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The depersonalized brain: New evidence supporting a distinction between depersonalization and derealization from discrete patterns of autonomic suppression observed in a non-clinical sample

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ABSTRACT

Depersonalization and Derealization are characterised by feelings of detachment from one's bodily self/surroundings and a general emotional numbness. We explored predisposition to trait-based experiences of depersonalization/derealization-type experiences and autonomic arousal toward simulated body-threats, which were delivered to the participant's own body (i.e. *Self*) and when observed being delivered to another individual (i.e. *Other*). Ninety participants took part in an "Implied Body-Threat Illusion" task (Dewe, Watson, & Braithwaite, 2016) and autonomic arousal was recorded via standardised skin conductance responses and finger temperature. Autonomic suppression in response to threats delivered to the Self correlated with increases in trait-based depersonalization-type experiences. In contrast, autonomic suppression for threats delivered to Others correlated with trait-based derealization-like experiences. Body-temperature and anticipatory arousal did not correlate reliably with predisposition to depersonalization- or derealization-type experiences. The theoretical implications of these findings are discussed in terms of a fronto-limbic autonomic suppression mechanism.

1. Introduction

During typical daily life, our experience of our bodily self is coherent and stable. We enjoy a firm feeling of embodiment with the conscious perceiving "self" located in its physical moorings. Such stable self-awareness is dependent on a multitude of multisensory processes, acting in concert to maintain a coherent sense of embodiment. Embodiment is a fundamental aspect of self-consciousness and underpins the notion that we are active cognizing agents, distinct from our environment and present in the here and now (Blanke & Metzinger, 2009; Ehrsson, 2012; Gallagher, 2000; Myachykov, Scheepers, Fischer, & Kessler, 2014).

A growing body of evidence suggests that the neurocognitive processes underlying stable embodiment can breakdown, leading to striking distortions in self-consciousness (Blanke, 2012; Blanke et al., 2005; Blanke & Arzy, 2005; Braithwaite, Broglia, & Watson, 2014; Braithwaite, Watson, & Dewe, 2017; Brugger, 2002; Lenggenhager, Tadi, Metzinger, & Blanke, 2007; Lenggenhager, Mouthon & Blanke, 2009; Seth, 2009, 2013; Seth, Suzuki, & Critchley, 2012). What is even more compelling is that such distortions are now known to occur spontaneously or can be artificially induced in non-clinical groups (Aderibigbe, Bloch, & Walker, 2001; Botvinick & Cohen, 1998; Braithwaite et al., 2017, 2014, 2013; Braithwaite, Samson, Apperly, Broglia & Hulleman, 2011; Ehrsson, 2007; Ehrsson,

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Holmes, & Passingham, 2005; Ehrsson, Spence, & Passingham, 2004; Hunter, Sierra, & David, 2004; Michal et al., 2009; see also Kessler & Braithwaite, 2016; Sierra, 2009). The emerging picture is one in which people can be placed on a continuum representing their predisposition to experiencing an aberration in self-consciousness (Johns & van Os, 2001; Verdoux & van Os, 2002; van Os, Hanssen, Bijl & Ravelli, 2000). Importantly, the presence of such experiences, in non-clinical groups, can provide crucial insights not only into the nature of aberrant experiences and those who experience them, but also more fundamental aspects of human self-consciousness.

In its clinical expression, depersonalization is characterised by a severe and profound disruption in self-awareness that can include aberrant bodily experiences and a subjective emotional "numbing" (Sierra, 2009; Sierra & David, 2011). Individuals often describe feelings of remoteness, of being detached or estranged from their bodies, a reduction in the sense of ownership or "presence" (i.e. of being in the here and now) and a flattening of affect (Medford, 2012; Medford, Sierra, Baker & David, 2005; Sierra, 2009; Sierra & Berrios, 1998, 2001; Sierra & David, 2011).

The overarching disorder of depersonalization subsumes two components, namely depersonalization (DP) itself which pertains to an unreality of the "self", and derealization (DR) which relates to an unreality of one's surroundings (Medford, 2012; Medford et al., 2005; Sierra, 2009; Sierra & David, 2011). Therefore, DP and DR can be seen as a kind of bias, with DP directed towards internal body-states and DR directed away from one's surroundings. Both depersonalization and derealization experiences (DP/DR) are examples of what happens when multisensory integration breaks down, with profound implications for self-consciousness (Sierra, 2009; Sierra & Berrios, 2001; Sierra & David, 2011; see also Medford et al., 2005; Seth et al., 2012).

While DP and DR experiences typically co-occur, there is some evidence to suggest that they are separate but possibly interconnected entities reflecting diverse neurocognitive underpinnings (though this remains a matter of debate: Sierra, Lopera, Lambert, Phillips, & David, 2002; see also Lambert, Senior, Fewtrell, Phillips, & David, 2001; Rosen, 1955, Sierra, 2009). However, DP/DR experiences are predominantly referred to as "depersonalization" and clinically classified as "depersonalization/derealization disorder" by the DSM-V (APA: American Psychiatric Association, 2013) or "depersonalization-derealization" syndrome by the ICD-10 (WHO, 1992). DP/DR-type experiences are also prevalent in the general population and thought to exist along a continuum of symptom severity, with an estimated lifetime prevalence rate of between 23 and 74% (Aderibigbe et al., 2001; Hunter et al., 2004; Dewe, Watson, & Braitheaite, 2016; Sierra, 2009).

Previous research has found that depersonalized patients show suppressed autonomic arousal to aversive stimuli in the form of reduced skin conductance responses (SCRs: Giesbrecht, Merckelbach, van Oorsouw, & Simeon, 2010; Sierra, Senior, et al., 2002; Sierra, Senior, Phillips, & David, 2006), and inhibited neural activity in brain regions associated with translating emotion into feeling states - areas such as the anterior insula and amygdala (Lemche et al., 2007, 2008; Medford et al., 2006; Phillips et al., 2001). More recently, suppressed SCRs toward simulated threats delivered to the participant's own physical body have been observed in non-clinical populations (Dewe et al., 2016). Consistent with the view of an autonomic suppression, depersonalized patients have also been shown to exhibit a reduced empathy for others (Lawrence et al., 2007), which is perhaps unsurprising, given that in order to infer the cognitive and emotional states of others (empathetic response), one must rely on coherent self-related processing and internal feeling states (Decety & Grèzes, 2006; Decety & Jackson, 2004; Decety & Lamm, 2006; Preston & de Waal, 2002; Singer & Lamm, 2009).

It has been argued that both the anterior insula (AI) and anterior cingulate cortex (ACC) play crucial roles in self-representation of internal bodily states and subjective emotional experience (Craig, 2002, 2003, 2009; Critchley, 2005; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004). Consistent with this, coactivation in these regions has been associated with the perception of emotion expressed by others; for example when observing facial expressions (Adolphs, Tranel, Damasio, & Damasio, 1994, 1995; Botvinick et al., 2005; Jackson, Brunet, Meltzoff, & Decety, 2006; Jackson, Meltzoff, & Decety, 2005; Lamm, Batson, & Decety, 2007; Saarela et al., 2007). Moreover, this coactivation has been found when observing painful stimuli (such as electric shocks) delivered to other individuals (Morrison, Lloyd, Di Pellegrino, & Roberts, 2004; Singer et al., 2004; see Jackson, Rainville, & Decety, 2006 for review), and for evaluative functions of pain experience, such as anticipation (Drabant et al., 2011; Hutchison, Davis, Lozano, Tasker, & Dostrovsky, 1999; Seifert et al., 2013; see also Medford & Critchley, 2010; Price, 2000).

1.1. Neurobiological accounts: Threshold theory

The dominant theoretical account proposed to explain these experiences argues for a dysfunctional fronto-limbic network. By this account, networks in the right ventro-lateral pre-frontal cortex (rVLPFC) become inappropriately triggered and suppress structures responsible for translating emotion into conscious feeling states (i.e., the anterior insula and amygdaloid regions: Sierra & Berrios, 1998; see also Jay, Sierra, Van den Eynde, Rothwell, & David, 2014; Lemche et al., 2007, 2008; Medford et al., 2006; Phillips & Sierra, 2003; Phillips et al., 2001). As a net consequence, conscious feeling states are prevented from colouring the typical integration between perception and cognition resulting in attenuated emotional experience, subjective feelings of "unreality" and profound alterations in self-consciousness.

