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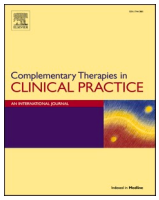

Online structured dance/movement therapy reduces bodily detachment in depersonalization-derealization disorder

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ABSTRACT

Background: Depersonalization-derealization disorder (DDD) is a dissociative disorder encompassing pronounced disconnections from the self and from external reality. As DDD is inherently tied to a detachment from the body, dance/movement therapy could provide an innovative treatment approach.
Materials and methods: We developed two online dance tasks to reduce detachment either by training body awareness (BA task) or enhancing the salience of bodily signals through dance exercise (DE task). Individuals with DDD (n = 31) and healthy controls (n = 29) performed both tasks individually in a cross-over design. We assessed symptom severity (Cambridge Depersonalization Scale), interoceptive awareness (Multidimensional Assessment of Interoceptive Awareness – II), mindfulness (Five Facet Mindfulness Questionnaire), and body vigilance (Body Vigilance Scale) before, during and after the tasks.
Results: At baseline, individuals with DDD exhibited elevated depersonalization-derealization symptoms alongside lower levels of interoceptive awareness and mindfulness compared to controls. Both tasks reduced symptoms in the DDD group, though dance exercise was perceived as easier. The DE task increased mindfulness in those with DDD more than the BA task, whereas controls showed the opposite pattern. In the DDD group, within-subject correlations showed that lower levels of symptoms were associated with task-specific elevations in interoceptive awareness and mindfulness.
Conclusion: Individual and structured dance/movement practice, performed at home without an instructor present, offers an effective tool to reduce symptoms in DDD and can be tailored to address specific cognitive components of a mindful engagement with the body.

1. Introduction

As defined by the American Dance Therapy Association (ADTA), Dance Movement Therapy (DMT) is "the psychotherapeutic use of movement to promote emotional, social, cognitive, and physical integration of the individual, for the purpose of improving health and well-being" (ADTA, [38]). Collectively, recent research has suggested that DMT or creative movement can have a positive impact on health and wellbeing in both physical and mental health conditions including dementia, Parkinson's disease, and depression [1], with a core feature of DMT being the observation of ones' own body and attending to physiological signals and physical boundaries. Physical exercise more broadly has shown a wide range of benefits for mental health [2,3], and dance training, more specifically, has been shown to alter behaviour and brain function within weeks or even days [4,5] and is linked to an improved sense of awareness of the body [64].

One of the premises of DMT is that psychological and bodily changes reciprocally influence each other. Therefore, dance/movement may be a powerful intervention for mental health disorders that are characterized primarily by somatic symptoms or experiences of disembodiment. A body-based approach may be especially efficacious for the treatment of dissociation and trauma [6–9] encouraging and training individuals to attend to their bodies and bodily sensations [10].

Depersonalization-derealization disorder (DDD), is a dissociative disorder (DSM-5 [11]; ICD-11 [12]); that presents itself as a natural candidate for body-based interventions. DDD is primarily characterized by symptoms of depersonalization and derealization (DD), which may manifest as disruptions in self-awareness, feelings of detachment and

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disembodiment, and a sense of unreality from both the self and the outside world [13]. Transient, short-lived experiences of DD are relatively common in the general population, with an estimated prevalence of 23% [13], and can occur as a result of fatigue, substance abuse, or trauma [14]. Chronic DDD affects approximately 1% of the population [14,15] but remains widely unknown and underdiagnosed. A core feature of DDD is the experience of physiological numbing and feelings of disembodiment [16].

Experiences of disembodiment and detachment from one's body in DDD may partly reflect altered [17] or deficient [18–20] interoceptive processing. Interoception is a sense of awareness of one's own body and its internal states and sensations [21] and encompasses dissociable dimensions of accuracy, awareness, and sensibility [22]. DDD patients show reduced activation in brain regions associated with interoception (e.g., insula; [18,23–25], with further work [17,19,26] providing evidence for deficits in interoception, abnormal cardiovascular sympathetic and parasympathetic responses to physical and emotional stimuli, and changes in the cortical representation of bodily signals in DDD patients. Overwhelmingly, previous explorations of interoception in DDD have focused on accuracy, measured with heartbeat detection or tracking tasks [27,28], or neural correlates of interoception, in comparison to self-reported trait level interoceptive awareness or sensibility. As previously described by Michal et al. [25], individuals with DDD have been found to exhibit 'normal' interoceptive accuracy and self-rated clearness of body perception despite reporting severe anomalous bodily experiences (Cambridge Depersonalization Scale; [46]). Importantly, self-reported interoceptive *awareness*, which does not necessarily correlate with interoceptive *accuracy* [29], has – to our knowledge – not yet been assessed in DDD [30]. The consideration of interoception within a multidimensional framework allows for a better understanding of interoceptive deficits in DDD as well as the nuanced relationships that could be at play across these dimensions [67].

Existing therapies for DDD are by and large talking therapies [31]. To date, Cognitive Behavioural Therapy (CBT) has been considered the primary treatment of choice for DDD, where the identification and correction of thinking patterns and changing non-adaptive behavioural patterns produces symptom change [68]. Although depersonalization-derealization symptom improvement following CBT has been reported [68], it has been suggested that these effects may be heavily linked to, or driven by, reductions in depression and anxiety, that may then indirectly alleviate detachment symptoms, rather than reflective of direct effects on depersonalization-derealization symptoms. Beyond this, evidence-based treatments for DDD often include case studies [32] and small sample sizes [33], and any randomized controlled trials performed evaluating pharmacotherapy (e.g., fluoxetine, lamotrigine) or psychotherapy (e.g., CBT, psychodynamic psychotherapy, biofeedback) reveal either a lack of efficacy of the treatments or inconsistent evidence across them [69,70]. Although some suggestions have been made with regard to future directions for treatment, including adaptive immersive virtual environments [31], there is an obvious and current need for controlled research on therapeutics for DDD.

A central feature of DDD is the experience of physiological numbing and a sense of detachment between one's sense of self and their body [16]. Talking therapies may be less likely to address this fundamental aspect of the disorder. Instead, "… treatment should focus on grounding and orientation to the self and the here and now" [7]; p. 468)." Wallman-Jones et al. [34] point towards a feedback loop between physical activity and interoceptive processing, where these may reciprocally influence one another. One form of physical activity that could be particularly useful in potentially altering interoceptive processing and enhancing interoceptive awareness and mindfulness in DDD is dance/movement therapy [1]. If DDD is indeed linked to a reduced awareness of bodily sensations, it may be more directly and effectively addressed by generating mindful body movements and experiences rather than discussing their absence. Indeed, mindfulness has also been shown to be reduced in DDD [35,36], which may be linked to the suggested deficits in interoceptive awareness.

Here, we report an online study that deploys dance/movement as a tool to develop a greater awareness of one's body in people with DDD and a control group of clinically healthy individuals. To this end, we developed two dance tasks that do not require any prior dance experience and can be performed alone at home, without an instructor present. The body awareness (BA) task, rooted in principles of body scanning and somatic practices, *explicitly* directs attention towards the body, whereas the dance exercise (DE) task, focused on aerobic physical dance movement, *implicitly* boosts the salience of bodily signals. We were interested in determining, in the context of DDD, if it is more effective to explicitly focus on bodily sensations, or to implicitly enhance the salience of bodily signals through dance-based exercise. Further, to control for potential social influences on treatment effectiveness [37], both tasks in our study were performed alone and at home, unlike traditional DMT that is typically performed in group settings [38]. Finally, the use of two dance tasks, instead of one dance task and a no-intervention control group, allows us to control for the influence of physical exercise [1,39].

We expect that the clinically healthy control group will exhibit superior interoceptive awareness and mindfulness as compared to the DDD group at baseline, with these differences remaining post-intervention. We predict that both dance tasks will reduce bodily detachment in DDD but may do so by affecting different components of interoceptive awareness and mindfulness. More specifically, if *explicit attention to bodily sensations* is helpful in reducing dissociation, then we would expect the BA task to decrease anomalous body experiences, whilst improving interoceptive awareness and mindfulness. Alternatively, if an *implicit engagement with the body* is helpful and can be elicited by increasing the salience of bodily signals, then we would expect the DE task to decrease anomalous body experiences, whilst improving interoceptive awareness and mindfulness. Moreover, we expect that reductions in depersonalization/derealization (DD) symptoms will scale with improvements in mindfulness and interoceptive awareness and daily state depersonalization/derealization (DD) scores will decrease across the two weeks, which will be positively associated with a decrease in trait DD scores.

2. Materials and Methods

2.1. Participants

Participants with DDD were recruited online through the UK DDD charity *Unreal* (https://www.unrealuk.org/) and relevant social media channels, and through referrals from a specialist DDD clinic in London (thedepersonalisationclinic.com). Healthy controls were recruited online through advertisements and newsletters at Goldsmiths, University of London as well as on general public sites. Interested participants were sent an information sheet before a phone screening to assess eligibility. All eligible participants provided informed consent in accordance with the Declaration of Helsinki and ethical approval from the research ethics committee at Goldsmiths, University of London, and received £40 for completion of both phases of the study. This study was preregistered, and more details can be found here: (https://osf.io/ymz2c).

