a memory-recall exercise. Finally, we will take measurements of your height and weight.

What are the risks and discomforts of taking part in this research?
There are no risks involved in this study. All information you provide is kept strictly confidential. Your identity will remain anonymous throughout the research.

Are there any benefits to you if you take part in this research?
Psychology students will be compensated with 2 SRPP points for participating in the experimental session. Please note that no SRPP points will be awarded for completing the screening questionnaire.

What happens if you do not want to take part in this research?
Nothing. It is your right to not take part in the research, or to withdraw at any time during the research with no consequence to you, whatsoever. Furthermore you may request that your data be removed confidentially from the dataset.

What happens at the end of this research?
Debriefing will take place once all data is collected. This will allow you the opportunity to learn more about the aims and objectives of the study.

*Required

I have read and understood the above and would like to participate *

- ○ Yes
- ○ No

NEXT

Never submit passwords through Google Forms.

Demographics

Name *

Your answer

Student number *

Your answer

Preferred email address *

Your answer

Date of birth *

Date

mm/dd/yyyy

Weight (in kilograms) *

If you are not sure how much you weigh, please give your best guess.

Your answer

Height (in centimeters) *

If you are not sure how tall you are, please give your best guess.

Your answer

I am... *

- Right-handed
- Left-handed
- Ambidexterous

Race *

e.g. "African", "White", etc.

Your answer

Are you a South African citizen? *

- Yes
- No

Do you have a history of traumatic head injury? *

- Yes
- No

Do you have a history of psychiatric illness? *

- Yes
- No

Are you currently taking any psychiatric medication? *

- Yes
- No

Appendix G

Debriefing email

Dear _____ (Participant name)

Thank you for participating in my study on emotion and perception of bodily processes!
There were two possible writing prompts you could have received, each intended to elicit a different emotional response: namely an increased sense of power, or a reduced sense of power. We hypothesised that these different emotional states would impact interoceptive accuracy in different ways.

Interoceptive accuracy, or the ability to accurately perceive internal bodily signals (like your heartbeat) varies from person to person, and likely throughout the course of the day. The aim of this particular research was to investigate how interoceptive accuracy might be linked to current feeling states. An accurate reading of interoceptive accuracy at a trait level would likely require several readings on different occasions, which was beyond the scope of this study.

Our hope in investigating the links between interoception and different emotions is that it might ultimately contribute towards new ways of understanding how individual differences in bodily processes influence coping in response to different psychological reactions.

Should you feel that you are experiencing psychological difficulties as a result of your participation in this study, please feel free to make use of UCT's Student Wellness Service (if you are a UCT student), or any of the other alternatives listed below.

UCT Student Wellness Service: Tel: **021 650 1017 / 1020**
28 Rhodes Ave, Mowbray, 7700

Alternatives

- SADAG UCT Student Careline: **0800 24 25 26 FREE** free from a Telkom line, or SMS **31393**for a call-me-back.
- If you have experienced any form of trauma, or are in any form of distress, and would like to talk to a counsellor, you are welcome to call the National Student Helpline* on the following toll free

number: **0800 41 42 43 FREE**.

* *Operated by the SA Depression & Anxiety Group*

- If you are feeling suicidal or are concerned about another person who is talking about suicide, please call the National Suicide Crisis Line the following toll free number: **0800 567 567 FREE** or SMS 31393.

If you have any further questions about the study or concerns about your participation, please feel free to contact me.

Appendix H

Letter of ethical approval

UNIVERSITY OF CAPE TOWN

Department of Psychology
Research Ethics Committee
Rondebosch, 7701
Tel: 27 21 6504607 Fax: 27 21 6504104
E-mail: Lauren.Wild@uct.ac.za

26 September 2016

REFERENCE NUMBER: PSY2016-042

Researcher Name: Freda Swan
Researcher Address: Department of Psychology, University of Cape Town

Dear Ms Swan

PROJECT TITLE: Interoception: An embodied mechanism of resilience

Thank you for your submission to the Department of Psychology Research Ethics Committee.