Essentially, the threshold model proposes the existence of two stages of processing: (i) mechanisms responsible for detecting and processing aversive stimuli, which initiates/serves as a "trigger" for suppression, and; (ii) mechanisms responsible for implementing the actual suppression of autonomic responses once an aversive stimulus has been detected. These processes are thought to become triggered when a certain "threshold" of anxiety or fear is crossed; and are intended to ensure adaptive behaviour during situations with disabling levels of anxiety, stress and fear. By this account, DP and DR occur due to an anxiety-triggered inhibitory response, which may occur due to the initial detection mechanism triggering the suppression too readily, or a lower threshold in the neurocognitive processes that facilitate conscious feeling states. As a result, these early processes may "over-estimate" the intensity of negative events and thus inappropriately trigger inhibition of autonomic responses – resulting in a profoundly altered conscious state (Jay et al., 2014; Lemche et al., 2007, 2008; Medford et al., 2006; Phillips et al., 2001; see also Hunter, Phillips, Chalder, Sierra, & David, 2003).

In contrast to the threshold account, predictive coding accounts argue that successful integration of interoceptive and exteroceptive information (the awareness of internal feeling states and incoming signals emanating from one's surroundings, respectively), is crucial in order to achieve stable self-consciousness, presence and embodiment (Seth et al., 2012; see also Bechara & Naqvi, 2004; Clark, 2013; Damasio, 2003; Seth, 2013; Seth & Friston, 2016; Suzuki, Garfinkel, Critchley, & Seth, 2013). A disruption to these predictive processes then results in altered experiences of self-consciousness, presence and embodiment such as DP/DR (Corlett, Frith, & Fletcher, 2009; Corlett, Honey, & Fletcher, 2007; Corlett, Taylor, Wang, Fletcher, & Krystal, 2010; Friston, 2005, 2010; Sedeño et al., 2014; see also Seth, 2013; Seth et al., 2012). Both the threshold theory and the predictive coding frameworks provide complementary accounts of how such DP/DR experiences may occur. Central to both is the notion of anticipation/prediction and how this might relate to subsequent autonomic suppression.

1.2. Overview of the current study

The current study examined autonomic arousal to aversive body-related threats in a non-clinical group of individuals with a high and low predisposition to depersonalization and derealization-type (DP/DR) experiences. In addition to the theoretical advancements for neurocognitive function, the study of sub-clinical populations also has the advantage that there is a reduced impact of a history of pharmaceutical agents mediating/suppressing experiences, and each individual is placed along a continuum of predisposition to DP/DR-type experience. A focus was placed on determining the relationship between anticipatory processing and the resultant suppression of threat-related psychophysiological responses – two components identified within the threshold theory of DP/DR experiences. For the purposes of the present study, we defined anticipatory processes as differences in the frequency and amplitude of spontaneous fluctuations in autonomic arousal (non-specific SCRs: NS-SCRs) occurring during the lead-up to the delivery of an aversive threat.

Participants were screened on questionnaire measures for predisposition to anomalous DP/DR experience and took part in modified versions of the Implied Body Threat task (IBT: Dewe et al., 2016). The IBT is based around a simulated blood-giving procedure conducted directly on the participant's body/hand. This illusion was used because it: (i) represents a validated technique for inducing autonomic reactions to realistic body-threats, (ii) is highly potent at inducing threat-related autonomic responses, (iii) has previously received 88% participant endorsement for being a realistic threat stimulus, and (iv) has successfully indexed a significant suppression in autonomic responding in sub-clinical groups with a predisposition to DP/DR-type experiences (Dewe et al., 2016).

We explored how predisposition to DP/DR-type experiences might interact with autonomic responding for threats delivered to the bodily self (i.e. *Self* threats) where the IBT was conducted on the participant's own body/hand, compared with responses of observed threats delivered to another individual who either shared or did not share the observer's visual perspective (i.e. *Other* threats). These manipulations facilitated an examination of the range of autonomic suppression present in aberrant experience that may occur as a function of self vs. other related threats (i.e., aversive events specifically to the self or generally within one's surroundings). For Other-related threats, participants passively viewed a modified version of the IBT where threats were delivered to another individual from two perspectives; one where the second individual shared the perspective of the observer (seated side-by-side) and one where the individuals faced each another (opposed 180-degrees apart). These new manipulations allowed for an examination of how autonomic responses to Other-related threats might be modulated by alignment with the self (shared vs. opposed perspective), and how predisposition to DP/DR-type experiences may impact on self vs. other perceptions, implicit perspective-taking, and the ability to empathise when observing others (see Lawrence et al., 2007; for general discussions on empathy and self-representation see Decety & Jackson, 2004; Decety & Sommerville, 2003; Jackson, Meltzoff & Decety, 2006; Grèzes & Decety, 2001; Lamm et al., 2007; Preston & de Waal, 2002; Ruby & Decety, 2004; Singer & Lamm, 2009).

The implicit effects of shared vs. opposed perspectives between self and others have been investigated by Jackson, Meltzoff et al. (2006) in the context of motor resonance. This is important in the current context because automatic "mirroring" of another's observed actions or their pain responses has been linked to basic forms of empathy and emotional alignment (for reviews see Jackson, Rainville, et al., 2006; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Indeed, Jackson, Meltzoff et al. (2006) revealed that a shared perspective elicited stronger activity in the observer compared to when participants were seated opposite each other. Furthermore, shared vs. opposed perspectives have been frequently investigated in perspective taking tasks and typically reveal very distinct embodiment profiles in behaviour and neural responses, suggesting distinct mental and empathic states associated with each of these two perspectives (for reviews, see Kessler, Cao, O'Shea & Wang, 2014; Wang, Callaghan, Gooding-Williams, McAllister & Kessler, 2016).

One possible outcome in relation to the present study is that predisposition to depersonalization-type experiences is associated with suppressed autonomic responses – but primarily for threats delivered to the participants own body/limb (due to the "Self"-related nature of these experiences). This could occur as a result of a basic attentional-biasing or weighting of signals from the participant's own body leading to strong and early suppression of autonomic responding and resulting in a reduced sense of self. A consequence of this self-bias would be reduced sensitivity to threats directed towards others. Thus, merely observing the same threats being delivered to another individual, from either perspective, may not be sufficiently potent to induce a defensive suppression response or may not be as strongly associated with DP-type experiences. In contrast, those predisposed to derealization-type experiences might display an autonomic suppression towards external threats in their surroundings, and hence threats delivered to another individual ("Other" threats) leading to an active suppression of external signals. Such a bias towards external threats would also result in a lower sensitivity to self-body threats, which may decrease the likelihood of a defensive suppression response being triggered. If true, this would support the idea that depersonalization and derealization experiences may reflect, at least in part, different neurocognitive underpinnings – even for sub-clinical groups.

Further, we also explored the relationship between autonomic mechanisms that might process the initial fearful anticipation during the lead-up to the threat (i.e., non-specific spontaneous fluctuations in autonomic responding), which could then trigger the suppression of threat-related responding as predicted by the threshold theory. This was achieved by examining whether both the anticipatory period and resultant suppression components were quantifiable in autonomic responding and related to DP/DR-type experiences.

Autonomic responses toward the threat procedure were recorded via two independent psychophysiological measures, skin conductance responses (SCRs) and finger temperature. In addition to quantifying the amplitude of threat-related SCRs, an analysis of both the frequency and amplitude of non-specific SCRs (NS-SCRs) during the period leading up to the threat (anticipation) was also explored as a measure of autonomic responding[1]. The frequency of NS-SCRs in particular, has been linked to anticipatory processes and as an indicator of negative emotional states (i.e., anxiety/fear: Boucsein, 2012; Nikula, 1991).

To summarise, we anticipated that those predisposed to depersonalization-like experiences would show greater autonomic suppression to threats directed to their own body than threats delivered to someone else. In contrast, those predisposed to derealization-like experiences would show the opposite effect. Furthermore, if aspects of the threshold theory are represented in autonomic responding, then it might also be the case that those showing greater anticipation of the threat (as indexed by an increase in frequency and/or amplitude of preceding NS-SCRs) would show greater autonomic suppression for the resultant threat SCRs.

2. Method

2.1. Participants

Ninety participants were recruited from the public and School of Psychology, University of Birmingham (UK). The total sample comprised 70 females (78%) and 20 males (22%), and a total of 84 participants (93%) reported that they were right-handed. The mean age of participants was 23 years, ranging from 17 to 52 years (SD = 7.34). Criteria for participation included no self-reports of severe or debilitating phobia of needles/injections and no previous diagnosis of any psychiatric or neurological disorders. All participants satisfied these criteria. In addition, ninety individuals were recruited to accompany each participant and experimental session to serve as *Confederates*, of whom, 81 (90%) were female (see Body-Threat Procedures).