Participants from both groups were included if they met the following criteria: aged 18–70; no previous or current head injury; no severe drug or alcohol use; no neurological disorder; and no severe physical impairment affecting motor performance. As the study took place entirely online, participants could be located anywhere worldwide. To qualify for the DDD group, all participants were required to meet DSM-5 (300.6) diagnostic criteria [11] for current DDD including: chronic or recurrent episodes of depersonalization and derealization; awareness that their symptoms are a subjective experience; the symptoms cause distress and/or impairment to their functioning; and the symptoms are not better explained by another disorder or substance use. In addition, DDD participants were also required to have no self-reported comorbid diagnosis of schizophrenia, other psychosis

spectrum disorder, or PTSD. To qualify for the control group, all participants were required to not meet diagnostic criteria for DDD and have no other self-reported current psychiatric diagnoses. These criteria were assessed as part of a structured screening interview carried out by the first author and developed in collaboration with the second author, a leading DDD clinician, both ahead of and throughout the study period (see Supplementary Materials for more details).

An effect size of the impact of the tasks on DD symptoms was estimated from a study examining changes in body image among depressed adult outpatients after a DMT treatment [40]. Their effect size for pre- and post-DMT intervention increase for the measure of body image was medium to large, $d = 0.73$. Using this effect size estimate, we performed an *a priori* sample size estimation (two-tailed $\alpha = 0.05$, power = 0.90, 1:1 group ratio), which yielded a required sample size of 22 participants in the DDD group. In order to account for attrition and poor data quality, we aimed to include a minimum of 30 participants per group.

We recruited a total of 44 participants with DDD and 36 healthy, demographically matched controls. Nine participants in the DDD group (Age: M = 28; SD = 5.59; Gender: 6F/3 M) dropped out at various points across the study period (two dropped out before the first online session; three dropped out after one week of participation; three dropped out after the first two weeks of participation; one dropped out half-way through the second two weeks) and four individuals did not meet inclusion criteria due to differential diagnosis and/or presence of PTSD. In cases where a reason for dropout was provided, time constraints were cited as the issue. Three controls (Age: M = 36; SD = 16.37; Gender: 3F) dropped out across the study period (one ahead of the first online session; one mid-way through the first week of the study; one after the first two weeks) and four did not meet inclusion criteria due to the presence of other psychiatric disorders or having symptoms of DDD. The final sample of participants comprised 31 individuals with DDD and 29 controls.

2.2. Design and procedure

A crossover design was used in which both dance/movement tasks (BA and DE) were sequentially completed by all participants (DDD group and controls) in counterbalanced order (see Supplemental Fig. 1). Participants were taught one of the two tasks (BA or DE) during the first online video session with the first author, and then asked to perform the task at home once per day across a period of six days. For both tasks, participants were provided with audio recordings of the warmup and task itself to guide them through the tasks at home. All participants had a second online video session on the seventh day of the study to check-in and discuss the participant's experience of the task thus far. Participants then continued to perform the task once per day across the second six-day period (12 days of daily task performance total). A washout period of four to six weeks separated the two tasks to minimize the risk of carry-over effects. During the washout period, participants were asked to discontinue performance of the task (either BA or DE) and continue with their daily routine as normal. After the washout period, participants were taught the other task and the same procedure (over two weeks) was repeated.

2.3. Measures

2.3.1. Baseline measures

Prior to taking part in the tasks, participants completed measures of depression, anxiety, obsessive compulsive disorder, visualisation, dance engagement and experience, and non-hypnotic direct verbal suggestibility (data reported in [36]).

The *Patient Health Questionnaire – 9* (PHQ-9 [41]) was used to measure depressive symptom severity (Kroenke & Spitzer, 2002). This 9-item scale ($\alpha = 0.93$) indexes symptoms over the last two weeks with items rated from 0 ("not at all") to 3 ("nearly every day") with total scores ranging from 0 to 27 and a separate tenth question concerning one's level of functional impairment. It is recommended that a score of 10 is used as a threshold for depression as this score has a sensitivity and specificity of 88% for major depression [71].

The *Generalized Anxiety Disorder – 7* (GAD-7 [42]) is a brief self-report scale of generalized anxiety. The 7 items ($\alpha = 0.91$) ask about symptoms over the last two weeks, rated from 0 ("not at all") to 3 ("nearly every day") with total scores ranging from 0 to 21. A score of 10 or greater acts as the single screening cut-off point with a sensitivity of 89% and a specificity of 82% for GAD [42]. The GAD-7 also includes a rating of functional impairment.

The *Obsessive-Compulsive Inventory Revised* (OCI-R [43]) is an 18-item ($\alpha = 0.90$) self-report scale used to screen and assess symptoms of obsessive-compulsive disorder (OCD). Items are scored on a five-point Likert scale from 0 ("not at all") to 4 ("extremely") with total scores ranging from 0 to 72. The recommended cutoff score indicating a probable diagnosis of OCD is 21.

The *Vividness of Visual Imagery Questionnaire* (VVIQ [44]) is a 16-item scale measuring the vividness or intensity of imagined visual scenes. The 16 items ($\alpha = 0.95$) comprise four groups of four items, with each item rated on a five-point Likert scale (1: "perfectly clear and vivid as normal vision" to 5: "no image at all, you only 'know' that you are thinking of the object") with scores ranging from 16 to 80. Each group of items presents a different scenario, and the respondent is asked to rate the vividness of specific details within each scenario.

The *Goldsmiths Dance Sophistication Index* (Gold-DSI [45]) is a 26-item self-report scale that measures participatory and observational dance experience. The participatory factor has one general factor and four subscales, and observational dance training has only one factor. Higher overall scores indicate increased experience and engagement with dance. This measure and its subscales showed high internal consistency ($\alpha = 0.94$; body awareness: $\alpha = 0.87$; urge to dance: $\alpha = 0.92$; social dancing: $\alpha = 0.80$; dance training: $\alpha = 0.83$).

2.3.2. Weekly measures

At three time points across each of the two-week testing periods (Day 1: Time 1, Day 8: Time 2 and Day 15: Time 3; see Supplemental Fig. 1), all participants completed self-report measures of DD, interoceptive awareness, mindfulness, and body vigilance.

The *Cambridge Depersonalization Scale* (CDS [46]) is a 29-item self-administered questionnaire designed to measure trait DD experiences. Respondents rate the frequency (0 ["never"] – 4 ["all the time"]) and duration (0 ["few seconds"] – 6 ["more than a week"]) of these different experiences in the preceding six months. As this research is concerned with week-to-week changes in symptoms, and the CDS is the most suitable and specific validated questionnaire to assess DDD symptoms, the instructions for this questionnaire were adjusted to ask respondents about their symptoms in the preceding week. It should be noted that the psychometric properties of using the questionnaire in this way are unknown. Frequency and duration scores are summed across all items, with a total scoring range of 0–290. The cut-off score for a clinical diagnosis of DDD in 80% of cases is 70 [46]. This measure displayed high internal consistency overall ($\alpha = 0.97$). Based on a previous factor analysis (Sierra et al., 2005), we also calculated scores for the Anomalous Body Experience subscale (9 items; $\alpha = 0.93$). Given the focus of the dance/movement tasks and central research questions within this study, we were particularly interested in examining the impact of the two tasks on anomalous body experiences more specifically.

The *Multidimensional Assessment of Interoceptive Awareness – II* (MAIA-II [29]) is a 37-item self-report questionnaire of interoceptive awareness measuring perceptions of and reactions to bodily sensations. Each question is scored on a Likert-type scale from 0 ("never") to 5 ("always"). In addition to the average scores for all eight subscales, we also calculated the mean score across the entire scale as a summary measure of interoceptive awareness [47,66]. Although a summary score is not typically used or recommended for the MAIA-II, we were nonetheless interested in capturing a broader, overall measure of interoceptive

awareness (which displayed high internal consistency; α = 0.92), alongside exploring specific interoceptive dimensions. Higher scores, both overall and on individual subscales, are indicative of increased body awareness. High internal consistency was seen for each subscale: Noticing (4 items; α = 0.76), Not Distracting (6 items; α = 0.89), Not Worrying (5 items; α = 0.81), Attention Regulation (7 items; α = 0.89), Emotional Awareness (5 items; α = 0.86), Self-Regulation (4 items; α = 0.86), Body Listening (3 items; α = 0.89), and Trusting (3 items; α = 0.90).

The *Five Facet Mindfulness Questionnaire* (FFMQ [48]) is a 39-item scale with five facets measuring trait mindfulness in everyday life. Each of the 39 items is rated on a Likert scale of 1 ("never or very rarely true") to 5 ("very often or always true"). Total scores and individual facet scores were calculated. As with the CDS, the instructions for this questionnaire were adjusted to ask respondents about these statements across the preceding week. Higher scores indicate increased mindfulness. This scale displayed high internal consistency overall (α = 0.92) and for each facet: Observing (8 items; α = 0.81), Describing (8 items; α = 0.86), Acting with Awareness (8 items; α = 0.91), Non-Judging (8 items; α = 0.93), and Non-Reactivity (7 items; α = 0.81).

