Uncomfortably Numb: New Evidence for Suppressed Emotional Reactivity in Response to Body-threats in those Predisposed to Sub-Clinical Dissociative Experiences.

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Abstract

Introduction: Depersonalization and derealization disorders refer to feelings of detachment and dissociation from one's '*self*' or surroundings. A reduced sense of self (or '*presence*') and emotional 'numbness' is thought to be mediated by aberrant emotional processing due to biases in self-referent multi-sensory integration. This emotional 'numbing' is often accompanied by suppressed autonomic arousal to emotionally salient stimuli.

Methods: 118 participants completed the Cambridge Depersonalization scale (Sierra & Berrios, 2000) as an index of dissociative anomalous experience. Participants took part in a novel 'Implied Body-Threat Illusion' task; a pantomimed injection procedure conducted directly onto their real body (hand). Objective psychophysiological data were recorded via standardised threat-related skin conductance responses and finger temperature measures.

Results: Individuals predisposed to depersonalization / derealization revealed suppressed skin conductance responses towards the pantomimed body-threat. Although the task revealed a reliable reduction in finger temperature as a fear response, this reduction was not reliably associated with measures of dissociative experience.

Conclusions: The present findings significantly extend previous research by revealing emotional suppression via a more direct body-threat task, even for sub-clinical groups. The findings are discussed within probabilistic and predictive-coding frameworks of multi-sensory integration underlying a coherent sense of self.

Introduction

Aberrations in self-consciousness are not just associated with neurological conditions, mental illness, psychosis and psychopathology. A growing body of research now clearly demonstrates that such experiences can and do occur in sub-clinical populations in the apparent absence of these disorders and conditions (Johns & van Os, 2001; Tien, 1991; Verdoux & van Os, 2002). The emerging picture is one in which aberrant experiences appear to be distributed in the general population with individuals showing greater / lesser predisposition to certain forms of anomalous experience. However, the underlying neurocognitive mechanisms driving these sub-clinical experiences awaits detailed clarification.

A constant multitude of inter-sensory processing culminates in a coherent experience of the bodily '*self*'; of being the agent of one's own actions, feeling embodied, and having a salient sense of *'presence'*; the conscious experience of *being present in the here and now* (Blanke, 2012; Blanke & Metzinger, 2009). Disorders or discrepancies in this sense of presence are associated with many dissociative states and conditions (Apps & Tsakiris, 2014; Braithwaite, Broglia & Watson, 2014; Brugger, 2002; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Sanchez-Vives & Slater, 2005; Seth, 2009; 2013; Seth, Suzuki, & Critchley, 2012). One example is the dissociative condition known as depersonalization disorder (DPD).

DPD is characterised by a persistent or recurrent disruption in self-awareness typically revolving around feelings of disembodiment and a subjective emotional numbing (see Table 1: Sierra, 2009; Sierra & David, 2011; Simeon et al., 2000). Patients often describe feeling detached or estranged from themselves, from their bodies and from their emotions. This can be conceptualised as an overall and general emotional numbness, in which individuals are less responsive or even aware (hence '*numb*') to informational sources from the self or the world. In essence, DPD pertains to either an unreality for the self or one's surroundings (the latter being termed derealisation). In more general terms, DPD represents a case in which the observer experiences a dissociative and altered sense of presence (Seth 2009; 2013). Although both depersonalisation and derealisation are seen as separate aspects, both can and do co-occur, and are incorporated into the overall condition known as DPD. Patients with DPD also report a host of anomalous body experiences. Unless occurring co-morbidly with other conditions (i.e., migraine or epilepsy), DPD is not typically associated with hallucinations (Sierra, 2009). Instead, the aberrant perceptions are more accurately defined as *distortions* in human experience; in sensory information that does exist, as opposed to perceiving something which has no external reference.

Table 1. Phenomenological characteristics and principle features of depersonalization and derealization that can make up DPD.

Depersonalization:	*Derealization:*
Self feels unreal	Surroundings feel unreal
Estranged from oneself	World feels dreamlike
Body actions do not feel real	Experiencing through a fog / veil
Dulled bodily sensations	Loss of vibrancy / realism
Flattened emotions	Dulled emotional reaction
Feel like an automaton / robot	Disconnection from the world
Loss of connection to body	World drained of colour and feeling

Theoretical Accounts

One prominent theoretical account proposed to explain the aberrant experiences reported by patients with DPD, argue for a fronto-limbic suppressive network where structures like the anterior insula and the amygdala become inappropriately inhibited by over-active inhibitory connections emanating from frontal regions (Phillips & Sierra, 2003; Sierra & Berrios, 1998;

for imaging evidence see Phillips et al., 2001; Lemche et al., 2007; 2008). As a net consequence of these interactions, emotion is divorced and prevented from colouring the typical integration between perception and cognition resulting in an altered, diluted, sense of presence and the subjective feelings of ‘unreality’.

Other more recent accounts concentrate on the constant dynamic interactions between intersensory processing and the setting up of top-down / bottom-up contingencies in producing a stable sense of embodiment and presence. Predictive-coding accounts are particularly noteworthy in this regard. Predictive-coding accounts of sensory integration are based on probabilistic (Bayesian) principles applied to sensory processes. According to these accounts, perceptual systems must reconcile new incoming sensory information against pre-existing expectations (referred to as *priors*) that constantly derive probabilistic predictions about the self and its surroundings (Clark, 2013; Friston, 2005; 2010).

A stable sense of presence and self-awareness results from the successful suppression of the emerging *prediction error* from the interaction between bottom-up sensory information and top-down predictive models (*priors*). The desired outcome is a close correspondence (or conversely, a low level of sensory discrepancy) between these sources of information. However, these probabilistic interpretations can become corrupted, and aberrant biases in this process can lead to disorders in the sense of presence, embodiment and self-awareness (Bechara & Naqvi, 2004; Clark, 2013; Critchley et al., 2004; Herbert, Herbert & Pollatos, 2011; Corlett, Frith & Fletcher, 2009; Corlett, Honey, & Fletcher, 2007; Corlett, Taylor, Wang, Fletcher & Krystal, 2010; Friston, 2005; 2010; Seth, 2009; 2013; Seth et al., 2012; Tsakiris, Tajadura-Jiménez & Costantini, 2011; see also Apps & Tsakiris, 2014). These predictive process are legion, constantly unfolding and occurring throughout a distributed network and at all levels of a hierarchically organised neuromatrix mediating self-consciousness.

Interestingly, some of these theoretical frameworks cast emotion (or 'interoception') as a crucial component in this predictive process. By these accounts the subjective experience of emotion results from the perception and recognition of changes in internal bodily states in response to external objects or emotional stimuli (e.g., increased heart rate in stressful situations). Further, an individual's intensity of the experienced emotion is reflected by the degree of sensitivity to internal bodily responses (Bechara & Naqvi, 2004; Critchley et al., 2004; Damasio, 2003; Herbert et al., 2011; Seth, 2009; 2013; Seth et al., 2012; Tsakiris et al., 2011; see also Medford & Critchley, 2010; Medford, 2012; for discussion). Interoception refers to the awareness of internal visceral / physiological body signals whereas exteroception relates to the perception of incoming signals from the outside world / environment. Accordingly, predictive processes rely on both interoceptive and exteroceptive sources for the successful multisensory integration of self-referent signals; resulting in stable embodiment, body-ownership and a salient sense of presence.