2.2. Measures

2.2.1. Cambridge depersonalization scale (CDS)

Based on previous research (Braithwaite, James, et al., 2013; Braithwaite et al., 2017; Dewe et al., 2016) two factors of the Cambridge Depersonalization Scale (CDS: Sierra & Berrios, 2000; see also Sierra, Baker, Medford, & David, 2005) were used to measure trait-based experiences of DP/DR in a sub-clinical sample. The CDS measure has high internal consistency (Cronbach's alpha = 0.89) and good split-half reliability (0.92). The two factors used were; Anomalous Body Experience (ABE) and Alienation from Surroundings (AFS). The ABE factor consists of nine items relating to feelings of dissociation from the body or self (namely, depersonalization-type experiences) and the AFS factor consists of four items relating to feelings of dissociation from the world or surroundings (namely, derealization-type experiences). Participants rated each item on a 5-point Likert scale for frequency (ranging from 0 – *Never,* to 4 – *All the time*) and a 6-point Likert scale for duration (1 – *Seconds,* to 6 – *Over a week*); and scores were pooled for each subscale. This provided a measure of increased/decreased predisposition to anomalous depersonalization- and derealization-type experiences.

2.2.2. Body-threat procedures

Three conditions were used to explore psychophysiological reactivity to aversive, body-related stimuli via a repeated-measures design[2]. The Self condition involved delivering a realistic blood-giving IBT procedure to the participant's limb, where participants observed from their own point-of-view (POV), named the *Self-POV* condition. For the two Other conditions, the threat was administered to a second individual (a confederate) while the participant passively observed the threat procedure being delivered. The confederate was either sat next to the participant, who observed the procedure from a shared POV perspective, termed the *Other-POV* condition, or was seated opposite so that they observed the threat delivery from an exocentric perspective, termed the *Other-EXO* condition.

For the *Self-POV* condition the experimenter began by giving a verbal detailed description of the threat/injection procedure. Participants were informed that they were going to receive a pantomimed blood-giving procedure applied to their real hand. The

[1] Dewe et al., (2016) also investigated background autonomic arousal in terms of frequency and amplitude of NS-SCRs, however this was collapsed across pre- and post-threat experimental stages as a generalised measure of background responding. Here however, we explored isolated anticipation toward an impending threat by observing the frequency and amplitude of NS-SCRs during the pre-threat (anticipatory) period.

[2] An aversive body-threatening stimulus was used in the present study as it has been well-established in the literature that depersonalized patients show attenuated autonomic arousal in relation to aversive or unpleasant stimuli specifically (Sierra et al., 2002, 2006; see also Medford et al., 2006; Phillips et al., 2001).

Fig. 1. Example set up procedure of the Other-POV perspective condition. Both individuals were seated side by side while the confederate (left side of page) received the simulated threat. The observing participant had psychophysiological measures taken during the whole process.

Fig. 2. Example set up procedure for the Other-EXO perspective condition. Both individuals were seated at opposite sides of the table while the confederate received the "injection". Psychophysiological measures of the observing participant were taken throughout the experiment.

realism of the "injection" procedure was not directly disclosed, only phrases such as "simulated" and "pantomime" were used. This maximized the task's potential at eliciting a fear/anxiety response whilst controlling for surprise and startle effects to the sudden appearance of an unexpected stimulus. Participants were not permitted to communicate with the experimenter during the procedure but were welcome to comment openly, or withdraw from the study at any time. Contingent on verbal and written consent, participants were instructed to place both hands out in front them on the table and remain fixated on their left hand at all times. An initial pre-threat (anticipatory) recording period began where participants viewed their hand for 60 s. During this period, SCRs and finger temperature were recorded. Following this, the experimenter put on medical latex gloves and "cleansed" the participant's skin with cotton wool (the skin was dry swabbed to avoid any response by applying cold liquids to the skin). For the blood-giving procedure a realistic syringe (7 cm total length) was moved toward the participant's left hand at a slow pace and pressed onto the skin. Then, the experimenter seemingly "inserted" the needle into the participant's skin made possible via a 2.5 in. retractable needle. After being inserted the plunger was slowly withdrawn causing the syringe (5 cc plastic unit) to fill with 3 cm of realistic "blood" (a special effects material). After the blood was "taken", the syringe was slowly removed from the hand and from view, and the skin was again cleansed using a dry swab. Participants were asked to remain fixated on their hand for a further 60 s after the threat (see Dewe et al., 2016).

For the *Other-POV* condition, the participant and confederate were seated side-by-side with both individuals placing both hands out on the table (Fig. 1). Individuals were informed that they were not permitted to communicate with each other at any stage, but that they could withdraw from the experiment at any time. The experimenter gave a short verbal description of the procedure similar to that in the Self-POV condition; except here, both the participant and confederate were instructed to fixate on the confederate's left hand at all times. The simulated injection procedure was conducted on the confederate's left hand, in an identical manner as described in the Self-POV condition. Although both individuals were instructed to observe the procedure, it was only the psychophysiological responses of the participant (observer) that were of interest and recorded. Here, participants observed the threat delivery from a point of view (POV) consistent to their own body, where the participant's and confederate's hands were matched in an anatomically congruent position.

In the *Other-EXO* condition, the participant and confederate sat at opposite sides of the table and both individuals placed both hands out in front of them (Fig. 2). The injection procedure was like that described for the Other-POV condition, except the individuals were seated opposite one another and thus did not share the same perspective. Instead, the injection procedure was delivered to the confederate's right hand and so both individuals were instructed to fixate on the confederate's right hand at all

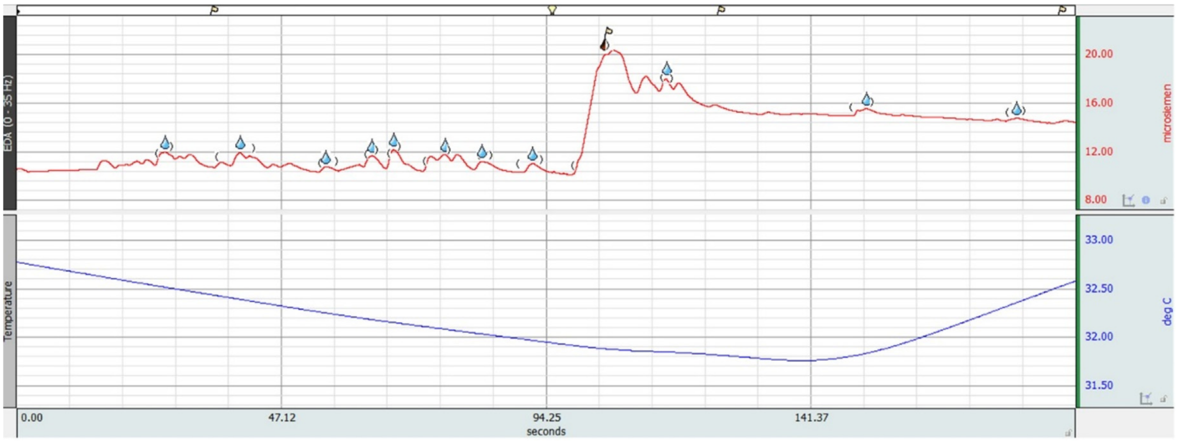

Fig. 3. Example signal from the Self-POV condition. The upper trace illustrates SCR activity including NS-SCRs (indicated by water droplets) and the threat-related SCR (indicated by a small flag and water droplet). This signal includes the 60 s pre-threat period, threat delivery, and a post-threat period (60 s). The lower trace depicts finger temperature (°C).

times[3]. To control for possible body-location effects, the confederate's hand that was closest to the participant's hand always received the threat. That is, the threat was delivered to the confederate's left hand in the Other-POV condition and on the right hand in the Other-EXO condition thus the threat always had the same proximity to the hand of the participant.