The *Body Vigilance Scale* (BVS [49]) is a four-item (α = 0.78) self-report assessment of one's sensitivity to and attentional focus on internal bodily sensations across the previous week. The first three items assess how much attention is paid to bodily sensations and how sensitive one is to changes in bodily sensations from 1 ("not at all") to 10 ("extremely"), and the average amount of time spent, per day, scanning for bodily sensations from 0 ("no time") to 100 ("all of the time"). The fourth item asks for ratings of how much attention is paid to 15 different bodily sensations, from dizziness to feeling detached from the self, on a scale of 0 ("none") to 10 ("extreme").

2.3.3. Daily measures

Participants were asked to complete a daily Diary Sheet on each of the 12-day at-home periods. Before completing the dance task, participants were asked to indicate the date and time. After task-completion, participants were asked to rate how easy it was to perform the task, and how they felt performing the task, rated on reverse 7-point Likert scales: ease = 1 ("very easy") to 7 ("very difficult"); feeling = 1 ("very bad") to 7 ("very good"). Participants could also provide open comments for each session. Finally, a 12-item DDD checklist [50] was included to measure current state DD symptoms. 12 symptoms were rated on a scale of 0 ("not at all") to 100 ("extremely"), with total scores ranging from 0 to 1200, and were to be completed daily both pre- and post-task. On Day 1, this scale has high internal consistency (α = 0.97).

2.4. Dance/movement tasks

We designed two dance/movement tasks that either focused on training explicit bodily awareness (Body Awareness [BA]) or implicitly enhancing the salience of bodily signals (Dance Exercise [DE]) (see Supplementary Materials for detailed, standardized instructions of both tasks). Both of these tasks are based on the first authors' experience as a dancer and choreographer, and her developing in-studio movement practice aimed at grounding in, and proactively engaging with, the body (de Tord & Brauninger, 2015). In the case of the BA task, this involves principles from body scanning [51] and the use of grounding objects in DDD treatment [52].

Body Awareness (BA): The BA task (see Supplemental Fig. 2) consists of a warmup (5.60 min) and structured dance movement (15.05 min), using imagery to guide participants to attend to their body via a set of standardized instructions. The warmup focuses on relaxation and being present in the current time and space. The main task involves guiding a "stress ball" (or comparable object) along the surface of the body and then imagining this same ball traveling both on the surface of and inside the body (see OSM Fig. S2). Participants were encouraged to explore different properties of the imagined ball, altering its size, weight and speed whilst traveling across their body and to notice their concomitant sensations in the process. Progressively, participants were then invited to use these sensations to generate their own movements. Throughout the entire task, participants were prompted to try their best to attend to bodily sensations they might be experiencing. Both the warmup and main task are paired with relaxing background music.

Dance Exercise (DE): This task (see Supplemental Fig. 2) consists of a warmup (4.58 min) and learning a short and simple dance phrase (10.33 min). The task requires participants to copy a set of pre-specified dance steps that follow the rhythm of a piece of music. The movement elements of the task include stretches, balances and swinging movements that are combined in an increasingly dynamic way (see OSM Fig. S2). The task involves learning the five movements (simple, coordinated movements of the arms and legs) included in the movement sequence and then stitching these together in a sequence for a set of eight counts, four counts and two counts. The warmup is also paired with a piece of upbeat music playing in the background.

In a follow-up in-person study from a different group of participants (DDD: n = 18, age M = 35.4, SD = 14.1, gender = 72% F, 28% M; Control: n = 14, age M = 31.2, SD = 10.5, gender = 86% F, 14% M) which will be reported in full in a future paper, we collected accelerometer and heart rate data to assess physiological differences across the time course of the two tasks. These data demonstrate that, at least on Day 1 of task performance, the DE task involves both more movement, $t(14) = -3.25$, $p = .006$, $g = 1.18$, and is associated with a higher heart rate, $t(15) = -2.35$, $p = .03$, $g = 0.80$, than the BA task, with both task differences being large in magnitude.

2.5. Analysis

The study was preregistered on OSF (https://osf.io/ymz2c). All data were analysed using the statistical software *R* (Version 4.1.0; [53]). Missing data for the CDS, MAIA-II, FFMQ and BVS was found for 0.3%–2.0% of cases. Little's MCAR test was non-significant, $\chi 2$ (5195) = 5329.55, p = .094, and therefore we assume the data were missing completely at random. Imputation via expectation-maximisation, an iterative procedure using other variables to impute missing values and check the likelihood of these values, was used to estimate missing data for these four questionnaires [54,55]. Outliers ($M \pm 2.5$ SDs) were identified and winsorised to allow for inclusion in the final analyses. The two groups were compared on demographics and psychometric measures using independent samples t-tests and Chi-squared tests. Hedges's g, which uses a pooled and weighted standard deviation [56], and phi were calculated as measures of effect size. Distribution normality was evaluated with QQ plots and Shapiro-Wilk tests, homogeneity of variance was evaluated with Levene's test, and sphericity was assessed with Mauchly's test. In cases where normality was not satisfied (Shapiro-Wilk test $p < .05$), the analyses were still carried out as all data points fell roughly along the reference line in QQ plots and ANOVA is tolerant to deviations of normality [57]. The data did violate homogeneity of variance (Levene's test $p < .05$) in some cases, however, insofar as the sample sizes are relatively equal (n = 31, n = 29), ANOVAs should be robust under these circumstances [57]. In situations where the assumption of sphericity was violated, degrees of freedom were corrected using Hyunh-Feldt estimates of sphericity. Five three-way (2 × 2 × 3: Group × Task Type × Time) mixed-model ANOVAs were conducted on CDS total scores, CDS-Anomalous Body Experience (CDS-ABE) scores, MAIA-II mean scores, FFMQ total scores, and BVS total scores with η_p^2 as the measure of effect size.

Finally, within-subject repeated measures correlations were computed for the DDD group alone to assess associations between DD (CDS and CDS-ABE), interoceptive awareness (MAIA-II), and mindfulness (FFMQ). We also examined the association between level of compliance, measured by the number of days the task was performed overall, and mean CDS scores across the study period. Secondary analyses examined daily state dissociative symptom scores (12-item DPD

checklist), with mean scores (pre-task, post-task) computed for days 1–12. Exploratory analyses investigated associations between the CDS and FFMQ and MAIA-II subscales. All analyses were two-tailed ($\alpha < 0.05$) except the exploratory correlational analyses which, given their exploratory nature, used a more conservative threshold for significance ($\alpha < 0.01$).

3. Results

3.1. Demographics

All participants with DDD experienced these symptoms chronically, on a daily basis, with the length of time of experience ranging from 1.5 to 50 years ($M = 11.6$ years). The two groups were well-matched on demographic variables including age, gender, employment status, and physical activity, with a weak trend toward lower education in the DDD group (Table 1). Participants with DDD reported more frequently to be taking medication (antidepressants [10], benzodiazepines [6], and unspecified [5]), with 3 controls taking medication for generalized anxiety. 12 participants in the DDD group were concurrently undergoing therapy (CBT [3], counselling [3], unspecified [6]. 19 participants with DDD and 21 controls were currently living in England, with the rest residing in Scotland, France (2), Ireland (2), Italy (2), USA (5), Croatia, Spain, Egypt, Germany, Slovakia (3) and Brazil.

As can be seen in Table 2, participants with DDD experienced elevated anxiety, depression, and obsessive-compulsive symptoms compared to the control group. At baseline, DDD participants scored significantly above the clinical cut-off for DDD [46], on depersonalization-derealization (CDS) and on the anomalous body experience subscale (CDS-ABE). The DDD group also exhibited significantly lower dance experience (Gold-DSI), overall interoceptive awareness (MAIA-II), with specific deficits in attention regulation (MAIA-AR), trusting (MAIA-T), and self-regulation (MAIA-SR), and overall mindfulness (FFMQ), with specific deficits in acting with awareness (FFMQ-AA), describing (FFMQ-D), and non-judging (FFMQ-NJ), compared to controls. Although not significant, a trend towards a reduced ability to vividly visualize scenarios in the DDD group was also present. Body vigilance did not differ between the two groups.

Table 1
Demographic characteristics as a function of group.

	DDD(n = 31) M (SD)	Controls(n = 29) M (SD)	$t(df)$	p	g
Age	32.97 (12.1)	31.8 (11.8)	−.37 (57.91)	.71	.10
	% (n)	% (n)	$\chi 2$	p	Φ
Education (% attended university)	52 (16)	79 (23)	3.91	.048	.26
Employment (% employed)	48 (15)	48 (14)	6.46e-31	1	1.04e-16
Gender (% female)	68 (21)	72 (21)	.013	.91	.01
Location (% in England)	61 (19)	72 (21)	.87	.35	.12
Medication (% on current medication)	48 (15)	10 (3)		.002[F]	
Therapy (% in current therapy)	39 (12)	0 (0)		<.001[F]	
Physical activity (% 3x/week or more)	58 (18)	62 (18)	.049	.82	.03

Notes. DDD = depersonalization-derealization disorder; M = mean; SD = standard deviation. [F] Fisher's exact test p-value.