In its simplest form, these probabilistic predictive processes ask; *"to what extent are these signals from me?"* and typically, these sensory contingencies arrive at an appropriate, probable, conclusion that the signals are *'me'* when indeed they are (due to the successful suppression of prediction error). However, it follows that aberrant experiences and disorders of presence may occur due to pathologically imprecise interoceptive (body-based) predictive signals. Specifically, imprecise predictions may lead to a failure to correctly integrate interoceptive body signals with exteroceptive information - leading to the false probabilistic interpretation that signals are '*not me'* when in fact they are (under-embodiment). It has been argued that such imprecisions might result in feelings of dissociation and disconnection from the bodily self, where the body no longer feels *real,* due to a remaining and aberrant degree of prediction error.

Put simply, non-suppressed prediction error leads to imprecision in probabilistic interpretations based on interoceptive / exteroceptive sources of information that result in a weakened saliency of the sense of self. Therefore, in the case of DPD, the brain decides that such bodily signals are '*not coming from me*' when in fact they are. Ultimately, this is somewhat akin to a Type II error in statistics, in that the system decides that there is not a significant '*me*' signal when in fact there is. Both the fronto-limbic and predictive / interoceptive coding accounts provide useful theoretical frameworks for understanding the aberrant experiences reported in DPD. Furthermore, these accounts may not be mutually exclusive, as aberrant fronto-limbic connectivity may influence the imprecision present in the system.

The Present Study

We examined neurocognitive biases underlying aberrant body experiences in a sub-clinical group. This was achieved by screening participants on questionnaire measures of trait-based dissociative experience and a novel body-threat illusion task. Previous research has established that patients diagnosed with DPD show a suppressed emotional response to aversive stimuli and that such biases are likely related to a reduced sense of presence and the distorted sense of self and surroundings often reported (Phillips et al., 2001; Sierra et al., 2002; Sierra, Senior, Phillips & David, 2006).

Some of these studies have investigated the issue using picture stimuli (i.e., the International Affective Picture System: Sierra et al., 2002; 2006) which depict various forms of generic aversive visual imagery, or aversive auditory tones (Giesbrecht, Merckelbach, ter Burg, Cima, & Simeon, 2008). Interesting, however the central characteristics of DPD involve anomalous body experiences (an unreality of the self), and studies using the IAPS or auditory probes do not measure biases in relation to aversive body-specific processing.

Indeed, there appear to be few, if any, studies examining biases in body-specific processing directly in relation to the anomalous body experiences reported by individuals. This is a problematic omission because probabilistic predictive-coding accounts of dissociative experience claim interoceptive awareness (body-states / visceral signals) is central to the experience of, and disorders in, presence. As a consequence of these theoretical developments, the need for tasks that examine body-processing more directly has increased in prominence[1].

The present study sought to address this explanatory gap by investigating emotional fear / anxiety responses (skin conductance responses and finger temperature) elicited by a perceived threat to the observer's own body. For this study we devised a novel procedure in which individuals experienced a fake blood-giving procedure carried out on their own hand. We term this the *"Implied Body-Threat"* (IBT) illusion. Individual predisposition to anomalous dissociative experiences was also measured.

A direct body-threat illusion was chosen because it has a number of advantages relative to alternative paradigms. First, as it is a clear threat to the individual's own body it is certainly more direct than passively viewing emotive images that may have little relevance to measuring embodiment / ownership per-se. Therefore, it may well be more accurate and more sensitive than aversive images for revealing differences in specific body-related processing.

Second, unlike the rubber-hand illusion or studies using virtual reality we do not need to induce an illusion of ownership / embodiment before carrying out our experimental manipulations as the illusion is carried out directly on the individuals own limb / body. Therefore, in our new procedure, individuals do not first have to undergo any induction procedure to assimilate an alien object that represents, but is not, the real hand. Furthermore,

[1] Oswald (1959) did investigate emotional responses to electric shocks - participants described being more dissociated at the time of the more extreme shocks. However, this current task differs significantly in that participants see the threat unfolding before them, have direct visual / tactile evidence of the threat taking place, and have been screened for latent predisposition to depersonalization / derealization type experiences.

the effectiveness of generating such illusions and the illusion strength may vary as a function of habitual endogenous predisposition to specific forms of anomalous experience (out-of-body experience, depersonalization, schizotypy, etc.). Finally, a task involving the hand was devised because patients with DPD most often describe an 'unreality' of the hands and face compared with other body parts (see Sierra & David, 2011 for a review).

Predictive-coding models of interoceptive awareness imply that latent biases in multi-sensory integration should also be present, albeit in attenuated form, in sub-clinical levels of dissociative states like depersonalization / derealization. By this account, those scoring higher on measures of dissociative experience should also show more suppressed fear responses to a perceived threat to one's own body than those with lower scores. If depersonalization represents a form of reduced saliency in the sense of presence, the observer might feel so removed and dissociated from their own physical body that they might not perceive the threat as being ‘as threatening’ or ‘as real’ towards one’s own body, thus resulting in a reduced fear response (cf. Phillips et al, 2001; Sierra et al., 2002; 2006; Sierra & David, 2011).

Two objective psychophysiological measures were taken, skin conductance responses (SCRs) and finger temperature. Based on the previous research discussed above, it was predicted that SCRs for threats would be suppressed for those predisposed to dissociative states. In addition, and slightly more speculative, it was hypothesised that those predisposed to dissociative experience might also show aberrant habituation patterns to repeated threats, which would be in line with broader research on schizophrenia and non-clinical groups showing signs of proneness to psychosis (Allen, Freeman, & McGuire, 2007; Dawson, Nuechterlein, & Liberman, 1983; Dawson, Nuechterlein, Schell, Gitlin, & Ventura, 1994; Giesbrecht et al., 2008; Raine, Benishay, Lencz, & Scarpa et al., 1997). Habituation refers to the process whereby repeated presentation of an unusual stimulus typically results in a reduction or complete disappearance of the autonomic response.

As an additional objective measure of autonomic arousal, surface body (finger) temperature was also measured. Research has argued that the hypothalamus and preoptic area (PO) play crucial roles in effective body temperature regulation, and a wealth of research has explored thermoregulation with respect to behaviour such as psychological reactivity to stress (Hammel, 1968; Nagashima, Nakai, Tanaka, & Kanosue, 2000; Oka, 2015; Oka, Oka & Hori, 2001). Indeed, drops in finger temperature have been associated with fear / anxiety responses (Vinkers et al., 2013), and have been demonstrated under body-illusion conditions (full body illusions: Salomon, Lim, Pfeiffer, Gassert & Blanke, 2013; the Rubber-hand illusion, RHI: Moseley et al., 2008; Kammers, Rose, & Haggard, 2011; Thakkar, Nichols, McIntosh, & Park, 2011: though see also Hohwy & Paton, 2010; Paton, Hohwy, & Enticott, 2012 for failures to replicate). This has led some researchers to suggest that such drops in temperature could also be used as a reliable index of fear processing, and that temperature regulation must therefore involve higher, top-down cognitive processing between physiological regulation of the physical self and the conscious 'self' (Moseley et al., 2008). The present study goes beyond previous work in that a direct body-threat task was used to examine fear / anxiety responses and such biases in emotional processing were explored in those showing sub-clinical levels of dissociative experience (depersonalization / derealization), thus increasing the relevance of such findings to wider populations.