2.2.3. Electrodermal activity (EDA): Skin conductance responses (SCRs)

An MP36R data-acquisition unit (Biopac systems Inc, Goleta, CA) linked to a HP pro Elitebook (64-Bit Windows 7OS) 8740w mobile workstation was used to record the psychophysiological measures. SCR data were collected at a sample rate of 2000 Hz via disposable Ag-AgCl pre-gelled electrodes (EL507) and SS57L leads attached to the distal phalanges of the index and middle fingers of the left hand. A visual analysis was used to identify any artefacts (i.e. noise or a deflection in the signal due to movement/cough), which were removed via a smoothing algorithm function that down-samples the whole signal in steps of 200 samples/s. This was followed with a quantitative analysis conducted via Biopac's AcqKnowledge software (v4.1) with customized Find-Cycles routines (Braithwaite, Watson, Jones & Rowe, 2013). Values that exceeded a threshold of 0.01 µS (microsiemens) from the background signal were defined as the onset of an SCR. SCRs were quantified as the difference between SCR onset and the maximum amplitude (peak) of the SCR (Fig. 3), and threat-SCRs were defined as the largest SCR occurring within 30 s after the initial presentation of the syringe. For each participant, all EDA signals (both SCRs and NS-SCRs) from all three conditions were merged to create an overall mean and standard deviation for that individual. To enable parametric analysis all SCRs were normalised via a Log (SCR + 1) transformation (Boucsein, 2012; Boucsein et al., 2012; Dawson, Schell, & Filion, 2007). In addition, to facilitate individual difference analysis, the Log transformed SCRs were standardised via Z-score transformations ([$z = (X - \mu)/\sigma$]: Ben-Shakhar, 1985; 1987; Braithwaite, Watson, et al., 2013; Braithwaite et al., 2017; Bush, Hess, & Wolford, 1993; Dewe et al., 2016).

2.2.4. Finger temperature

Temperature (°C) was recorded simultaneously with EDA using a second channel of the data acquisition unit described in the EDA/SCR section. Temperature was sampled at a rate of 7.8 Hz using a digit sensor (SS18LA) attached to the distal phalanx of the right hand index finger. Finger temperature is regarded as a sensitive index of overall thermal comfort and body temperature (Wang, Zhang, Arens, & Huizenga, 2007). Here, temperature was used to provide an additional measure of threat-related anxiety based on previous findings of an association between drops in finger/body temperature with anxiety, and disruptions of ownership/embodiment using body illusions (Kammers, Rose, & Haggard, 2011; Moseley et al., 2008; Thakkar, Nichols, McIntosh, & Park, 2011; Vinkers et al., 2013; though these associations are somewhat controversial - see Hohwy & Paton, 2010; Paton, Hohwy, & Enticott, 2012; Rohde, Wold, Karnath, & Ernst, 2013; Sadibolova & Longo, 2014).

2.3. Procedure

Two individuals were recruited for each session (lasting 75 min) and after screening criteria had been established and satisfied, they were randomly assigned by the experimenter as a *Participant* or *Confederate.* Once the experimenter had provided instruction and obtained consent, the participant completed the ABE and AFS factors of the CDS questionnaire (the confederate was taken to a second room and given additional instructions concerning their role in the experiment). The EDA electrodes and body temperature sensor were applied to the participant as early as possible to ensure the sensors had acclimatized for optimum data collection; which was

[3] The crucial factor was for the threat to be delivered to the hand that was matched in terms of proximity to the participant's hand – so that all threats occurred in an equivalent space to the participant's own body.

followed by the Self-POV condition, as outlined earlier.

Next, the confederate was brought back to join the participant in the laboratory (confederates were instructed not to communicate with the participant at any stage, and to remain completely impassive). Both the participant and confederate took part in the Other-POV and Other-EXO conditions as described earlier. All three conditions were completed in this single session. In order to ensure the present sample replicated that of our previous investigation and could be considered comparable (Dewe et al., 2016), the Self-POV condition was always delivered first as it was considered a priori that it would serve as a baseline (maximum) condition for the participant's capacity, and likelihood, to respond to a threat/injection procedure given that it was delivered to their own physical body. The order of the two *Other* perspective conditions (Other-POV and Other-EXO) was counterbalanced across participants.

3. Results

Based on established criteria, 16 participants out of the 90 tested (18%) were classified as hypo-responders (defined as those who generated fewer than two NS-SCRs per minute in at least one condition) and removed from the analysis (Dawson et al., 2007; Boucsein, 2012), and one further participant withdrew from the study. This resulted in a final sample of 73 participants (59 females, ranging in age from 18 to 51 years, $M = 23$ years, SD = 6.87). When applicable, non-parametric tests were applied for non-normally distributed data sets and adjusted values were taken when homogeneity of variance was violated. Effect sizes are provided as Pearson's r, partial eta squared (η_p^2) and Cohen's d (Cohen, 1962, 1992).

All multiple comparisons were corrected using the False Discovery Rate procedure (FDR: Benjamini & Hochberg, 1995). The FDR is considered to be a powerful approach to correct for multiple comparisons and is superior for situations involving more than three comparisons, where other methods become overly conservative (Benjamini, 2010; Benjamini & Hochberg, 1995). Each original p-value is placed and ranked in ascending order. A new critical value (termed the B&H value) is calculated using the formula $\alpha = (i/k) * Q$ (where i is the original p-value's rank number, k is the total number of comparisons, and Q is the threshold, typically 0.05). If the original p-value is smaller than the new B&H critical value ($p < \alpha$), the comparison is considered significant (Benjamini & Hochberg, 1995).

To complement the frequentist analysis, Bayesian analyses were also conducted using JASP software (version 0.8.1.2: JASP Team, 2017) using a default prior width of 0.707 (JASP Team, 2017; see Wagenmakers et al., 2017). Each Bayes Factor (BF_{10}) indicates the probability of the data being in favour of the alternative hypothesis (if $BF_{10} > 1.0$) or null hypothesis (if $BF_{10} < 1.0$). As a general interpretation for Bayes factor probability, values close to 0 are considered evidence of the null hypothesis (for example values between 0.33–0.10 are considered substantial and 0.10–0.01 are strong to very strong), and values at 1 (or between 0.33–3) are considered insensitive/anecdotal evidence. In favour of the alternative hypothesis, values between 3–10 are considered substantial, 10–100 are strong to very strong and > 100 is thought to be decisive (Jarosz & Wiley, 2014; Jeffreys, 1961; Kass & Raftery, 1995; Raftery, 1995; see also Dienes & Mclatchie, 2018; Marsman & Wagenmakers, 2016; Rouder, Speckman, Sun, Morey, & Iverson, 2009).

3.1. Task efficacy – threat SCR frequency

The success of the simulated threat procedure at eliciting a fear response was defined as the frequency of the maximal SCR occurring within a time window of 30 s after the point at which the syringe was perceivable and engaged in the threat. Defined in this way, the Self-POV condition was effective at eliciting a threat response in 100% of the participants. Similarly, the Other-POV and Other-EXO successfully elicited a threat-SCR in 99% and 85% of participants respectively. A non-parametric Friedman's test revealed a significant effect of condition, χ^2 (2) = 20.18, $p < .001$. Wilcoxon signed-rank tests revealed no significant difference between the Self-POV and Other-POV condition on the efficacy in generating SCRs (Z = −1.00, $p = .317$, $r = 0.08$). However, both the Self-POV and Other-POV were more effective when compared to the Other-EXO condition (Z = −3.32, $p < .001$, $r = 0.27$ and Z = −3.16, $p < .01$, $r = 0.26$ respectively).

3.2. Threat-SCR amplitudes

The average transformed threat-SCR amplitudes for the Self-POV, Other-POV and Other-EXO conditions are presented in Fig. 4. A one way ANOVA revealed a significant effect of condition $F(2, 144) = 111.69$, $p < .001$, $\eta_p^2 = 0.608$. Pairwise comparisons showed that the amplitude for the Self-POV threat-SCR was significantly greater than both the Other-POV ($t(72) = 10.79$, $p < .001$, $d = 1.26$, $BF_{10} > 1000$) and Other-EXO conditions ($t(72) = 14.18$, $p < .001$, $d = 1.66$, $BF_{10} > 1000$). The amplitude of SCRs in the Other-POV condition was also significantly greater than in the Other-EXO condition ($t(72) = 2.75$, $p < .01$, $d = 0.32$, $BF_{10} = 4.17$).

To examine the relationship between autonomic response and individual predisposition to DP/DR experience, the amplitude of the threat-SCRs was correlated with the ABE and AFS questionnaire scores (Table 1). It should be noted that both the ABE and AFS factors correlated positively, r = 0.45, $p < .001$.

Overall, predisposition to DP/DR experience correlated negatively with the amplitude of threat-related SCRs. As predisposition to depersonalization-like experiences (ABE) increased, the amplitude of threat-related SCRs decreased significantly but only for the Self-POV condition. In contrast, as predisposition to derealization-type experiences (AFS) increased, threat SCRs decreased significantly but only in the Other-POV and Other-EXO conditions.