Table 2
Baseline research variables as a function of group.

Variable	DDD (n = 31)	Controls(n = 29)	T (df)	p	g
	M(SD)	M (SD)			
BVS	22.5 (8.34)	19.9 (6.48)	−1.33 (56.15)	.19	.34
CDS	151.99 (38.9)	28.7 (20.9)	−15.41 (46.58)	<.001	3.86
CDS-ABE	47.73 (16.0)	6.03 (6.72)	−13.31 (40.81)	<.001	3.31
FFMQ	107 (19.4)	129 (18.1)	4.64 (58)	<.001	1.16
FFMQ-AA	18.9 (6.20)	26.6 (5.70)	4.99 (57.98)	<.001	1.29
FFMQ-D	23.4 (6.12)	28.1 (5.18)	3.21 (57.45)	.002	.83
FFMQ-NJ	21.8 (8.62)	26.9 (7.55)	2.47 (57.76)	.017	.63
FFMQ-NR	17.8 (5.26)	20.1 (4.37)	1.82 (57.22)	.07	.47
FFMQ-O	25.1 (6.20)	27.7 (5.27)	1.79 (57.49)	.08	.45
GAD-7	12 (5.64)	3.90 (2.77)	−7.13 (44.30)	<.001	1.78
Gold-DSI	102 (23.9)	116 (21.5)	2.42 (57.92)	.019	.61
MAIA-II	2.30 (0.64)	2.78 (0.55)	3.14 (57.63)	.003	.79
MAIA-AR	2.12 (.97)	2.82 (.90)	2.90 (57.99)	.005	.74
MAIA-BL	1.82 (1.18)	2.22 (.97)	1.45 (57.05)	.15	.37
MAIA-EA	2.97 (1.03)	3.26 (1.23)	1.00 (54.88)	.32	.26
MAIA-N	3.08 (1.07)	2.97 (1.02)	−.43 (57.97)	.67	.11
MAIA-ND	2.16 (1.33)	2.51 (.96)	1.16 (54.72)	.25	.30
MAIA-NW	2.28 (.83)	2.39 (.83)	.42 (54.24)	.67	.13
MAIA-SR	2.10 (1.12)	2.78 (.91)	2.56 (56.90)	.013	.66
MAIA-T	1.65 (1.26)	3.41 (.92)	6.24 (54.71)	<.001	1.59
OCI-R	19.8 (12.9)	11.5 (6.45)	−3.19 (44.76)	.003	.80
PHQ-9	14.1 (7.95)	4.46 (3.73)	−6.03 (43.51)	<.001	1.51
VVIQ	45.13 (14.9)	51.72 (11.9)	1.90 (56.66)	.06	.48

Notes. BVS = *Body Vigilance Scale;* CDS = *Cambridge Depersonalization Scale*; CDS-ABE = *Cambridge Depersonalization Scale – Anomalous Body Experience*; FFMQ = *Five Facet Mindfulness Questionnaire*; FFMQ-AA = *Five Facet Mindfulness Questionnaire* – Acting with Awareness; FFMQ-D = *Five Facet Mindfulness Questionnaire* – Describing; FFMQ-NJ = *Five Facet Mindfulness Questionnaire* – Not-Judging; FFMQ-NR = *Five Facet Mindfulness Questionnaire* – Not-Reacting; FFMQ-O = *Five Facet Mindfulness Questionnaire* – Observing; GAD-7 = *Generalized Anxiety Disorder-7*; Gold-DSI = *Goldsmiths Dance Sophistication Index;* MAIA-II = *Multidimensional Assessment of Interoceptive Awareness;* M = mean; MAIA-AR = Multidimensional Assessment of Interoceptive Awareness – Attention Regulation; MAIA-BL = Multidimensional Assessment of Interoceptive Awareness – Body Listening; MAIA-EA = Multidimensional Assessment of Interoceptive Awareness – Emotional Awareness; MAIA-N = Multidimensional Assessment of Interoceptive Awareness – Noticing; MAIA-ND = Multidimensional Assessment of Interoceptive Awareness – Not Distracting; MAIA-NW = Multidimensional Assessment of Interoceptive Awareness – Not Worrying; MAIA-SR = Multidimensional Assessment of Interoceptive Awareness – Self Regulation; MAIA-T = Multidimensional Assessment of Interoceptive Awareness – Trusting; OCI-R = *Obsessive Compulsive Inventory Revised*; PHQ-9 = *Patient Health Questionnaire-9*; SD = standard deviation; VVIQ = *Vividness of Visual Imagery* Questionnaire.

3.2. Changes in symptom severity and bodily experiences across tasks

3.2.1. Depersonalization-derealization

A three-way mixed ANOVA was performed to evaluate the effects of group (DDD, Controls), task type (BA, DE), and time (Week 1, Week 2, Week 3) on DD symptom severity (CDS, Fig. 1, Table 3). There were significant main effects of group, $F(1, 56) = 157.45$, $p < .001$, $\eta_p^2 = 0.74$), and time, $F(1.58, 88.64) = 20.98$, $p < .001$, $\eta_p^2 = 0.27$), on CDS scores, and a significant group × time interaction, $F(1.58, 88.64) = 7.14$, $p = .003$, $\eta_p^2 = 0.11$). There was no significant main effect of task type, $F(1, 56) = 1.20$, $p = .23$, $\eta_p^2 = 0.02$, or any interactions between task type × group, $F(1, 56) = 0.85$, $p = .36$, $\eta_p^2 = 0.02$, or task type × time, $F(2, 112) = 0.61$, $p = .54$, $\eta_p^2 = 0.01$, and no three-way interaction, $F(2, 112) = 0.53$, $p = .59$, $\eta_p^2 = 0.01$.

Post hoc tests on the significant group × time interaction collapsed across tasks in the two groups, with a Bonferroni adjustment, reveal a significant main effect of time in the DDD group, $F(1.56, 45.2) = 18.32$, $p < .001$, $\eta_p^2 = 0.39$, but not in the control group, $F(1.51, 40.7) = 3.71$, $p = .03$, $\eta_p^2 = 0.12$. Further, pairwise comparisons with a Bonferroni adjustment reveal that CDS scores were significantly different in the DDD group from Week 1-Week 2 ($p < .001$, $d = 0.25$) and Week 1-Week 3 ($p < .001$, $d = 0.41$), but not from Week 2-Week 3 ($p = .11$, $d = 0.15$). These results suggest that both tasks reduce the severity of DD symptoms over time, in the DDD group.

3.2.2. Anomalous body experience

A three-way mixed ANOVA was performed to evaluate the effects of group, task type, and time on anomalous body experience scores (CDS-ABE, Fig. 1, Table 3). Similar to CDS total scores, there were significant main effects of group, $F(1, 56) = 128.22$, $p < .001$, $\eta_p^2 = 0.70$, and time, $F(1.82, 101.74) = 9.87$, $p < .001$, $\eta_p^2 = 0.15$, and a significant group × time interaction, $F(1.82, 101.74) = 8.83$, $p < .001$, $\eta_p^2 = 0.14$. There was no significant main effect of task type, $F(1, 56) = 0.41$, $p = .52$, $\eta_p^2 = 0.01$, or any additional interactions (task type × group: $F(1, 56) = 0.34$, $p = .56$, $\eta_p^2 = 0.01$; task type × time: $F(2, 112) = 1.48$, $p = .23$, $\eta_p^2 = 0.03$; group × task type × time: $F(2, 112) = 0.58$, $p = .56$, $\eta_p^2 = 0.01$).

As observed with the CDS, Bonferroni-corrected *post hoc* tests on the group × time interaction, collapsed across tasks in the two groups, revealed a significant main effect of time in the DDD group ($F(2, 58) = 11.82$, $p < .001$, $\eta_p^2 = 0.29$), but not in the control group ($F(2, 54) = 0.053$, $p = .95$, $\eta_p^2 = 0.00$). Pairwise comparisons with a Bonferroni adjustment reveal that CDS-ABE scores were significantly different among participants with DDD in the first week (Week 1-Week 2: $p = .002$, $d = 0.24$) and Week 1-Week 3 ($p < .001$, $d = 0.37$), but not the second week of the task (Week 2-Week 3: $p = .49$, $d = 0.13$). These results suggest that both tasks reduce the severity of anomalous body experiences over time in the DDD group.

3.2.3. Interoceptive awareness

A three-way mixed ANOVA was performed to evaluate the effects of group, task type, and time on overall interoceptive awareness (MAIA-II, Fig. 1, Table 3). There were significant main effects of group, $F(1, 56) = 25.77$, $p < .001$, $\eta_p^2 = 0.32$, reflecting lower MAIA-II scores in the DDD group, and time, $F(2, 112) = 8.61$, $p < .001$, $\eta_p^2 = 0.13$. There was no significant main effect of task type, $F(1, 56) = 1.89$, $p = .17$, $\eta_p^2 = 0.03$), or any interactions (group × task type: $F(1, 56) = 0.36$, $p = .55$, $\eta_p^2 = 0.01$; group × time: $F(1.81, 101.45) = 1.09$, $p = .34$, $\eta_p^2 = 0.02$; task type × time: $F(2, 112) = 0.25$, $p = .78$, $\eta_p^2 = 0.02$; group × task type × time: $F(2, 112) = 0.44$, $p = .65$, $\eta_p^2 = 0.01$).