It is a pleasure to inform you that the Committee has **granted approval** for you to conduct the study.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote your REFERENCE NUMBER in all your correspondence.

Yours sincerely

Associate Professor Lauren Wild
Acting Chair, Department of Psychology Research Ethics Committee

Appendix I

Informed consent form

PARTICIPANT INFORMATION LEAFLET AND INFORMED CONSENT

Informed Consent Document

Instructions:

Please read through the following questions and their answers very carefully. After you have read through the document, please comment on whether you understood everything written in it, and sign where indicated.

If you have any further questions or concerns, please feel free to contact us:

Principal Investigator: Mark Solms

Department of Psychology **Tel: 021 650-3417**

University of Cape Town, Upper Campus

Rondebosch, Cape Town

Why is this research being done – what is it trying to find out?

This research is being done to find out more about how certain emotions influence perceptions of the body.

Why are you being invited to take part?

You are being invited to take part because you have expressed an interest to participate.

What procedures, drugs or other treatments are involved in this research?

During this experiment you will be requested to fill in several questionnaires that will ask you about aspects of your personality and emotional feelings. We will then assess your ability to keep track of your heart rate, followed by a memory-recall exercise. Finally, we will take measurements of your height and weight.

What are the risks and discomforts of taking part in this research?

There are no risks involved in this study. All information you provide is kept strictly confidential. Your identity will remain anonymous throughout the research.

Are there any benefits to you if you take part in this research?

Psychology students will be compensated with 2 SRPP points.

What happens if you do not want to take part in this research?

Nothing. It is your right to not take part in the research, or to withdraw at any time during the research with no consequence to you, whatsoever. Furthermore you may request that your data be removed confidentially from the dataset.

What happens at the end of this research?

Debriefing will take place once all data is collected. This will allow you the opportunity to learn more about the aims and objectives of the study.

Having read through all the questions and answers, please comment on whether you understand everything written in it, if not then please comment on what you did not understand, or any concerns that you might have:

(Please turn over)

_____

Full names and surname (Please Print): _____

Student number (for SRPP points): _____

Signature: _____ Date: _____

What if Something Goes Wrong?

Prof. Mark Solms, is covered under University of Cape Town no fault clause of the University of Cape Town Insurance. As per this: the University of Cape Town (UCT) undertakes that in the event of you suffering any significant deterioration in health or well-being, or from any unexpected sensitivity or toxicity, that is caused by your participation in the study, it will provide immediate medical care. UCT has appropriate insurance cover to provide prompt payment of compensation for any trial-related injury according to the guidelines outlined by the Association of the British Pharmaceutical Industry, ABPI 1991. Broadly-speaking, the ABPI guidelines recommend that the insured company (UCT), without legal commitment, should compensate you without you having to prove that UCT is at fault. An injury is considered trial-related if, and to the extent that, it is caused by study activities. You must notify the study doctor immediately of any side effects and/or injuries during the trial, whether they are research-related or other related complications.

UCT reserves the right not to provide compensation if, and to the extent that, your injury came about because you chose not to follow the instructions that you were given while you were taking part in the study. Your right in law to claim compensation for injury where you prove negligence is not affected. Copies of these guidelines are available on request.

What if you have complaints about the study? If you want any information regarding your rights as a research participant, or have complaints regarding this research, you may contact Prof. Marc Blockman, the **Chairperson of the Research Ethics Committee** at the University of Cape Town. The contact information for the HREC is as follows:

Human Research Ethics Committee
Faculty of Health Science
E-52-54 Groote Schuur Hospital Old Main Building
Observatory 7925
Tel: (021) 406 6626
Fax: (021) 406 6411
Email: lamees.emjedi@uct.ac.za

After you have consulted your doctor or the ethics committee and they have not provided you with answers to your satisfaction, you should write to: The Registrar, South African Medicines Control Council (MCC), Department of Health, Private Bag X 828, PRETORIA 0001.