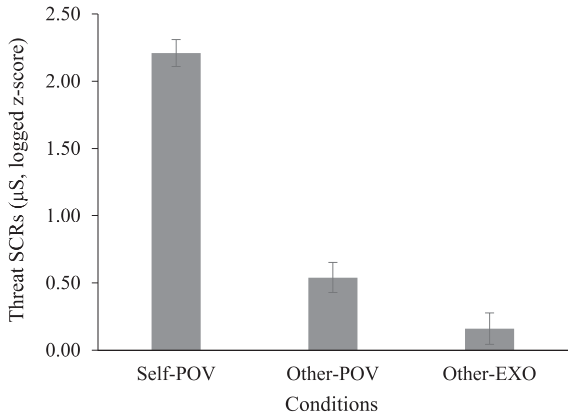

Fig. 4. Standardised threat-SCRs (Log[SCR + 1], Z-scored) for the Self-POV, Other-POV and Other-EXO conditions (error bars indicate ± 1 SE).

Table 1
Pearson correlation coefficients with corrected significance values and Bayes factor analysis of threat-SCR amplitudes (Log[SCR + 1], Z-scored) from the Self-POV, Other-POV and Other-EXO conditions with ABE and AFS scores.

		Frequentist				Bayes	
	r	P-value	Rank	B&H value	Sig	BF_{10}	Interpretation
ABE × Self-POV	−0.37	0.002	1	0.008	sig*	20.29	Strong Alt
AFS × Other-EXO	−0.35	0.003	2	0.017	sig*	12.84	Strong Alt
AFS × Other-POV	−0.29	0.014	3	0.025	sig*	2.84	Anecdotal Alt
AFS × Self-POV	−0.18	0.128	4	0.033	ns	0.45	Anecdotal Null
ABE × Other-EXO	−0.13	0.288	5	0.042	ns	0.25	Substantial Null
ABE × Other-POV	−0.05	0.654	6	0.050	ns	0.16	Substantial Null

Note: Sig* = indicates the significant correlations after correcting for multiple comparisons (ns = non-significant) using the FDR procedure (Benjamini & Hochberg, 1995). Bayes factors and interpretations are reported (Alt = Alternative hypothesis, Null = Null hypothesis) in line with recommended guidelines (Jeffreys, 1961; see Jarosz & Wiley, 2014).

3.3. Non-specific SCRs (NS-SCRs) frequency

Non-Specific SCRs (NS-SCRs) were examined in terms of their frequency of occurrence during the 60 s lead up/anticipation to each threat (the pre-threat period, Fig. 5).

A one way ANOVA revealed a significant effect of condition on NS-SCR frequency $F(1.77, 127.40) = 5.92, p < .010, \eta_p^2 = 0.076$. Pairwise comparisons revealed that the frequency of NS-SCRs was significantly higher in the Self-POV condition compared to the Other-POV ($t(72) = 2.87, p < .01, d = 0.34, BF_{10} = 5.51$) and Other-EXO ($t(72) = 2.66, p < .01, d = 0.31, BF_{10} = 3.35$) conditions. However, no reliable difference was observed between the Other-POV and Other-EXO conditions ($t(72) = 0.06, p = .955, d = 0.01, BF_{10} = 0.13$).

To explore any relationship between predisposition to depersonalization-/derealization-type experiences and non-specific

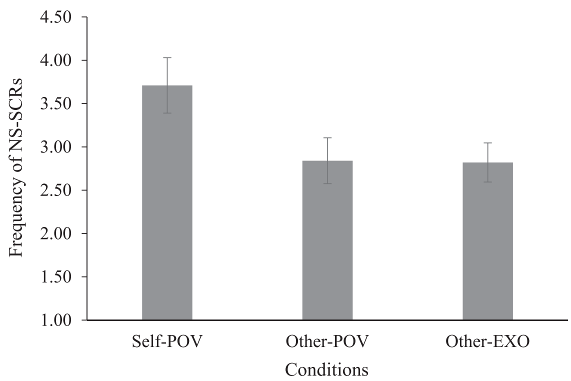

Fig. 5. Average frequency of NS-SCRs during the pre-threat anticipatory period for the Self-POV, Other-POV and Other-EXO conditions (error bars indicate ± 1 SE).

Table 2
Pearson correlation coefficients with corrected significance values and Bayes factor analysis of NS-SCR frequencies in the three conditions with ABE and AFS scores.

		Frequentist				Bayes	
	r	P-value	Rank	B&H value	Sig	BF_{10}	Interpretation
AFS × Self-POV	−0.17	0.144	1	0.008	ns	0.42	Anecdotal Null
ABE × Self-POV	−0.15	0.204	2	0.017	ns	0.32	Substantial Null
AFS × Other-POV	−0.08	0.488	3	0.025	ns	0.19	Substantial Null
AFS × Other-EXO	−0.07	0.558	4	0.033	ns	0.17	Substantial Null
ABE × Other-POV	−0.03	0.777	5	0.042	ns	0.15	Substantial Null
ABE × Other-EXO	−0.03	0.780	6	0.050	ns	0.15	Substantial Null

Note: Corrected for multiple comparisons using the FDR procedure, ns = non-significant result (Benjamini & Hochberg, 1995). Bayes factors and their general interpretations are reported (Null = Null hypothesis).

anticipatory responding, we correlated pre-threat NS-SCR frequencies with scores on the ABE and AFS in all conditions (Table 2). This analysis revealed no significant relationships between the NS-SCR frequencies prior to the threat (anticipation) with scores on the ABE and AFS factors of the CDS questionnaire.

3.4. Non-specific SCRs (NS-SCRs) amplitudes

As an additional index of autonomic arousal, the mean amplitudes of all NS-SCRs (Log[SCR + 1], Z-scored) occurring during the pre-threat anticipatory period for each condition were compared (Fig. 6).

A one way ANOVA conducted on the mean amplitudes of NS-SCRs revealed a significant main effect of condition, $F(2, 144) = 7.72$, $p < .001$, $\eta_p^2 = 0.097$. Pairwise comparisons showed that the Self-POV condition had significantly larger NS-SCR amplitudes compared to both the Other-POV ($t(72) = 3.61$, $p < .001$, $d = 0.42$, $BF_{10} = 42.17$) and Other-EXO ($t(72) = 3.43$, $p < .01$, $d = 0.40$, $BF_{10} = 24.65$) conditions. However, there was no reliable difference in NS-SCR amplitudes between the Other-POV and Other-EXO conditions ($t(72) = 0.21$, $p = .836$, $d = 0.02$, $BF_{10} = 0.13$). Similar to the NS-SCR frequency findings, the greatest NS-SCR amplitudes occurred in the condition involving the participant's own hand, and no differences between the perspectives were observed between the Other-POV and Other-EXO conditions.

To explore the relationship between DP/DR experience and the general strength of anticipatory arousal, we correlated NS-SCR amplitudes with scores on the ABE and AFS (Table 3). This analysis revealed no reliable correlations between scores on the ABE or AFS questionnaire and NS-SCR amplitudes in any condition.

To examine the relationship between initial anticipatory fear processing and later acting suppression, the average NS-SCR amplitudes during the pre-threat stage were subtracted from the (larger) threat-SCRs for each participant in each condition, providing a difference (delta) value. A correlation analysis was conducted on these delta values with predisposition to DP/DR experience (see Fig. 7 and Table 4).

There was an overall negative correlation between predisposition to anomalous experience and the difference between threat-SCR and NS-SCR amplitudes. That is, the higher individuals scored on measures of DP/DR-type experience, the smaller the difference between threat-related (SCR) and anticipatory related arousal (NS-SCRs).

To explore whether the relationship between NS-SCRs and threat-SCRs was due to the amplitudes of the former increasing (reflecting anticipatory processes) or the amplitude of the latter decreasing (reflecting suppressive processes), or both, a quartile split analysis was conducted based on the ABE and AFS factors, creating "high" and "low" scoring groups. First, we explored autonomic

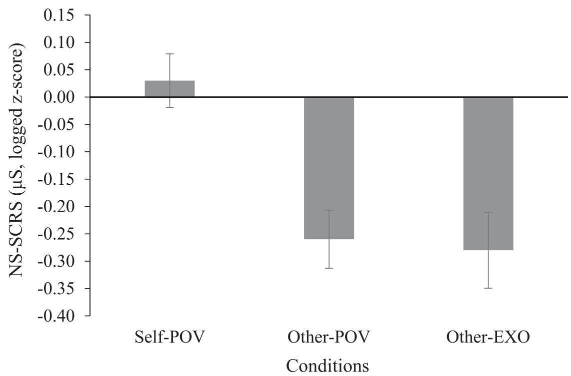

Fig. 6. The average NS-SCR amplitudes (Log [SCR + 1], Z-scored) during the pre-threat period for the Self-POV, Other-POV and Other-EXO conditions (error bars indicate ± 1 SE). Please note, the negative directions in this (and subsequent) Figures (for logged, Z-score amplitudes) reflects the fact that the merged signals used to calculate the amplitudes included threat-related and spontaneous SCRs.