Method

Participants

One hundred and eighteen participants were recruited from the School of Psychology, University of Birmingham (UK) and members of the general public. Of these, 105 were female (89%), and 110 were right-handed (93%). Participants ranged in age from 18 to 45 years (*M* = 19 years, SD = 2.68). All self-reported no medical history of migraine, epilepsy or seizure.

Measures

Cambridge Depersonalization Scale (CDS)

The trait version of the Cambridge Depersonalization Scale is a well-established and reliable index of predisposition to dissociative and anomalous experiences that are often associated with depersonalization and derealization (Sierra & Berrios, 2000; Sierra & David, 2011). For all 29-items, participants provide a frequency score on a 5-point Likert scale (from 0 - *Never,* to 4 - *All the time*) and a duration score on a 6-point Likert scale (from 1 - *Seconds,* to 6 - *Over a week*). Frequency and duration scores are then summed for each item, giving a potential range of scores between 0 – 290. The measure has high internal consistency (Cronbach alpha = 0.89). Exploratory factor analysis has revealed a four-factor structure accounting for 73.3% of the variance (Sierra, Baker, Medford & David, 2005). The factors were identified as: (i) Anomalous Bodily Experiences (ABE), (ii) Emotional Numbing (EN), (iii) Anomalous Subjective Recall (ASR), and (iv) Alienation from Surroundings (AFS: pertaining to derealization experiences). For the purpose of the present study the CDS was used to quantify individual’s predisposition to dissociative aberrant experiences indicative of depersonalization / derealization type experiences.

The 'Implied Body-Threat' illusion (IBT)

Participants took part in our newly devised IBT procedure. This began with the verbal reading of a short description detailing the upcoming procedure (this lasted approximately 70 s). To avoid contamination from possible startle responses, participants were fully informed that they would receive a "*pantomimed blood-giving procedure".* Note – at no point were phrases such as 'fake' or 'pretend' used so as not to render the procedure completely benign in its potential to elicit a fear / anxiety response. Participants were asked if they were happy to continue and informed that the experimenter could no longer converse with them during the process, but they were free to comment openly at any time. Participants were also told that they could withdraw at any point during the procedure. If consent was obtained, participants were instructed to view their real hand and the IBT procedure at all times. The experimenter then began the scenario by putting on a pair of medical / surgical latex gloves and dry swabbing the skin on the hand with cotton wool as if to prepare the skin region for a typical injection. Dry swabbing was used to avoid a response due to the application of a potentially cold water / alcohol swab. This was followed by a simulated blood-giving procedure administered directly onto the participant's real hand, using a realistic 5 cc needle / syringe[2]. The syringe was a 5 cc (cubic centimetres) plastic unit with a 2.5 inch needle.

The syringe was made visible and moved towards the hand at a steady / realistic pace, then pressed up against the participant's real hand and after a short pause, the needle was 'inserted' into the limb. Once fully 'inserted', the experimenter slowly withdrew the plunger by pulling it backwards approximately 3 cm along the length of the plastic unit (which was 7 cm in total length). This caused the lower area of the syringe to seeming fill with simulated 'blood' (actually a realistic film grade special effects material). Pilot testing revealed that this was sufficient enough to 'suggest' blood-giving and provide a strong visual cue, while not

[2] Note, the syringe was fitted with a spring loaded retractable needle. As the needle was pressed up against the skin it retracted into the body of the syringe yet gave the strong perceptual effect of entering the limb.

being overly long and protracted so as to become unbelievable. The syringe was then removed from the hand (and from view) and the area was again swabbed clean (Figure 1).

This threat procedure was repeated three times over an approximate 80 s period. After the final threat, participants were instructed to simply remain fixated on their hand for 40 s (timed by the experimenter) to provide a post-threat baseline period. The entire procedure took approximately 190 s (3 min: including the instructions, threat period, and post-threat baseline).

Figure 1. A pictorial representation of the IBT procedure in sequential order (top left to bottom right) showing the simulated threat (blood giving procedure) to the participant's real hand. Also shown are the psychophysiological sensors; finger temperature (participant's left hand) and skin conductance (participant's right hand).

Electrodermal Activity (EDA): Skin Conductance Responses (SCRs)

Psychophysiological measures were obtained using a MP36R data-acquisition unit (Biopac systems Inc, Goleta, CA), connected to a HP pro Elitebook 8740w mobile workstation running 64-Bit Windows 7OS). Data were sampled at 2 KHz from the index and middle fingers of the right-hand, via EL507 and SS57L sensor leads and disposable pre-gelled Ag-AgCl electrodes. All signal data were initially subjected to visual analysis. Where appropriate, artefacts were removed via a baseline smoothing algorithm by down-sampling the whole signal by 200 samples / sec. Next, data were analysed via Biopac AcqKnowledge software (v4.1), applying custom programmed Find-Cycles routines and Event-related analysis (Braithwaite, Watson, Jones & Rowe, 2013). SCRs were defined as a delta function between the onset of the SCR (crossing a threshold of 0.01µs - microsiemens) and the maximum peak amplitude reached for that SCR (see Figure 2 for an example signal). Threat SCRs were identified as those that satisfied the criteria outlined above and were the largest SCR that occurred or began to occur within 20 s of the needle / syringe being presented to the hand.

Threats that were delivered and produced no responses over the 20 s window were scored with a zero. All SCRs (deltas) were normalised via Log (SCR+1) corrections to enable suitable analysis (Dawson, Schell & Filion, 2007; Boucsein, 2012; Boucsein et al., 2012). Following the recommendations for standardizations to facilitate individual differences analysis (Ben-Shakhar: 1985; 1987; Bush, Hess & Wolford, 1993), SCRs from each individual participant were then standardised via z-score transformations. To do this, all specific threat-based and non-specific SCRs (NS-SCRs which are those not tied to specific stimuli / threats) of the signal were pooled, which generated a large 'sample' of SCRs from which a representative mean and standard deviation, per participant, could be derived. This procedure ensured that the threat-related SCR amplitudes were accurate representations of the individual's capacity to respond relative to the parameters of their responsivity (see Figure 2 for example signal).

The standardised SCR for the first threat (of three) delivered to participants provided a measure of psychophysiological reactivity (fear / anxiety) for each individual that was not contaminated by habituation (as it was the first threat viewed). Once standardised, these values were correlated with scores on questionnaire measures to examine if threat SCRs were suppressed in association with predisposition to dissociative experience. To provide an assessment of habituation, in line with previous research and suggestions outlined elsewhere (Allen et al., 2007; Raine et al., 1997), the third threat SCR was subtracted from the first threat SCR, to provide a metric of declination for each participant across the threat sequence. This difference was then correlated to questionnaire measures.

Finger / Body Temperature

Finger temperature measurements are considered reliable and sensitive measures of overall body temperature and thermal comfort (Wang, Zhang, Arens, & Huizenga, 2007). In addition, previous research has argued that drops in body / finger temperature can reflect a psychophysiological anxiety response (Vinkers, et al., 2013), and this has been shown for non-clinical samples in relation to body illusions (full body illusions: Salomon et al., 2013; the RHI: Moseley et al., 2008; Kammers et al., 2011; Thakkar et al., 2011: though see also Hohwy & Paton, 2010; Paton et al., 2012 for failures to replicate). Therefore, finger temperature was measured as an additional objective index of threat-related anxiety, via a separate channel on the same MP36R unit described above. Finger temperature (°C) was sampled continuously at 7.8 Hz using a reusable finger digit sensor (SS18LA) attached to the distal phalange of the index finger of the left hand (see example signal in Figure 2).