Bonferroni-corrected *post hoc* tests on the significant main effect of time revealed significant differences in MAIA-II scores in the total sample from Week 1-Week 2 ($p = .04$, $d = 0.33$) and Week 1-Week 3 ($p < .001$, $d = 0.54$), but not from Week 2-Week 3 ($p = .34$, $d = 0.21$). Exploratory *post hoc* tests looking at the two groups separately revealed significant effects of time in the control group from Week 1-Week 3 ($p = .003$, $d = 0.43$), but not from Week 1-Week 2 ($p = .28$, $d = 0.25$) or Week 2-Week 3 ($p = 1.00$, $d = 0.17$). In the DDD group, no significant effects of time were seen (Week 1-Week 2: $p = 1.00$, $d = 0.11$; Week 1-Week 3: $p = .88$, $d = 0.12$; Week 2 –Week 3: $p = 1.00$, $d = 0.02$). These results suggest that both tasks improve overall interoceptive awareness over time in the control group.

3.2.4. Mindfulness

A three-way mixed ANOVA was performed to evaluate the effects of group, task type, and time on overall mindfulness (FFMQ, Fig. 1, Table 3). There were significant main effects of group, $F(1, 56) = 22.78$, $p < .001$, $\eta_p^2 = 0.29$, and time, $F(1.62, 90.68) = 14.19$, $p < .001$, $\eta_p^2 = 0.20$, on FFMQ scores, but there was no significant main effect of task type ($F(1, 56) = 0.49$, $p = .49$, $\eta_p^2 = 0.01$). Following up the simple main effect of time in each group separately, FFMQ scores improved over the complete two weeks of the task (Week 1-Week 3) in both the DDD group ($p < .001$, $d = 0.30$) and the control group ($p = .03$, $d = 0.32$), but not separately from Week 1-Week 2 (DDD: $p = .48$, $d = 0.17$; Control: $p = 1.00$, $d = 0.17$) or Week 2-Week 3 (DDD: $p = .48$, $d = 0.14$; Control: $p = 1.00$, $d = 0.16$) for both groups.

Additionally, we observed a significant group × task type × time interaction, $F(1.88, 105.52) = 3.46$, $p = .038$, $\eta_p^2 = 0.06$. This appears to be driven by differential effects of the two tasks on mindfulness in the two groups. Bonferroni-corrected *post hoc* tests reveal that across Week 1-Week 3, FFMQ scores in the DDD group increased significantly after performing the DE task, $F(1.51, 45.4) = 8.76$, $p = .002$, $\eta_p^2 = 0.23$, but not the BA task, $F(1.66, 48.1) = 1.93$, $p = .16$, $\eta_p^2 = 0.06$. Interestingly, we observed the opposite effect in healthy controls: across Week 1-Week 3, FFMQ scores increased after performing the BA task, $F(2, 54) = 6.66$, $p = .003$, $\eta_p^2 = 0.20$, but not the DE task, $F(1.61, 45.0) = 1.66$, $p = .21$, $\eta_p^2 = 0.06$. In sum, the DE task increased mindfulness in the DDD group whereas the BA task increased mindfulness in the control group.

3.2.5. Body vigilance

A three-way mixed ANOVA was performed to evaluate the effects of group, task type, and time on body vigilance (BVS, Fig. 1, Table 3).

Table 3
Descriptive statistics [*M* and (*SD*)] for core research variables as a function of study time point, task, and group (DDD $n = 31$, Control $n = 29$).

Variable	Task	DDD			Controls		
		Week 1	Week 2	Week 3	Week 1	Week 2	Week 3
BVS	BA	22.4 (7.92)	21.2 (8.07)	21.4 (7.77)	19.9 (5.92)	21.8 (6.68)	21.2 (6.67)
	DE	21.7 (8.07)	21.6 (7.79)	20.8 (8.03)	20.3 (6.41)	20.3 (6.07)	21.8 (7.53)
CDS	BA	145 (45.4)	137 (46.7)	128 (45.3)	27.5 (21.0)	25.9 (21.2)	24.5 (23.6)
	DE	143 (44.5)	128 (47.9)	123 (46.8)	28.8 (26.3)	26.1 (24.1)	22.4 (23.0)
CDS-ABE	BA	44.2 (17.2)	42.2 (16.8)	39.1 (17.1)	6.03 (7.10)	6.62 (7.11)	6.71 (7.75)
	DE	44.8 (17.5)	38.6 (18.1)	37.2 (16.7)	6.81 (8.20)	6.60 (7.79)	6.10 (8.02)
MAIA-II	BA	2.34 (.64)	2.40 (.54)	2.42 (.60)	2.93 (.50)	3.05 (.53)	3.13 (.50)
	DE	2.32 (.67)	2.39 (.65)	2.40 (.65)	2.83 (.52)	2.96 (.53)	3.06 (.52)
FFMQ	BA	112 (19.3)	112 (20.1)	115 (21.6)	130 (18.3)	135 (17.5)	138 (16.3)
	DE	106 (22.8)	113 (21.6)	116 (22.2)	132 (16.9)	133 (17.5)	135 (17.2)

Notes. BA = Body Awareness task; DE = Dance Exercise task; BVS = *Body Vigilance Scale*; CDS = *Cambridge Depersonalization Scale*; CDS-ABE = *Cambridge Depersonalization Scale – Anomalous Body Experience*; M = mean; MAIA-II = *Multidimensional Assessment of Interoceptive Awareness*; FFMQ = *Five Facet Mindfulness Questionnaire*; SD = standard deviation.

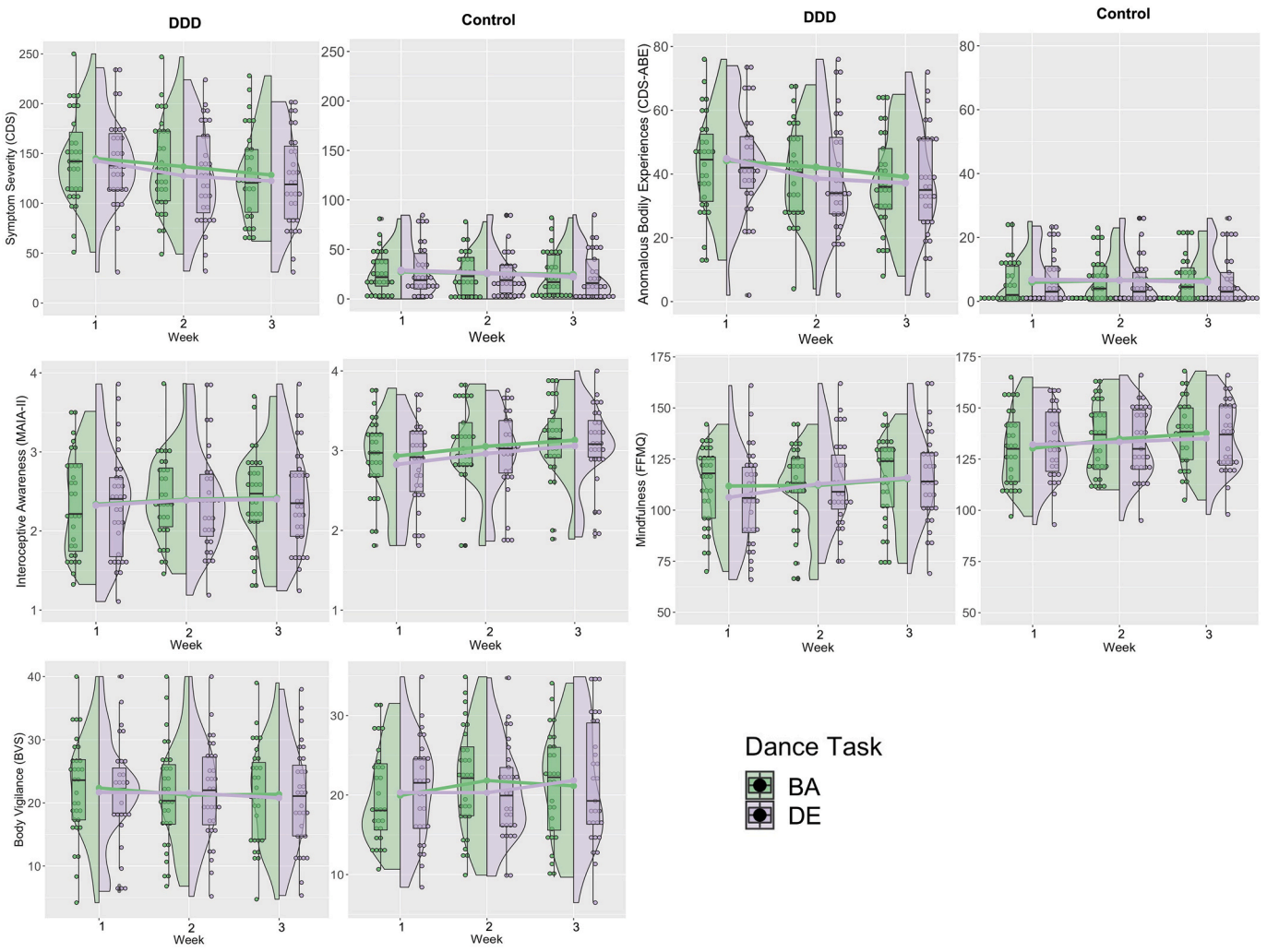

Fig. 1. Core research variables measured from Week 1 – Week 3.
Notes. BA = Body Awareness task; DE = Dance Exercise task; CDS = *Cambridge Depersonalization Scale*; CDS-ABE = *Cambridge Depersonalization Scale – Anomalous Body Experience*; MAIA-II = *Multidimensional Assessment of Interoceptive Awareness – II*; FFMQ = *Five Facet Mindfulness Questionnaire*; BVS = *Body Vigilance Scale.*