Table 3
Pearson correlation coefficients with corrected significance values and Bayes factor analysis of NS-SCR mean amplitudes for all conditions with ABE and AFS scores.

		Frequentist				Bayes	
	r	P-value	Rank	B&H value	Sig	BF_{10}	Interpretation
ABE × Other-EXO	0.22	0.059	1	0.008	ns	0.84	Anecdotal Null
ABE × Other-POV	0.21	0.077	2	0.017	ns	0.68	Anecdotal Null
AFS × Self-POV	0.13	0.280	3	0.025	ns	0.26	Substantial Null
ABE × Self-POV	0.12	0.306	4	0.033	ns	0.25	Substantial Null
AFS × Other-EXO	0.11	0.360	5	0.042	ns	0.22	Substantial Null
AFS × Other-POV	0.09	0.429	6	0.050	ns	0.20	Substantial Null

Note: Corrected for multiple comparisons using the FDR procedure (Benjamini & Hochberg, 1995), ns = non-significant result. Bayes factors with their recommended interpretations are reported (Null = Null hypothesis).

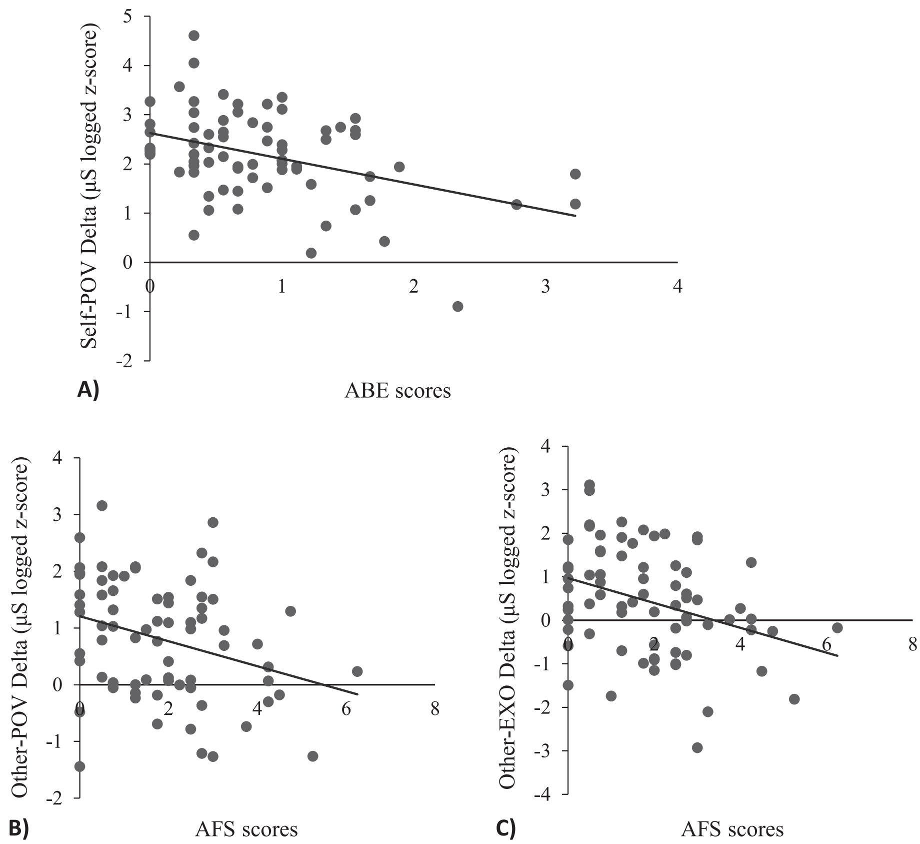

Fig. 7. Average deltas between threat-SCR and NS-SCR amplitudes (µS logged, Z-scored) correlated with the ABE factor in the Self-POV condition (A), the AFS factor in the Other-POV condition (B), and the AFS factor in the Other-EXO condition (C).

arousal in the Self-POV condition in relation to high and low scorers on the ABE factor (upper 75% and lower 25% quartiles: Fig. 8). In the Self-POV condition, the high ABE group did not differ significantly from the low ABE group in terms of NS-SCR amplitudes ($t(37) = 0.59$, $p = .560$, $d = 0.19$, $BF_{10} = 0.36$), however, the high group displayed significantly reduced threat-SCR amplitudes compared to the low group ($t(37) = 3.08$, $p < .01$, $d = 0.99$, $BF_{10} = 10.48$).

Next, the Other-POV and Other-EXO conditions were explored in relation to high and low scorers on the AFS factor (upper 75% and lower 25% quartiles: Fig. 9). The high and low AFS groups did not significantly differ in NS-SCR amplitudes during either the Other-POV ($t(37) = 1.00$, $p = .326$, $d = 0.32$, $BF_{10} = 0.46$) or Other-EXO condition ($t(37) = 1.09$, $p = .283$, $d = 0.35$, $BF_{10} = 0.50$). In addition, the groups did not reliably differ in threat-SCR amplitudes during the Other-POV condition ($t(37) = 1.67$, $p = .103$, $d = 0.54$, $BF_{10} = 0.93$), however the high AFS group demonstrated significantly reduced threat-SCRs in the Other-EXO condition compared to the low AFS group ($t(37) = 2.43$, $p = .020$, $d = 0.78$, $BF_{10} = 2.95$).

Table 4
Pearson correlation coefficients (with corrected significance values) and Bayes factors of the deltas between threat-SCRs and NS-SCRs amplitudes with ABE and AFS scores.

		Frequentist				Bayes	
	r	P-value	Rank	B&H value	Sig	BF_{10}	Interpretation
ABE × Self-POV	−0.41	0.000	1	0.008	sig*	76.56	Strong Alt
AFS × Other-EXO	−0.34	0.004	2	0.017	sig*	9.07	Substantial Alt
AFS × Other-POV	−0.31	0.009	3	0.025	sig*	4.26	Substantial Alt
AFS × Self-POV	−0.23	0.048	4	0.033	ns	1.00	Anecdotal
ABE × Other-EXO	−0.21	0.075	5	0.042	ns	0.69	Anecdotal Null
ABE × Other-POV	−0.14	0.239	6	0.050	ns	0.29	Substantial Null

Note: Sig* = indicates significant correlations after correcting for multiple comparisons (ns = non-significant) using the FDR procedure (Benjamini & Hochberg, 1995). Bayes factors and the recommended interpretations are also reported (Alt = Alternative hypothesis, Null = Null hypothesis).

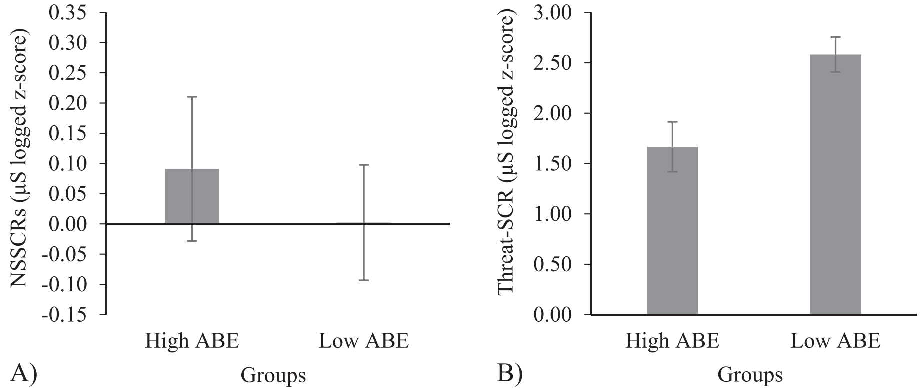

Fig. 8. (A) Average amplitudes for NS-SCRs (µS logged, Z-scored) and (B) average threat-SCRs (µS logged, Z-scored) in the Self-POV condition for high and low ABE groups (error bars indicate ± 1 SE).