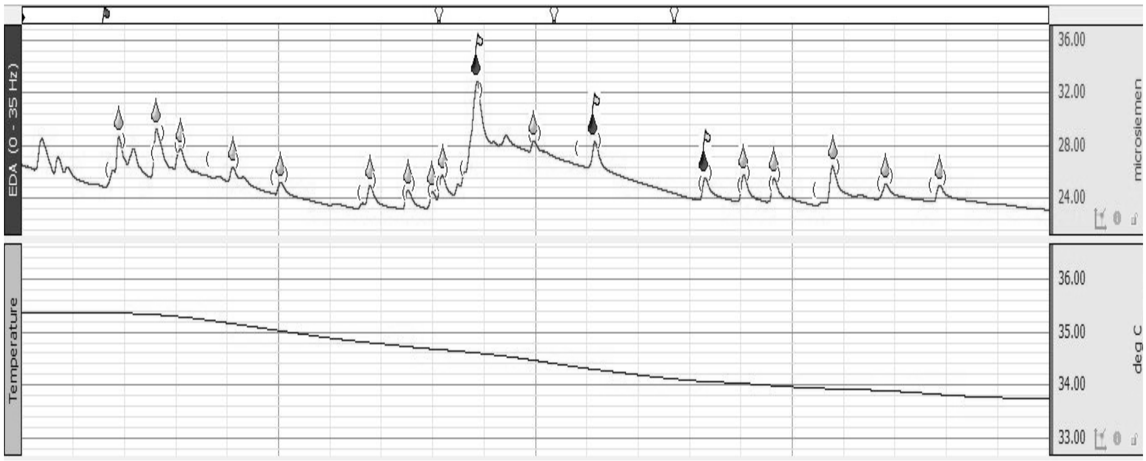

Figure 2. An example signal from the IBT (190 s). The top signal illustrates the phasic SCRs (microsiemens; depicted as water droplets): the three flagged water droplets indicate the three threat-related SCRs. All other SCRs (water droplets) are classified as NS-SCRs. The bottom signal illustrates body temperature declination in °C.

Procedure

Before any psychophysiological recordings were taken, all electrodes (SCRs and finger temperature) were attached for approximately 15 min before the start of data collection. This ensured optimum EDA contact and that the temperature sensor had stabilized. All participants then completed the CDS questionnaire. Following this, the experimenter gave the verbal instructions while psychophysiological measurements were taken, and this was followed by the IBT procedure. For the duration of the procedure, participants were instructed to remain as still as possible in order to provide quality psychophysiological data.

Results

Of the 118 participants tested, 18 participants (15%) were removed from the analysis for producing too few SCRs and thus classified as hypo-responders (based on criteria established and outlined by Dawson et al., 2007)[3]. The analysis was conducted on the remaining 100 participants (*M* = 19 years, SD = 2.90). When appropriate, Bonferroni correction was applied for multiple comparisons and corrected values were taken when homogeneity of variance could not be assumed. All SCRs were normalised using Log (SCR+1) calculations, and standardised using Z-score transformations (see method for detail).

In addition to standard frequentist statistics we also report the results of Bayesian analyses performed using the JASP package v0.7.5 (Love et al., 2015). This type of analysis produces a Bayes Factor (BF_{10}) which is a numerical measure of evidence in favour of the alternative ($BF_{10} > 1.0$) or null-hypothesis ($BF_{10} < 1.0$). For example, a BF_{10} of 10 indicates that the research hypothesis is 10 times more likely than the null. In contrast, a BF_{10} of 0.10 indicates that the null is 10 times more likely than the research hypothesis (for an introduction see Jarosz & Wiley, 2014). Generally speaking, Bayes factor probability scores of 3 - 10 are regarded as providing good to substantial evidence in favour of the alternate hypothesis, 10-100 to be strong to very strong, and >100 to be decisive (Raftery, 1995; Jeffreys, 1998; see Jarosz & Wiley, 2014).

IBT Illusion: SCRs

The average threat-SCRs (z-scores) for the three sequential threat presentations are presented in Figure 3.

[3] Approximately 10% of control / healthy populations and 25% of psychopathic populations are considered non-responders / hypo-responsive if a certain degree of SCR responsiveness is not displayed (see Dawson et al. 2007).

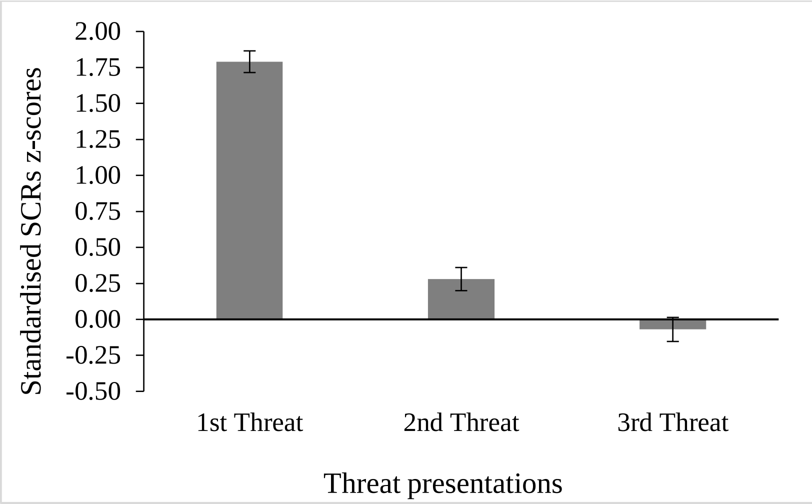

Figure 3. Standardised threat-SCRs (z-scores) for the three threat presentations during the IBT procedure (error bars indicate ±1 SE).

To examine emotional responses and their possible suppression in relation to predisposition to anomalous dissociative experience, a correlational analysis was conducted on SCRs to the first threat and individual scores on the CDS questionnaire. Note, threat SCRs had already been z-scored and thus standardised providing a more consistent measure of reactivity across individuals. In addition, by focusing on the first threat only, the effects of habituation were avoided. There was a significant negative correlation between overall CDS scores and SCR strength to the first threat, $r(100) = -.33$, $p < .001$, $BF_{10} = 26.62$. The higher the participants scored on the CDS measure of anomalous experience, the lower the amplitude of the threat SCR. This result suggests that predisposition to depersonalization / derealization type experiences is associated with a suppressed emotional response to the threat.

These findings were explored further by examining first threat SCR amplitudes to the individual factors of the CDS measure. Table 2 shows that all four factors on the CDS parallel the overall negative relationship reported above. When corrected for multiple comparisons, only the two factors ABE (Anomalous Bodily Experience) and AFS (Alienation from Surroundings) significantly correlated negatively with the first threat-SCR (the two factors EN: Emotional Numbing, and ASR: Anomalous Subjective Recall were not significant).

Table 2. Correlation coefficients of SCR amplitudes from the first threat with CDS factors. (Bonferroni-corrected alpha value of 0.01, * indicates significance).