There was a significant two-way interaction between group and time, $F(2, 112) = 3.30$, $p = .041$, $\eta_p^2 = 0.06$, but no other significant effects (group: $F(1, 56) = 0.00$, $p = .95$, $\eta_p^2 = 0.00$; time: $F(2, 112) = 0.07$, $p = .93$, $\eta_p^2 = 0.00$; task type: $F(1, 56) = 0.28$, $p = .60$, $\eta_p^2 = 0.01$; group × task type: $F(1, 56) = 0.02$, $p = .89$, $\eta_p^2 = 0.00$; time × task type: $F(2, 112) = 0.24$, $p = .79$, $\eta_p^2 = 0.00$; group × time × task type: $F(2, 112) = 2.62$, $p = .078$, $\eta_p^2 = 0.05$). Bonferroni-corrected *post hoc* tests on this group × time interaction, collapsed across tasks in the two groups, revealed nonsignificant main effects of time at each level of group (DDD: $F(1.58, 45.8) = 1.99$, $p = .16$, $\eta_p^2 = 0.06$; Control: $F(2, 54) = 1.49$, $p = .23$, $\eta_p^2 = 0.05$). It appears that the group × time interaction is simply driven by a general upward trend in BVS scores from Week 1-Week 3 in the control group paired with a general downward trend in the DDD group. These results suggest that neither task significantly altered levels of body vigilance across the study period, in both the DDD and control groups.

3.3. Correlations between depersonalization, mindfulness and interoceptive awareness

3.3.1. BA task

A significant negative association between the CDS and MAIA-II was found in the DDD group alone (Fig. 2; Table 4), suggesting that lower DD symptoms are linked to elevated interoceptive awareness. In contrast, there was no relationship between the CDS-ABE and MAIA-II. We further observed significant negative associations between the CDS and CDS-ABE and the FFMQ in the DDD group alone, suggesting that elevated mindfulness may be linked to fewer DD symptoms and anomalous body experiences more specifically.

Exploratory correlations examining associations between the CDS and FFMQ subscales (Table 4) revealed significant negative correlations between the CDS and CDS-ABE with the FFMQ-Describing facet as well as trends towards negative associations with the FFMQ-Non-Reacting facet and a trend towards a negative association between the CDS-ABE and FFMQ-Non-Judging facet. No other significant correlations were seen (FFMQ-O; FFMQ-AA). With regards to the MAIA-II subscales, exploratory correlations revealed a significant negative association between the CDS and the MAIA-Body Listening subscale, with no other significant correlations present (MAIA-AR; MAIA-EA; MAIA-N; MAIA-ND; MAIA-NW; MAIA-SR; MAIA-T).

Exploring the relationship between overall interoceptive awareness and mindfulness, significant positive associations were found in both the DDD group, $r_{rm}(60) = 0.38$, $p = .002$ [95% CI = 0.14, 0.58], and control group, $r_{rm}(56) = 0.62$, $p < .001$ [95% CI = 0.42, 0.76]. These results suggest that mindfulness and interoceptive awareness are linked in both participant groups.

3.3.2. DE task

Significant negative associations were observed between the CDS

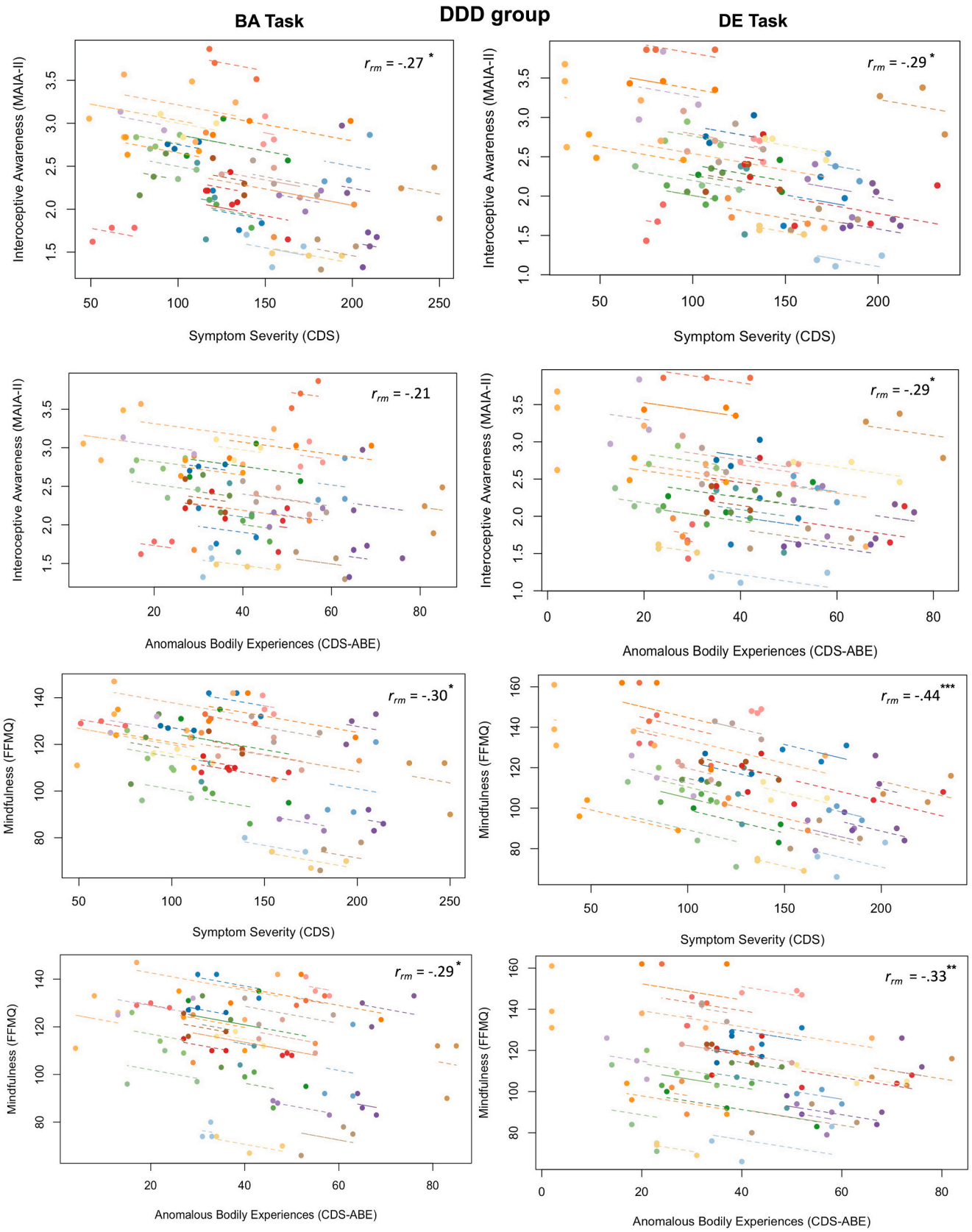

Fig. 2. Repeated measures correlations between symptom severity, interoceptive awareness and mindfulness in participants with DDD (n = 31)
Notes. Each colour and regression line represents one individual with DDD. BA = Body Awareness task; DE = Dance Exercise task; CDS = *Cambridge Depersonalization Scale*; CDS-ABE = *Cambridge Depersonalization Scale – Anomalous Body Experience*; MAIA-II = *Multidimensional Assessment of Interoceptive Awareness – II*; FFMQ = *Five Facet Mindfulness Questionnaire*. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 4
Correlations between depersonalization, mindfulness and interoceptive awareness in the DDD group alone ($n = 31$).