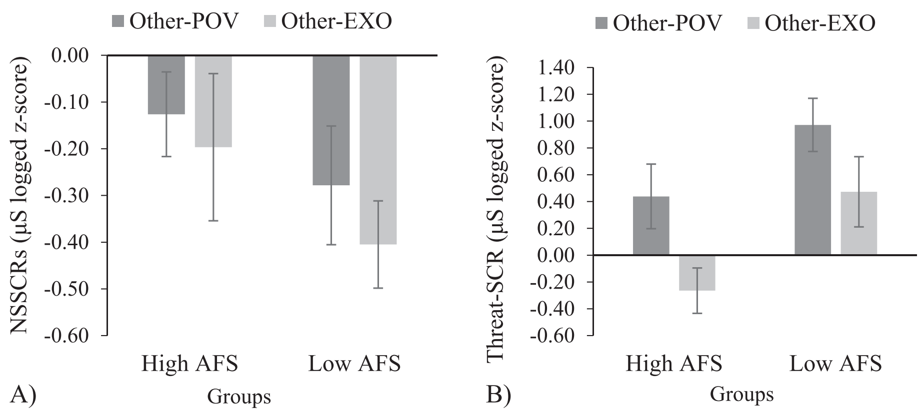

Fig. 9. (A) Average NS-SCR amplitudes (µS logged, Z-scored) and (B) average threat-SCRs in both the Other-POV and Other-EXO conditions for high and low AFS groups (error bars indicate ± 1 SE).

3.5. Body temperature

Average body temperature dropped over time in the Self-POV, Other-POV and Other-EXO conditions in line with the notion of a fear/anxiety response. Temperature was determined by subtracting average temperatures during the last (post-threat) experimental stage from the first, pre-threat (anticipatory) stage; creating an average drop per condition (Fig. 10). A one way ANOVA revealed a significant effect of condition, ($F(2, 144) = 3.60, p < .05, \eta_p^2 = 0.048$). When explored via pairwise comparisons the data revealed a significantly larger temperature drop for the Self-POV condition compared to both the Other-POV ($t(72) = 2.18, p < .05, d = 0.26$, $BF_{10} = 1.19$) and Other-EXO ($t(72) = 2.26, p < .05, d = 0.26, BF_{10} = 1.40$) conditions. However, there was no reliable difference in temperature between the Other-POV and Other-EXO condition, ($t(72) = 0.11, p = .916, d = 0.01, BF_{10} = 0.13$).

Temperature was also examined in relation to predisposition to DP/DR-type experiences by correlating average temperature

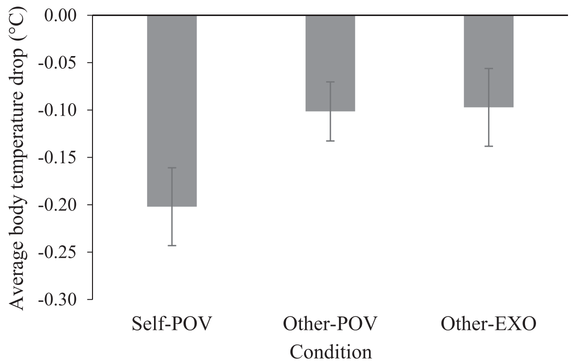

Fig. 10. Average body temperature drop (°C) from the pre-threat (anticipatory) stage to the post-threat period in all three conditions (error bars indicate ± 1 SE).

drops with scores on the ABE and AFS for all conditions. This analysis revealed no significant relationships between ABE or AFS scores and average body-temperature (all $r < 0.12$, all *ps* $> .320$, all $BF_{10} < 0.24$). The findings suggest no reliable difference in average temperature drops during anxiety-provoking/threatening situations in relation to those predisposed to these particular experiences.

4. General discussion

The present study examined autonomic responses to an aversive body-threat in those predisposed to sub-clinical levels of anomalous depersonalization- and derealization-type experiences. We examined aspects of DP/DR-type experiences via a body-threat delivered either to the physical self (the IBT: Dewe et al., 2016), or to another individual in conditions in which they either shared or did not share the perspective of the observer.

The basic IBT effect originally reported by Dewe et al., (2016) was replicated by the current independent sample showing that predisposition to DP/DR-like experiences was associated with increased suppression of threat-related SCRs. The more depersonalized the participants were from their own bodies or sense of self, the lower their psychophysiological response to a threat delivered to their own body. As well as establishing the presence of such biases in this independent sample, and thus facilitating sound comparisons and theoretical extensions to previous work, this also complements the broader literature which reports a selective suppressed autonomic response when observing aversive imagery in patients diagnosed with depersonalization disorder, now also reported here for non-clinical groups and with a direct body-related manipulation (Lemche et al., 2007, 2008; Medford et al., 2006; Phillips et al., 2001; Sierra, Senior et al., 2002; Sierra et al., 2006; Sierra & David, 2011).

The findings presented here significantly extend previous research in a number of important ways. Both the efficacy and strength of the IBT task at eliciting a response showed clear effects of perspective. The Self-POV condition, in which the observer received a threat to their own body, produced the highest number of threat-related SCRs across participants, and of the highest amplitude relative to both the Other-POV and Other-EXO conditions.

It might be argued that some of these mean differences could be due to habituation processes as the "Self" condition was always delivered first. However, while some degree of habituation may well have been present (and unavoidable to some degree) this cannot fully explain the effects observed here. For example, in terms of efficacy at eliciting responses, at no point did a condition fail to achieve a threat-related SCR when collapsed across participants. The Self-POV condition produced responses in 100% of presentations, with the Other-POV eliciting an SCR 99% of the time and 85% for the Other-EXO condition. Therefore, the general efficacy of eliciting non-zero threat responses never dropped below 85%. In terms of the amplitude of responses, a significant difference occurred between the amplitude of threat-SCRs between the two "Other" conditions - and the order of these conditions was fully randomised across participants. Therefore, order effects and habituation cannot explain this observation within the two Other conditions as its impact should have been constant and affected both conditions equally.

Furthermore, habituation cannot explain the selective correlations that emerged between autonomic responding and specific forms of DP/DR-type experiences (discussed more fully below). Therefore, while we accept that habituation processes may well mediate, at least in part, the overall mean difference in amplitude between the Self and the Other conditions, habituation effects cannot explain the difference between the Other conditions, and the more crucial selective correlations to anomalous experience reported here.

Instead we suggest that the evoked threat response decreased in strength as the observer's viewpoint deviated from that of the individual receiving the threat. From the Other-POV perspective, the participant observed a body anatomically and spatially aligned with their own physical body, and thus, we argue, reflected the greatest self-other overlap between observer and confederate and this, in turn, mediated threat responding (for self vs. other discussion see Decety & Lamm, 2006; Decety & Sommerville, 2003; Jackson, Meltzoff et al., 2006; Ruby & Decety, 2004). Collectively, these findings not only replicate the effectiveness of the IBT at eliciting a response for Self-related threats, but also demonstrate its success in eliciting a significant autonomic response merely when passively viewing the procedure being conducted on someone else's body.

The strength of threat-SCRs correlated negatively with measures of DP/DR experience in all three conditions, but did so in a revealing manner. The ABE factor (i.e. depersonalization-type experiences) correlated negatively with threat-SCRs, but only in the Self-POV condition (a threat delivered to the participant's real hand). There were no reliable effects for the ABE factor in relation to the two Other perspective conditions. In contrast, the AFS factor (i.e. derealization-type experiences) correlated negatively with the strength of threat SCRs in both the Other-POV and Other-EXO conditions (a threat delivered to a second individual). There was no reliable difference between the two perspectives (POV and EXO) in relation to the AFS factor, and no correlation between this factor and the Self-POV condition.

Put simply, a stronger predisposition to ABE experiences (an unreality of the self) revealed a selective suppression only for threats delivered to the observer's own physical body. In contrast, a stronger predisposition to AFS experiences (an unreality of surroundings) revealed selective suppression only for threats delivered to another individual (when sharing both a similar and opposing perspective). These new findings suggest a surprising specificity in how differences in DP/DR type-experiences may map onto autonomic responding. Indeed, there has been some debate over the distinction between depersonalization and derealization and whether they in fact represent diverse entities or merely different aspects of a unitary phenomenon (see Lambert et al., 2001; Rosen, 1955; Sierra, 2009; Sierra & David, 2011; Sierra, Lopera, et al., 2002). This novel effect between self vs. other perspective and selective forms of anomalous experience (ABE vs. AFS) lends support to the notion that there may well be some separation between the cluster of experiences reported as depersonalization and derealization.

Findings from the anticipatory NS-SCRs were also revealing. The frequency of NS-SCRs (the number of SCRs occurring during the anticipatory period) were significantly greater in the Self-POV condition relative to both "Other" perspective conditions (and there was no difference between these two Other perspectives). The same was true for the amplitude (strength) of NS-SCRs. Interestingly, there were no reliable correlations between the frequency of NS-SCRs, or their strength with predisposition to DP/DR-type experiences (see also Dewe et al., 2016).