	ABE	EN	ASR	AFS
Pearson's *r*	-.27*	-.21	-.22	-.31*
Sig. values	$p < .01$	$p = .036$	$p = .026$	$p < .01$
BF_{10}	4.53	1.09	1.42	13.49

These findings suggest that those predisposed to depersonalization and derealization (high scoring on the CDS factors) reveal attenuated autonomic arousal towards a threat directed at their real hand. Increased threat-SCRs and higher emotional arousal were associated with lower scores on these CDS factors.

Habituation

To assess habituation, following previous research (Allen et al., 2007; Raine et al., 1997), the SCRs from the third threat were subtracted from SCRs of the first threat for each participant to create a delta score of habituation. On average, the response to the first threat was greater than that to the third threat by 1.87µs (microsiemens). This difference was then correlated with predispositions to dissociative anomalous experience. Overall CDS scores correlated with the difference between the first and the third threat, and revealed a significant negative correlation, $r(100) = -.34$, $p < .001$, $BF_{10} = 44.05$. That is, as indices of anomalous experience increased, the difference between the first and the third threat decreased (less habituation).

When broken down across the four separate factors, only the ABE and AFS factors produced statistically reliable negative correlations (Table 3). This suggests that those scoring high on depersonalization and derealization experiences (ABE and AFS factors) demonstrate a smaller difference between the first and the third threat SCRs compared to those scoring low on the CDS measure.

Table 3. Correlation coefficients of the difference between the first and the third threat SCR amplitudes with CDS factors. (Bonferroni-corrected alpha value of 0.01, * indicates significance).

	ABE	EN	ASR	AFS
Pearson's *r*	-.29*	-.19	-.18	-.37*
Sig. Values	$p < .01$	$p = .050$	$p = .067$	$p < .01$
BF_{10}	9.74	.825	.652	133.53

Non-Specific SCRs

SCRs that occur spontaneously and are not tied to specific events are referred to as non-specific SCRs (NS-SCRs). These responses can also be taken as an indicator of general emotional arousal. Researchers have previously argued that their frequency can be a reliable indicator of negatively tuned emotions connected with internal mental states (Nikula, 1991; Boucsein, 2012). The frequency of NS-SCRs during the instructions compared with the post-threat period was used as an additional index of pre- and post-threat response. For each participant, the rate of NS-SCRs was calculated by counting the number of NS-SCRs and dividing by time (in seconds) for that period (frequency per sec: Figure 4). A paired t-test revealed that the frequency of NS-SCRs was significantly higher during the instruction period than in the post-threat period, $t(99) = 8.64$, $p < .001$, $BF_{10} > 1000$.

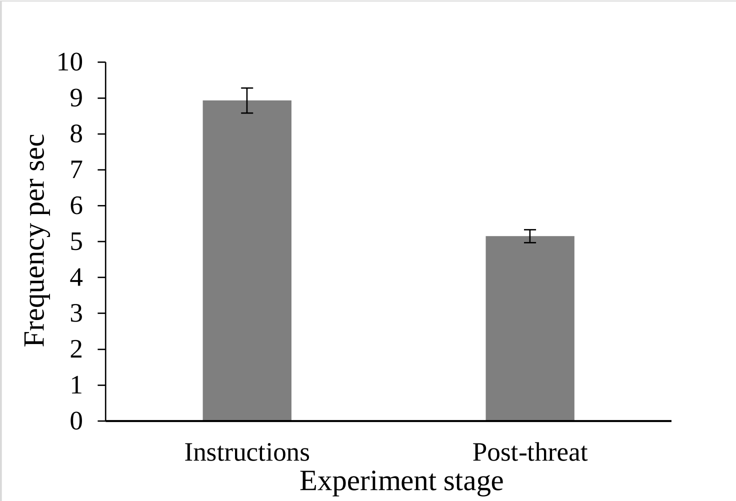

Figure 4. Frequency of NS-SCRs (NS-SCRs / second) during the instructions and post-threat periods (error bars indicate ±1 SE).

Frequency of NS-SCRs during both the instructions and post-threat periods were then examined relative to the CDS measure. The results revealed that there were no reliable correlations between total CDS scores and the frequency of NS-SCRs in the instructions period, $r(100) = .00$, $p = .994$, $BF_{10} = .125$, or in the post-threat period, $r(100) = -.04$, $p = .688$, $BF_{10} = .135$. The data were further explored with respect to the individual four factors of the CDS (Table 4). These analyses also revealed no reliable correlations between factors on the CDS and frequencies of NS-SCRs during the instructions and post-threat periods. These findings suggest that predispositions to anomalous experience had no association to differences in background autonomic activity levels.

Table 4. Correlation coefficients of NS-SCR frequencies for the instructions and post-threat periods correlated with CDS factors.

		ABE	EN	ASR	AFS
Instruction Freq.	Pearson's *r*	.09	-.08	-.00	-.01
	Sig. values	$p = .327$	$p = .418$	$p = .980$	$p = .913$
	BF_{10}	.201	.173	.125	.126
Post-threat Freq.	Pearson's *r*	.048	-.055	-.062	-.061
	Sig. values	$p = .633$	$p = .588$	$p = .538$	$p = .549$
	BF_{10}	.140	.144	.151	.149

The maximum SCR amplitude during both the NS-SCR periods (instructions and post-threat) were calculated and are presented in Figure 5. A paired t-test revealed that the maximum SCR was significantly greater during the instructions period than in the post-threat period, $t(99) = 9.86$, $p < .001$, $BF_{10} > 1000$. Participants, on average, demonstrated an increased maximum SCR amplitude in anticipation of the upcoming threat procedure compared to maximum SCR amplitudes in the post-threat period.

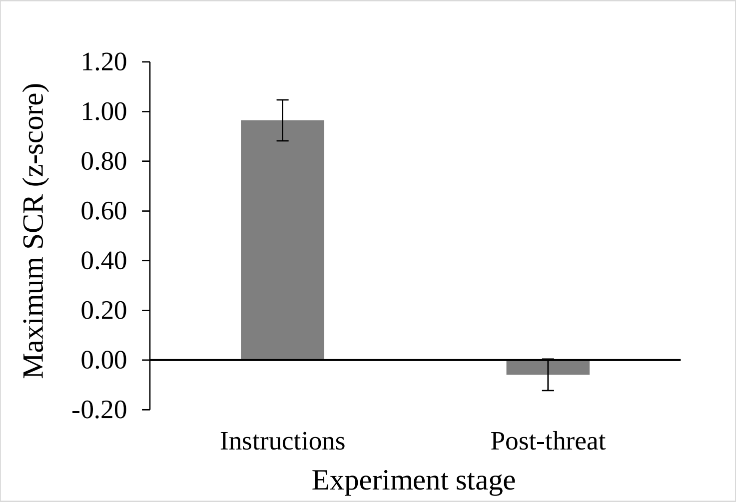

Figure 5. Maximum SCR (z-score) during the instructions and post-threat periods (error bars indicate ±1 SE).

This reliable difference in maximum SCR amplitudes during pre- and post-threat periods was then explored in relation to predispositions to anomalous experience. Total scores on the CDS measure revealed no reliable associations between the maximum SCRs amplitudes during the instructions, $r(100) = -.05$, $p = .601$, $BF_{10} = .143$, or post-threat periods, $r(100) = -.08$, $p = .444$, $BF_{10} = .167$. This pattern was also observed when the CDS was broken down over the four separate factors (Table 5). Similar to the above frequency findings, the data revealed that predisposition to anomalous experience had no reliable association with maximum SCRs pre- and post-threats.