Variable	CDS				CDS-ABE			
	BA		DE		BA		DE	
	r_{rm}	p	r_{rm}	p	r_{rm}	p	r_{rm}	p
FFMQ	−.30	.017	−.44	<.001	−.29	.020	−.33	.008
FFMQ-AA	−.06	.66	−.40	.001	−.04	.78	−.37	.003
FFMQ-D	−.38	.002	−.16	.20	−.34	.006	−.26	.038
FFMQ-NJ	−.10	.44	−.27	.030	−.07	.58	−.18	.16
FFMQ-NR	−.27	.030	−.01	.91	−.27	.03	.06	.62
FFMQ-O	−.07	.59	−.31	.010	−.16	.22	−.09	.47
MAIA-II	−.27	.034	−.29	.022	−.21	.10	−.29	.022
MAIA-AR	−.18	.15	−.22	.08	−.11	.38	−.16	.22
MAIA-BL	−.35	.005	−.29	.02	−.20	.13	−.27	.036
MAIA-EA	−.06	.65	−.18	.15	−.05	.69	−.15	.24
MAIA-N	−.24	.06	.03	.79	−.21	.11	−.01	.93
MAIA-ND	.02	.89	−.11	.40	−.03	.84	−.18	.15
MAIA-NW	−.02	.88	.05	.72	−.03	.81	.04	.76
MAIA-SR	−.22	.08	−.21	.11	−.22	.08	−.17	.18
MAIA-T	−.15	.24	−.36	.004	−.06	.65	−.36	.004

Notes. BA = Body Awareness task; DE = Dance Exercise task; CDS = *Cambridge Depersonalization Scale*; CDS-ABE = *Cambridge Depersonalization Scale – Anomalous Body Experience*; FFMQ = *Five Facet Mindfulness Questionnaire*; FFMQ-AA = *Five Facet Mindfulness Questionnaire* – Acting with Awareness; FFMQ-D = *Five Facet Mindfulness Questionnaire* – Describing; FFMQ-NJ = *Five Facet Mindfulness Questionnaire* – Not-Judging; FFMQ-NR = *Five Facet Mindfulness Questionnaire* – Not-Reacting; FFMQ-O = *Five Facet Mindfulness Questionnaire* – Observing; MAIA-II = *Multidimensional Assessment of Interoceptive Awareness – II*; MAIA-AR = Multidimensional Assessment of Interoceptive Awareness – Attention Regulation; MAIA-BL = Multidimensional Assessment of Interoceptive Awareness – Body Listening; MAIA-EA = Multidimensional Assessment of Interoceptive Awareness – Emotional Awareness; MAIA-N = Multidimensional Assessment of Interoceptive Awareness – Noticing; MAIA-ND = Multidimensional Assessment of Interoceptive Awareness – Not Distracting; MAIA-NW = Multidimensional Assessment of Interoceptive Awareness – Not Worrying; MAIA-SR = Multidimensional Assessment of Interoceptive Awareness – Self Regulation; MAIA-T = Multidimensional Assessment of Interoceptive Awareness – Trusting.

and CDS-ABE and the MAIA-II in the DDD group alone (Fig. 2; Table 4). The reduction in overall DD symptoms as well as anomalous body experiences appear to be associated with increased interoceptive awareness. The CDS and FFMQ were also negatively related in the DDD group alone, as were the CDS-ABE and FFMQ. Elevated mindfulness appears to be linked with decreased overall DD symptom severity as well as anomalous body experiences.

Exploratory correlations examining associations between the CDS and FFMQ subscales (Table 4) revealed significant negative correlations between the CDS and FFMQ-Observing facet and between both the CDS and CDS-ABE and the FFMQ-Acting with Awareness facet. There was also a trend towards a negative association between the CDS and FFMQ-Non-Judging facet and a trend towards a negative relationship between the CDS-ABE and FFMQ-Describing facet. Exploring the MAIA-II subscales, significant negative correlations were seen between the CDS and CDS-ABE with the MAIA-Trusting subscale, as well as trends towards negative associations with the MAIA-Body Listening subscale. Correlations between the CDS and CDS-ABE with all other subscales of the MAIA-II were nonsignificant (MAIA-AR; MAIA-EA; MAIA-N; MAIA-ND; MAIA-NW; MAIA-SR).

Exploring the relationship between overall interoceptive awareness and mindfulness when performing both tasks, significant positive associations were found in both the DDD group, $r_{rm}(61) = 0.31$, $p = .013$ [95% CI = 0.07, 0.52], and control group, $r_{rm}(57) = 0.42$, $p < .001$ [95% CI = 0.18, 0.62], again suggesting that mindfulness and interoceptive awareness are linked.

3.4. Daily diary sheet

Secondary analyses of daily state DD (12-item DDD checklist) overall mirror the change in weekly scores. A three-way mixed ANOVA was performed to evaluate the effects of group, task type, and time (pre, post) on mean daily state DD scores (day 1–12 mean pre-task, day 1–12 mean post-task). Significant main effects of group, $F(1, 58) = 112.18$, $p < .001$, $\eta_p^2 = 0.66$, and time, $F(1, 58) = 23.83$, $p < .001$, $\eta_p^2 = 0.29$, on mean state DD scores were found, as well as significant interactions between group × time, $F(1, 58) = 29.64$, $p < .001$, $\eta_p^2 = 0.34$, and task type × time, $F(1, 58) = 14.15$, $p < .001$, $\eta_p^2 = 0.20$. There was no interaction between group × task type, $F(1, 58) = 0.51$, $p = .48$, $\eta_p^2 = 0.01$, and no three-way interaction, $F(1, 58) = 0.42$, $p = .52$, $\eta_p^2 = 0.01$.

Bonferroni-corrected *post hoc* tests on the group × time interaction collapsed across the tasks in the two groups revealed a significant main effect of time in the DDD group $F(1, 30) = 39.2$, $p < .001$, $\eta_p^2 = 0.57$, but not in the control group, $F(1, 28) = 0.27$, $p = .61$, $\eta_p^2 = 0.01$, indicating that across time, daily state DD scores decreased in the DDD group. Across the two-week period (Fig. 3), both tasks reduced daily state DD symptoms in the DDD group (BA: $F(1, 30) = 34.9$, $p < .001$, $\eta_p^2 = 0.54$; DE: $F(1, 30) = 35.1$, $p < .001$, $\eta_p^2 = 0.54$) with no significant changes seen in the control group (BA: $F(1, 28) = 2.61$, $p = .12$, $\eta_p^2 = 0.09$; DE: $F(1, 28) = 3.47$, $p = .07$, $\eta_p^2 = 0.11$). These results suggest that both tasks reduce the severity of daily state DD in the DDD group. Interestingly, as can be seen in Fig. 3, the BA task appeared to induce some state dissociative symptoms in controls post-task performance.

When examining the relationship between state (12-item DPD checklist; pre-task mean, post-task mean) and trait (CDS; Week 1, Week 3) DD, we see a positive correlation: $r_{rm}(177) = 0.21$, $p = .004$ [95% CI = 0.07, 0.35]. This demonstrates an association between state and trait DD such that as state depersonalization scores decrease, trait depersonalization scores also decrease.

Part of the daily diary sheet asked participants to indicate how easy it was to perform the task and how they felt performing the task. In the DDD group, the BA task was rated as more difficult to perform than the DE task ($t(59.77) = 2.33$, $p = .02$, $g = 0.59$; BA: $M = 2.91$, $SD = 1.11$; DE: $M = 2.23$, $SD = 1.18$), but there was no significant difference in ratings of how participants felt after performing the tasks ($t(59.92) = 0.61$, $p = .55$, $g = 0.16$; BA: $M = 4.13$, $SD = 0.98$; DE: $M = 4.29$, $SD = 1.01$). The same was seen in the control group, with the BA task rated as more difficult ($t(53.84) = 2.93$, $p = .005$, $g = 0.78$; BA: $M = 2.51$, $SD = 1.03$; DE: $M = 1.78$, $SD = 0.84$) and no significant difference in ratings of how participants felt after performing the tasks ($t(53.48) = 0.91$, $p = .34$, $g = 0.25$; BA: $M = 4.68$, $SD = 1.28$; DE: $M = 4.97$, $SD = 1.03$).

The relationship between the level of compliance (the number of days the task was performed across each of the two weeks), and mean CDS scores in the DDD group alone, was non-significant for the DE task, $r(29) = -0.00$, $p = .99$ [95% CI = −0.36, 0.35], but trended towards significance with the BA task, $r(29) = -0.33$, $p = .07$ [95% CI = −0.61, 0.03]. The reduction in DD symptoms did not depend on how diligently people with DDD performed dance exercise, but better compliance with performing body awareness tended to more strongly improve mean CDS symptom scores. Importantly, differences seen between the two tasks imply that the reduction in CDS scores was not merely a result of time passing between measurement points (Fig. 3).