The negative relationships between the amplitude deltas (threat-SCRs minus NS-SCRs) and measures of DP/DR-type experiences are particularly noteworthy. There was a reduced difference between the threat-SCR and NS-SCR amplitudes as predisposition to anomalous experience increased. The quartile split analysis revealed that this negative relationship was driven primarily by the suppression of threat-related autonomic responding and not increases in NS-SCR amplitudes. No reliable differences were observed for high and low scorers on measures of depersonalization or derealization in terms of the frequency and amplitude of NS-SCRs.

The current findings go against the notion that the effects of a reduction in threat-related SCRs reported here could be explained merely by a response bias or generic flattening/reduced autonomic response in those predisposed to DP/DR-type experiences. If this were the case, a negative correlation between aberrant experience and NS-SCRs should have also occurred, with individuals revealing suppressed NS-SCRs (both frequency and strength) across all conditions. Clearly this did not happen. Crucially, the suppressed autonomic/emotional responding was only present for aversive, threatening stimuli.

The findings on finger temperature were mixed. Finger temperature reliably declined throughout the duration of the experiment; however, drops in body temperature did not reliably correlate with DP/DR-type experience levels. Therefore, although there was a reduction in body temperature consistent with an anxiety/fear response, this was not mediated further as a function of anomalous experience (see Dewe et al., 2016). Coupled to our previous findings (Braithwaite et al., 2017; Dewe et al., 2016) the current study also suggests that temperature drops are not mediated by, or related to, the processes underlying aberrations in self-consciousness, at least in terms of the current experimental manipulations.

4.1. Theoretical implications

A predisposition to DP/DR-type experience was reliably associated with suppressed threat-related SCRs. The present sample displayed psychophysiological and psychological response patterns consistent with the basic concept of the threshold model; (i.e., the association between aberrant autonomic responding and the phenomenological aspects of depersonalization: Sierra & Berrios, 1998; Sierra & David, 2011). However, the present findings significantly extend the neurobiological threshold account in several ways.

The threshold model assumes that when an aversive threat is detected there is an aberrant coding of the intensity of the threat, which elicits a secondary fronto-limbic suppression of autonomic response. DP/DR-type experiences may occur if the detection mechanism triggers this suppression too readily due to a lower "threshold" in the neurocognitive processes mediating the production of conscious feeling states (Craig, 2002, 2003; Seth, 2013; Seth et al., 2012). Following on from this, one possibility is that anticipatory and spontaneous NS-SCR responding might reflect aspects of a triggering/threshold mechanism, as these components have been shown to reflect increased arousal, increased anticipatory processes and have been associated with negatively tuned cognitive states (Boucsein, 2012; Nikula, 1991). If this were the case, then predisposition to DP/DR-type experiences might be associated with increased NS-SCR responding during the anticipatory period, which may form an early part of a neuro-defence mechanism resulting in suppressed threat-related responding.

Our present findings show an absence of an association between DP/DR-type experiences and so any increase in NS-SCR responding does not appear to be associated with any underlying threshold/trigger mechanism – at least as far as non-clinical levels of depersonalization and derealization are concerned. Therefore, it appears as if no part of spontaneous NS-SCR responding (frequency or amplitude) is reliably related with the autonomic suppression seen for aversive threats. These findings also place important constraints on the notion of "anticipation" within theoretical frameworks and the forms that this may take. The present study demonstrates that the form of anticipation taking place preceding the threat by some seconds and represented in spontaneous fluctuations of non-specific responses is not reliably associated with predisposition to anomalous experience or autonomic suppression. This implies that the initial phase of threat anticipation/detection is likely represented within the early time period of the threat-related SCR itself.

In contrast, the strength of threat-related SCRs correlated negatively with measures of DP/DR experience. This relationship was dependent on the type of anomalous experience; the ABE factor correlated negatively only with the Self-POV condition, and the AFS factor correlated negatively only with the two Other conditions (POV and EXO). This suggests that, while overall NS-SCR responding was unrelated to DP/DR experience, the magnitude of the difference between threat-related responses and NS-SCRs was reliably related to measures of anomalous DP/DR experience.

Further, the additional analysis on the difference between threat-SCR and the pre-threat NS-SCR amplitudes allowed us to explore anticipatory factors toward the threat. The difference between threat-SCR and NS-SCR amplitudes during the pre-threat period correlated negatively with ABE and AFS factors. That is, as predisposition to these experiences increased, the difference in amplitudes between the two types of autonomic responding (threat-related SCRs and spontaneous NS-SCRs) decreased. Although this would be predicted by the threshold account, it has not been previously determined whether this might occur due to increased responding in anticipatory processing, aberrant suppression in actual autonomic/threat responding, or indeed both.

Based on the current findings we tentatively suggest that the aberrant neurocognitive processes mediating non-clinical DP/DR-type experiences likely take place due to a lower threshold for the initiation of autonomic suppression. By this account, these experiences result from the inappropriate activation of suppression mechanisms, rather than by abnormally increased anticipatory processes – at least in terms of anticipatory processes taking place a few tens of seconds before the event.

One explanation proposed for the experiences of depersonalization/derealization is that of a basic attentional bias where an aberrant prominence is given towards either internal (interoceptive/visceral body signals) or external (exteroceptive) sources (Hunter et al., 2003; Medford, 2012; Medford et al., 2006; Sass, Pienkos, Nelson, & Medford, 2013). Yet, the co-occurrence of depersonalization and derealization might appear to make the basic notion of a bias, somewhat problematic. One cannot be biased both towards and away from sources of information simultaneously.

However, there is an alternative way to view attentional biases as an underlying explanation for understanding these diverse experiences which might also explain why DP/DR-type experiences often co-occur. Specifically, ABEs might reflect, at least in part, attentional biases directed toward the processing of internal bodily signals (biases in interoception) which, in turn, produce an aberrant saliency for these body signals. The effects of this would be two-fold. First, the aberrant salience would, in a system already predisposed to hyper-react, inappropriately induce states of supressed emotional processing directed towards those very body signals, resulting in an unreality for the self (depersonalization-type experiences). Second, due to the self-focussed nature of these attentional biases, less attention would be available or paid to external sources of information from the external world resulting in some degree of derealization-type experiences: Hunter et al., 2003; Medford, 2012; Medford et al., 2006: Sass et al., 2013).

4.2. Limitations and future research

Subsequent studies could extend the present efforts in important ways. For example, the current study concentrated on exploring effects with aversive stimuli. While based on logic from previous research, i.e., that suppressive effects are principally associated with aversive stimuli (Sierra, Lopera, et al., 2002; Sierra, Senior, et al., 2002; Sierra et al., 2006; Medford et al., 2006; Phillips et al., 2001; see also Dewe et al., 2016), future studies could explore additional types of events and actions such as positive or neutral instances of body-related behaviours and conduct direct comparisons between these alternatives.

In addition, it would also be helpful to broaden the scope of anomalous experience beyond that of DP/DR into areas such as schizotypy, anxiety disorders, and dissociation more generally. Similar designs using between-participant protocols (i.e., a different sample for each condition – matched in terms of factors of interest) might help to navigate around any issues of habituation of autonomic responses because each sample would only receive one threat condition – though of course, such designs bring their own limitations.

Irrespective of these helpful developments, the present study establishes: (i) the existence of distinct effects of threat-related autonomic responding as a function of the congruency in perspective between the self and other, (ii) selective associations between certain clusters of aberrant experiences and supressed autonomic responses for aversive threats delivered to the self or other individuals, and (iii) direct evidence that the suppressive mechanism is not triggered by aberrant anticipatory processes reflected in background autonomic components.

4.3. Conclusion

The present study has shown, for the first time, the existence of distinct autonomic response patterns for those predisposed to DP/DR-type experiences within a sub-clinical group. Selective suppressive mechanisms were revealed, which were dependent on whether a realistic threat was carried out on the participant's own body compared to when it was delivered on someone else's. There was an overall effect of perspective, suggesting that threat-related autonomic responses were facilitated by the congruency in viewpoint between the observing participant and the individual receiving the threat. These effects were further mediated by the nature of the anomalous experience; namely whether they were more in line with depersonalization- or derealization-type experiences. The present findings are in general line with those predicted by the threshold model (Sierra & Berrios, 1998; Sierra & David, 2011) and can be accommodated within predictive-coding frameworks, but now reveal that the aberrant suppression is more tractable to aberrations in suppressive mechanisms rather than in anticipatory processes dedicated to coding the aversive stimuli in the first place. Collectively, these findings are revealing for the scientific understanding of the underlying neurocognitive mechanisms mediating aberrations in self-consciousness.

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