Table 5. Correlation coefficients of Maximum SCR amplitudes for the instructions and post-threat periods correlated with CDS factors.

		ABE	EN	ASR	AFS
Instructions Max SCR	Pearson's *r*	.04	-.10	-.03	-.06
	Sig. values	$p = .675$	$p = .324$	$p = .768$	$p = .554$
	BF_{10}	.136	.202	.130	.149
Post-threat Max SCR	Pearson's *r*	-.08	-.03	-.08	-.03
	Sig. values	$p = .433$	$p = .777$	$p = .442$	$p = .774$
	BF_{10}	.169	.130	.167	.130

Findings from our NS-SCR data reveal that on two, independent measures of autonomic activity (frequency and maximum SCR amplitude) there were no reliable associations with predisposition to anomalous experience.

Finger Temperature

Average finger temperatures were calculated for three epochs across the experiment (1 = the instructions period; 2 = threat presentations; and 3 = post-threat period). As shown in Figure 6, mean temperature dropped significantly by approximately 0.7 °C from epoch 1 to epoch 3, $F(1.21, 119.50) = 195.19$, $p < .001$. Pairwise comparisons revealed that all temperature epochs significantly differed from each other (all *T*s > 10.16 and all *ps* < .001).

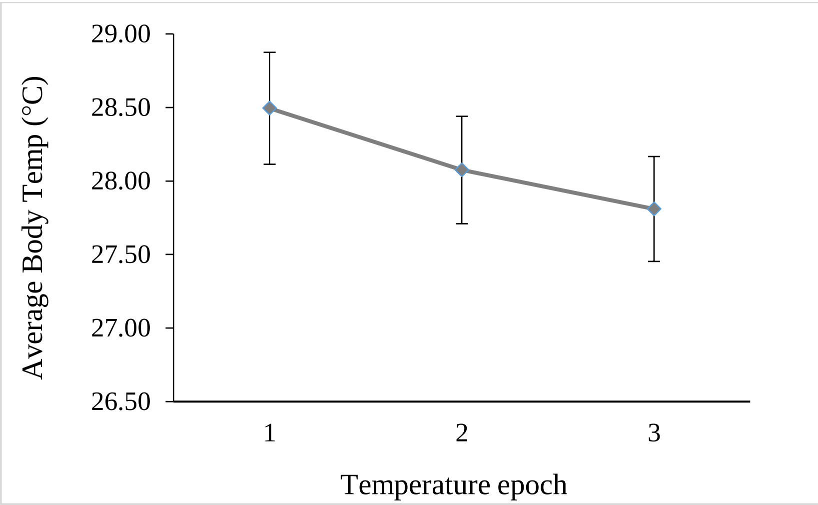

Figure 6. Average body temperature (°C) during the three epochs of the IBT procedure (error bars indicate ±1 SE).

The drop in finger temperature was characterised by calculating the slope of the temperature across the three epochs individually for each participant. The correlation between these slopes and the CDS scores was then taken as an additional measure of fear / anxiety response. Although finger temperature fell during the procedure (in line with the notion of a fear response; Figure 6), there were no significant correlations between total CDS scores and declinations in finger temperature, $r(100) = .01$, $p = .918$, $BF_{10} = .126$. A similar pattern was observed when the CDS was broken down into the four separate factors (Table 6).

Specifically, predisposition to anomalous bodily experience had no reliable effect on body temperature fluctuations when threats to the real hand were presented.

Table 6. Correlation coefficients of the average body temperature slope with CDS factors.

	ABE	EN	ASR	AFS
Pearson's *r*	-.01	.03	-.05	-.02
Sig. values	*p* = .929	*p* = .757	*p* = .650	*p* = .852
BF_{10}	.126	.131	.138	.127

Subjectively, 88% of participants endorsed the convincingness of the IBT procedure, declaring that it was highly realistic and akin to the experience of a real injection. Common expressions that were reported included *"I felt like I was receiving a real injection!"* and *"I felt anxious / nervous during the procedure".* Furthermore, nearly 20% of participants spontaneously reported the same physiological bodily sensations that they would usually experience when having a real injection such as perceiving an increase in heart rate, nausea and feeling "*weird*". Remarkably, these participants also reported the experience of tingling sensations and a weakness / numbness from the hand up through to the arm, and claimed to feel the sensation of blood being 'withdrawn' from their body.

General Discussion

This is the first study to our knowledge to examine biases in direct body-processing in those predisposed to sub-clinical levels of dissociative depersonalization / derealization experiences. The findings demonstrate clear evidence for a suppression in the emotional fear / anxiety response to a perceived threat to one's own body, providing the individual is also predisposed to dissociative experiences. In contrast to previous studies, our investigation demonstrates the presence of emotional suppression as a result of direct threats to the participant's actual body as compared to an illusory representation of it. Moreover, this was demonstrated within a sub-clinical group.

Findings based on SCR data revealed a significant negative correlation in which increased scores on measures of predisposition to depersonalization / derealization experiences were associated with a suppressed SCR threat response. The Bayes factor analysis revealed that this hypothesis was almost 27 times more likely than the null hypothesis. When broken down across the separate factors, significant negative correlations were observed for all factors, but primarily for the ABE and even more so, the AFS factors. This is consistent with the notion that those with a predisposition to depersonalization / derealization experiences also display a suppressed emotional response possibly reflecting a dissociative disconnection from the body / distortion in the sense of presence (Phillips et al., 2001; Sierra & David, 2011; Sierra et al., 2002; 2006; Seth, 2013; Seth et al., 2012). Here however, these effects were observed with a novel and direct own body-threat, with SCRs that had been standardised for individual differences thus facilitating a more sensitive analysis, and extended to those experiencing sub-clinical levels of aberrant experience. Importantly, the presence of a suppressed physiological response dovetails neatly with the phenomenological aspects (feeling 'unreal' and lifeless) reported by those suffering from DPD-type experiences.

Although an apparent habituation effect occurred for all participants (there was almost no SCR response at all by the third presentation of the threat), the rate of habituation correlated significantly with predisposition to dissociative experience (again, with the Bayes factor indicating that this hypothesis was 45 times more likely than the null). Higher scores on the CDS measure were negatively correlated with a smaller difference between the first and third threat. Although this finding is consistent with less habituation occurring in individuals predisposed to dissociative experience, it could equally reflect the suppressed response from the first threat already observed, thus generating a smaller delta function between threats one and three. Limitations in the current protocol (using only three threats) do not allow us to provide a more comprehensive analysis of habituation[4]. Future studies should be directed specifically at the habituation issue more directly by perhaps utilising more threat instances, in order to facilitate a more extensive modelling of the habituation profile, its recovery, and exploring state as well as trait based measures of anomalous experience in relation to these factors.

Interestingly, both the frequency and amplitudes of NS-SCRs increased significantly during the instruction period relative to the post-threat period. However, perhaps more importantly, neither correlated reliably with scores on the CDS measure. Although typically we should be cautious at interpreting a null result, the use of Bayes Factors facilitates some interpretation here. As a result, these findings are noteworthy for a number of reasons.

This finding could suggest either that the mere verbal suggestion of the body-threat procedure is sufficient to induce signs of an increased anticipatory anxiety response during the instructions period, or a flattening of emotional response for some time after a series of implied yet potent threats[5]. As the difference is relative, both accounts are possible. However, more importantly, the effect was no larger or smaller in those showing a predisposition to dissociative experience relative to those who did not. Therefore, these specific effects with NS-SCRs do not appear to be reliably associated with dissociative experience. As a

[4] Note - habituation effects were not the primary focus of this study. Utilising a three-threat procedure merely allowed us to take a cursory look at this additional factor.
[5] The increase in the frequency of NS-SCRs is thought to be associated with negatively tuned emotions (anxiety, fear, apprehension: Nikula, 1991; see also Boucsein, 2012; Dawson et al., 2007) though the increase in amplitudes of NS-SCRs is not as clearly associated with such cognitions. We report it here for completeness.

consequence, they most likely reflect a very typical form of responding in relation to tasks of this type.

However, the findings for NS-SCRs are crucial in that they show the suppression observed for the main threat SCRs cannot be due to an overall, non-specific ‘flattening’ in autonomic reactivity in those prone to dissociative experience. As noted above, there were no reliable differences in NS-SCRs as a function of dissociation (see Sierra & David, 2011; Sierra et al., 2002; 2006 for similar findings and arguments based on startle responses). If the results for the threat SCRs were simply due to non-specific factors, we would expect such differences (a flattening or suppression) to occur across all aspects of SCR responding, including during the instructions and post-threat periods. Instead, the reduced SCR response for those showing an increased predisposition to dissociative experience appeared to be specifically tied to the perception of the direct body-threat (the IBT) alone.

One reason for this selective correlation might be related to the overall level of the anxiety / fear induced. It might be the case that once a particular threshold is crossed, then those SCR responses elicit a counter-inhibitory process, one that is associated with dissociative experiences. By this account, the actual perceived threat (seeing the needle approach and seemingly penetrate the hand) would be sufficiently potent to reveal these differences (exceed the threshold), whereas the mere verbal suggestion and expectation of it (i.e., the description in the instructions phase) would not.

Importantly, these findings can be integrated into the fronto-limbic inhibition model of depersonalization. In their original neurological account, Sierra and Berrios (1998) argued that once a certain threshold of anxiety / fear is reached, specific neural systems within the medial prefrontal cortex are activated and inhibit emotional processing in the amygdala (and related limbic structures), leading to reductions in sympathetic output and emotional experience (Sierra & Berrios, 1998; Sierra, 2009; Sierra & David, 2011). Relating this concept to the current data, the average z-scored SCR for the instruction period was -0.15 compared with 1.79 for the first threat SCR. Thus, the threat SCR was approximately 12 times stronger than the NS-SCRs during the instructions period and this increase appears to have been sufficient for a reliable correlation to have emerged for the larger threat-related SCR.

One might wonder if the inhibitory mechanism has been triggered, why then are the threat SCRs still significantly higher than the NS-SCRs? Would the presence of an inhibitory mechanism not mean the opposite; that is, threat SCRs would be severely attenuated (due to a triggered inhibitory process) relative to the frequency or amplitude of NS-SCRs when no process has been triggered? However, it should be remembered that the suppressive mechanism is not absolute and would not be expected to lead to a complete cessation of autonomic responding - even less so with sub-clinical groups. A certain degree of emotional responsiveness would be required to trigger the process, however those resultant responses may never enjoy their full expression. The suppression then, should be thought of more in terms of a reduced strength in SCRs to threats - not something leading to a complete absence of them.

A possible alternative interpretation might be that the SCR responding is more related to the sensation of the pinprick of the needle rather than any anticipation of the threat per-se. However, there are a number of reasons why this is questionable. First, a previous study has shown significant anxiety responses in relation to the presentation of a needle merely approaching the hand and not actually making contact with it (Ehrsson et al., 2007). Second, in a sister paper we have found the blood-giving IBT to be very effective under 'rubber-hand' illusion conditions, where no needle touches the real hand at all. Therefore this alternative interpretation seems unlikely.

The reliable correlations observed between threat-related SCRs and the CDS measure of dissociative experience was observed mainly for both the Anomalous Body Experience (ABE) and Alienation from Surroundings (AFS) factors. The reasons for this are not immediately clear. However, other studies have shown identical findings with a perspective-taking task with those predisposed to out-of-body experiences - where only the ABE and AFS factors were reliably associated with performance (Braithwaite et al., 2013). Coupled to the present findings, this may imply that both of these factors are stable and reliable indicators of the core aspects of DPD, and are particularly sensitive for predicting the attenuated experiences of sub-clinical populations. It is also worth highlighting that even though the remaining two factors EN and ASR failed to reach significance, they show the same negative correlational relationship as the two reliable factors (ABE and AFS).

Finger temperature decreased as the illusion progressed over time from the anticipation of the threat (instructions period) to the post-threat period. These data provide converging support for the notion that finger temperature can be used to index anxious states and fear responses. However, there were no reliable associations between drops in temperature and CDS scores.

In terms of a broader discussion, it is also worth highlighting that previous findings of disruptions in thermoregulation during body-based illusions such as the RHI (Moseley et al., 2008) are believed to reflect a shift of ownership (a dissociation) from the real hand in favour of the alternate rubber hand. In regards to the present study, ownership of the limb was not experimentally manipulated yet we still observed a reliable drop in temperature. The present findings are perhaps more consistent with a general fear / anxiety response to the body-threat (see Vinkers et al., 2013), rather than reflecting shifts in limb ownership.

It should be noted however that the effects of changes in finger temperature are controversial both as an indicator of fear / anxiety responses (Marazziti, Di Muro &

Castrogiovanni, 1992), and in relation to the rubber-hand illusion and other body-based illusions (Hohwy & Paton, 2010; Paton et al, 2012; see also Sadibolova & Longo, 2014); which suggests a lack of reliability with such measures. Moreover, the precise biological and neuronal underpinnings of how psychological stress can regulate the areas mediating body temperature regulation are still unknown (Oka, 2015). Irrespective of the utility of finger temperature as an index of fear / anxiety processing, we found no associations with this variable and dissociative experience, while, at the same time, observed reliable associations with other objective autonomic measures (SCRs). To our knowledge, there has been no detailed investigation of body-temperature fluctuations in DPD or sub-clinical depersonalization-type experiences.

It should be acknowledged that measuring both hands for finger-temperature during the IBT would have improved on the current methodology and allowed an examination of whether effects were general or specific to the hand being threatened. However, an important point is that the current study focused on the main hand of interest (the one that did receive the threat) but even so, we did not observe any significant correlations with additional measures of anomalous and dissociative experience. Therefore, even if the temperature of the two hands had differed in some way, the hand of primary interest was measured, yet showed no reliable correlations.

Theoretical implications: In and out-of-the-body dissociative experience

The present findings are consistent with both the fronto-limbic suppression and interoceptive / predictive coding accounts for aberrations in the sense of presence associated with depersonalization (Seth, 2009; 2013; Seth et al., 2012; Sierra & Berrios, 2000; Sierra & David, 2011). However, our findings suggest that these frameworks might have merit even for sub-clinical levels of dissociative experience. We now provide some tentative speculations on the broader theoretical implications of these findings.

Aberrant neural connectivity and / or aberrant activity can underpin both the fronto-limbic and predictive coding accounts of anomalous experience. According to the fronto-limbic suppression account, perception of adverse threat / anxiety can exceed a given threshold and trigger an aberrant inhibitory process leading to a dissociation between emotion and cognition, culminating in a distorted sense of presence. It is noteworthy that this neurobiological account was developed for DPD patients - though it appears it may have some implications for sub-clinical groups. The notion that sub-clinical groups may have some form of widespread over-inhibitory feedback mechanism, which may well be due to dysfunctional neural pathways, might be a somewhat strong notion outside of patient groups - at least as originally proposed.

Predictive-coding accounts seek to explain disorders of consciousness and presence via a mismatch between incoming sensory data and internal expectations taking place at any one time in perceptual systems. The lower the level of sensory discrepancy (prediction error) between top-down and bottom-up sources of information, the stronger the sense of presence and selfhood. In other words, dissociative states can occur due to imprecise top-down predictive signals either producing or failing to suppress excessive prediction error.

The neural networks thought to mediate interoceptive awareness include the anterior insula cortex (AIC) which has a distributed connectivity with the frontal and somatosensory cortex as well as other subcortical regions including the amygdala (Critchley et al., 2004; Seth et al., 2012). These regions have also been previously identified in studies on disorders of consciousness that make up DPD and related conditions (Sierra & Berrios, 2000; Sierra, 2009; Sierra & David, 2011). The notion of suppression in predictive processes is supported by findings from the wider literature. For example, neuroimaging studies have demonstrated that hypo-activation in the AIC is associated with psychopathological symptoms and dissociative experience - which is consistent with the general notion of suppression in brain regions pivotal for emotional processing, embodiment, and prediction (Phillips et al., 2001). Therefore, emotional suppression could be a *consequence* of imprecision in the predictive process (non-suppressed prediction-error leading to suppressed emotional responding). Furthermore, suppression of the emotional response as a result of exceeding a threat threshold seems reasonable because we only observed effects with dissociative experience for the threat SCRs. There were no reliable effects for the NS-SCRs.

In a recent theoretical account, Uddin (2014) outlined the importance of the AIC in mediating multi-sensory processing, particularly in relation to behaviourally salient stimuli such as pain (referred to as the 'saliency network'). The insular cortex and its subdivisions are fundamental in salience detection, integrating relevant external sensory information with internal emotional and interoceptive states. Functional subdivisions of the AIC have now been proposed arguing for the co-activation of the dorsal AIC, which is known to be associated with cognitive processing areas; the ventral AIC, associated with affective processing areas; and the posterior AIC, associated with sensorimotor processing (see Uddin, 2015; for a review). The emerging view is that the aberrant engagement of specific subdivisions of the insula may trigger associated co-activations recruiting multiple brain regions in a widespread neuromatrix representing disorders of presence, which could be a key feature underlying many anomalous experiences associated with diverse neuropsychiatric disorders.

Thus, aberrant connectivity or activity in these networks may contribute to an aberrant saliency in attentional / emotional processing. If predictions about the interoceptive state of the body underpin subjective feeling states, then the present findings are consistent with imprecision in this process being associated with predisposition to distortions in the sense of presence, but here, even in sub-clinical groups.

In relation to DPD, imprecise predictions (priors) might lead to a failure to correctly integrate veridical interoceptive body signals with exteroceptive information. The net consequence of this is a false probabilistic interpretation that signals are '*not from me'* when indeed they are (leading to a form of under-embodiment: Seth, 2009; 2013; Seth et al., 2012). Such imprecision could underlie the attenuation in the sense of presence leading to the feeling of dissociation and disconnection from the bodily self in that the body no longer feels *real*. Put simply, imprecision results in a weakened sense of self.

Other findings are also consistent with this proposal. For example, Braithwaite et al., (submitted) examined biases in those predisposed to specific out-of-body experiences (OBEs) on the Rubber-hand illusion (Botvinick & Cohen 1998). Those predisposed to OBEs showed the same emotional response (SCRs) to a threat under asynchronous baseline conditions as they did under synchronous illusion conditions. There was no reliable difference in SCRs between the conditions. In addition, the asynchronous SCR was significantly larger for the OBE group than that seen for control groups. To explain these findings, Braithwaite and colleagues proposed a probabilistic predictive-coding mechanism in which OBEers over-embodied even in situations where the spatio-temporal contingencies were not tightly coupled (i.e., the asynchronous brushing condition of the illusion where visual and tactile information is 180-degrees out of phase).

The present study reports a single experiment designed to investigate multi-sensory biases in embodiment. It was not the aim of the present work to tease apart the finite subtleties from different overarching theoretical frameworks. Indeed, such a pursuit may well be a folly. For example, it is possible that probabilistic models and those positing an aberrant modulatory role for the frontal-lobe can be assimilated. Such aberrant connectivity between and within certain brain regions may well impact on the accuracy of predictive processes resulting in imprecision. By this view, imprecise predictions can be a consequence or emergent property of the over inhibitory fronto-limbic network identified by previous studies as being important for anomalous experiences in DPD. Although the present study does not differentiate between the possible alternatives, the fact that emotional suppression is primarily seen for aversive stimuli, and that we only observed effects for the threat SCR and not for NS-SCRs, suggests some selectivity in emotional responding and not a complete absence of it.

One way to reconcile the broader observations in the literature, with the present findings, might be to merge the idea of a trigger 'threshold' from the fronto-inhibitory account of emotional suppression to the predictive / interoceptive account of 'presence'. The prediction is that unless the threshold is reached or crossed, emotional processing would be relatively intact. However, additional biases in predictive coding may change the level of the threshold itself - making some observers more predisposed and others more resilient to being 'triggered' and having the resultant experiences. As a consequence, exploring the degree to which these models might be complementary rather than dichotomous is an important avenue for future research.

Collectively, those findings, and the current ones presented here suggest that diverse forms of dissociative experiences might reflect distinct forms of emotional / interoceptive processing. DPD-type experiences appear to reflect a 'dulling' or dampening of the emotional response resulting in a reduced saliency in the sense of self (under-embodiment). In contrast, OBEs appear to be associated with an inappropriate and increased emotional / interoceptive response, leading to an over-embodiment. The predictive-coding account then becomes attractive for explaining, at least in part, diverse dissociative experiences by the presence of over or under emotional activity mediated through interoceptive processes. The existence of a suppressed physiological response for those showing signs of depersonalization / derealization experiences may help to explain some of the phenomenological aspects where interoceptive sensations from the self are typically described as feeling unreal, lifeless, and dulled, resulting in the feeling of emotional numbness.

Conclusion

The present findings provide evidence for biases in self-awareness or ‘presence’ associated with predisposition to dissociative anomalous experiences in sub-clinical populations. Evidence of emotional suppression was shown based on psychophysiological responses which were reliably associated with predisposition to dissociative experiences. The findings are comparable with contemporary predicative coding / interoceptive awareness accounts of multi-sensory integration and disorders in the sense of presence they seek to model. The current study demonstrates such biases via the presentation of realistic threats directly to the body, and that they are present in sub-clinical populations (in attenuated form). In conclusion, the present findings support the notion that latent biases in interoceptive awareness are associated with dissociative experience and such accounts help to dovetail the reported phenomenology to a more tractable neurocognitive substrate.

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