3.5. Qualitative comments

Finally, we explored the qualitative, open comments provided by the DDD group throughout the study process. The comments highlight individual participants' preference for either the BA or the DE task. Whereas some participants with DDD found both tasks equally effective ("in different ways, [both tasks] encourage me to think about my physical body,") many participants felt strong inclinations to one task over the other. Participants with DDD in particular reported that the DE task helped them to become more aware of their bodies: "… I did notice

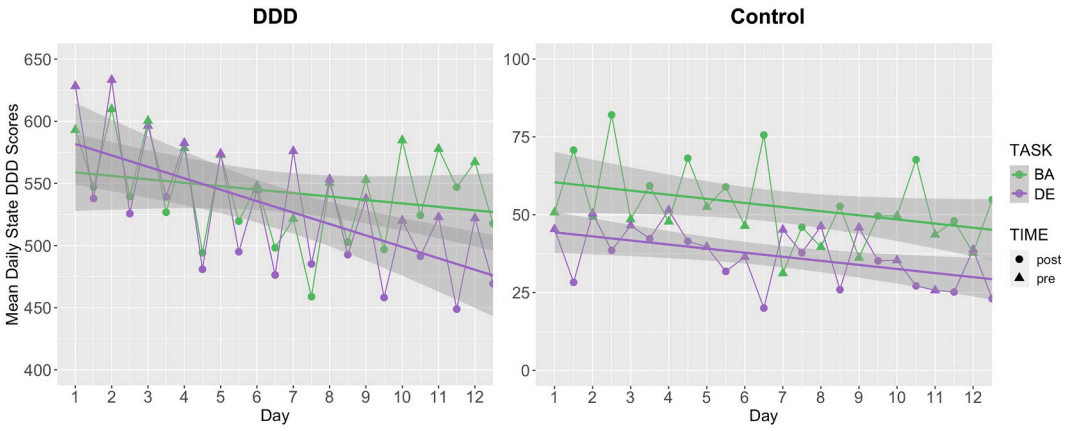

Fig. 3. Pre- and post-task mean daily state DD scores from Days 1–12.
Notes. BA = Body Awareness task; DE = Dance Exercise task; Mean Daily State DDD Scores = *12 Item DPD Checklist.*

quite consistently that after I had done it, I did have less feelings of numbness. I definitely felt more attuned to my body"; "Overall, [I] have noticed that the movements and exercise in general makes me feel a bit more grounded and more in control, less unreal." Comments were also made regarding the task breaking the "constant worrying thoughts" accompanying DDD, since the task required concentration and learning a dance phrase.

Other DDD participants preferred the BA task (" It grounds me and I feel every part of my body," and "I feel the connection coming back"). This was reported as exciting. One participant reported that even just the warmup for the BA task "really helps … the first time when we did it over Zoom, I did feel really bad before, but the moment we started the warmup I felt so much better." A number of participants with DDD also reported enjoying a combination of the two tasks: the warmup of the BA task and the main sequence of the DE task. On the whole, more participants with DDD reported experiencing benefits from the DE task, yet benefits of the BA task should not be discounted. Overall, individual differences in these open comments were striking and show the importance of tailoring tasks to the specific needs and symptoms experienced by each person with this condition.

4. Discussion

In this study we developed two dance/movement tasks, to be completed individually at-home, with the aim of reducing bodily detachment in DDD: one task *explicitly* directing attention towards the body (BA) and the other to *implicitly* boosting the salience of bodily signals (DE). We then tested whether these tasks could reduce symptom severity and improve interoceptive awareness and mindfulness in a group of people with DDD compared to healthy controls. Overall, our results point towards the efficacy of dance/movement in reducing DD symptoms in this disorder whilst improving a sense of body awareness.

In the DDD group, significant reductions in symptom severity, both overall and on the anomalous body experiences subscale, were seen with the performance of both dance/movement tasks over a two-week period. The healthy control group exhibited a floor effect with no changes in DD symptoms, due to already low baseline scores. Additionally, the daily diary shows that state symptoms for those with DDD also improve after performing the sessions, especially after the DE task. Interestingly, in the control group, the BA task appeared to induce some dissociative symptoms, conceivably inviting bodily experiences from a 3rd rather than 1st person perspective in some participants [58]. Both the daily diary and difficulty ratings suggest that overall, the BA task was more challenging to perform and may require a greater length of practice, as compared to the DE task, but is less physically demanding. Psychological therapies are often expensive, time-consuming, and difficult to access [59,60]. Our study shows that simple, brief and engaging dance tasks, performed at home and without an instructor, produce significant reductions in DD symptoms and bodily detachment. These tasks are accessible, do not require prior dance experience, and can be easily integrated into existing treatment plans and the daily life of individuals with DDD.

Both tasks reduce symptoms in individuals with DDD yet impacted mindfulness differently in both participant groups. In those with DDD, the DE task appears to enhance mindfulness and awareness of bodily sensations without explicitly asking participants to do so. Performing a simple sequence of movements does not require participants to explicitly focus on their inner bodily sensations but instead requires participants to shift attention away from these sensations in order to accurately reproduce and remember the sequence of instructed dance movements. Our study is not the first to report that shifting attention in this way can support wellbeing. A similar effect was found in a study on the benefits of drawing for emotional regulation [65], where drawing-to-distract (drawing something unrelated to one's feelings after watching a sad movie) proved to be the more effective intervention to counter the negative emotions elicited by the movie. In our study, dance exercise may fulfil a similar function, where people with DDD shift their attention away from the experience of DDD whilst at the same time increasing bodily sensations. In contrast, body awareness may be more challenging for those with DDD as it instructs participants to explicitly focus on their bodily experiences, but may also promote an individual's ability to verbalize and articulate bodily experiences/sensations. In other words, both tasks appear to address specific cognitive components of mindfulness in DDD. These results align with current theory on the causes of dissociative experiences [16] which proposes that atypical somatosensory attenuation may play a role in dissociation. On this view, explicit instructions to focus on the body (as seen with the BA task) may be less effective and/or more difficult for those experiencing dissociation because they are already hyper-focused on, or "overthinking," these bodily sensations [61]. In contrast, a more implicit task (DE) may be easier to complete and potentially more beneficial as it encourages movement and exertion without an explicit instruction to focus on the body. Similarly, predictive coding models of DDD suggest that the disorder is the result of a systematic downregulation or suppression of interoceptive signals ("interoceptive silencing"; [63]), which may also be enhanced by the performance of a task that makes bodily signal "louder" by means of exertion. In healthy controls, the improvement in mindfulness seen after the BA task aligns with existing literature on mindfulness interventions and body scanning wherein participation in these types of interventions, and explicitly paying attention to the body, encourages the development of a mindful awareness of the body [51, 62].

In the DDD group, mean interoceptive awareness did not

significantly improve after performing either task. However, reduced overall DD symptom severity was still associated with elevated interoceptive awareness, suggesting a role for interoceptive processing in the attenuation of DD symptoms [63]. Further explorations of the subscales of the MAIA-II and their relationships to DD symptoms suggest that the two tasks influence distinct aspects of interoceptive awareness: dance exercise appears to encourage a sense of trust and comfort within the body, whereas body awareness promotes a specific type of paying attention to the body. DMT thus allows for the tailoring of tasks to specifically address components of interoceptive awareness, that are also dissociable in the MAIA-II. In controls, overall interoceptive awareness did improve after both dance/movement tasks. Given the finding that people with DDD may continuously attempt to experience their bodies, engaging with their potential lack of bodily experiences, it is perhaps not surprising that we see larger effects in the realm of interoception in controls who may not consciously attempt to engage with their body in the same way on a day-to-day basis [16]. Improved interoceptive awareness in the control group, in particular after dance exercise, aligns with a putative feedback loop of physical activity and interoceptive processing [34]. These results indicate that, overall, these dance tasks are effective tools to enhance both mindfulness and interoceptive awareness in the general population and further implies that these two processes are linked.

Despite the novelty and strengths of this study, the interpretation of the results should be framed by the limitations of the study. Our lack of a no-intervention control group means that our findings could be potentially explained by mere spontaneous symptom improvements, regression to the mean, or other therapeutic interventions (talk therapy, medication) over time. However, the observed task differences and the marked and consistent benefit to DD symptom ratings from pre-post task on each day of performance (see Fig. 3), makes it unlikely that the findings could be simply explained by time passing or individuals with DDD working with someone who cares about their condition, and implies that the reductions in bodily detachment are indeed linked to performing the two dance/movement tasks. Moreover, all participant sessions were conducted both online and individually, rather than in-person and in a group environment which is most common to DMT (ADTA, [38]), though this does exclude a possible role of the social influences on symptom improvements. The online nature of the study may call into question the control of the experimental procedure, however the provision of guided, consistent, and clear audio recordings helped to ensure that all participants were completing the same tasks across at-home practice. This was also following the initial online video session wherein the lead researcher performed the task alongside the participant to make sure the task was clearly understood and could be comfortably completed.

Another important limitation within this research is that all measures included were self-report due to the ethical requirement that the study be conducted fully online during the COVID-19 pandemic. As such, it remains to be seen whether the perceived improvement of interoceptive awareness translates to actual interoceptive accuracy [22]. It is important and necessary that research using DMT and body-based interventions works towards the regular inclusion of more contemporary cognitive neuroscience research and physiological methods for rigorously assessing embodiment and interoception [1]. It is also important that future research includes follow-up measures to get a gauge on whether or not these reductions in DD symptoms remain in the long term. Alongside this, it would be useful to note if individuals with DDD actually continue to perform one or both of these tasks, or another type of body-based intervention, in their own time after study completion.

We conclude that brief and engaging dance/movement tasks provide a potentially effective, accessible, and bespoke tool to reduce bodily detachment in DDD, as it allows us to address deficits in mindfulness and interoceptive awareness in this population. Our findings suggest that dancing can influence different components of both mindfulness and interoceptive awareness and highlights the usefulness and specificity of dance/movement as an intervention for dissociative symptoms while improving body awareness. In this way, dance/movement allows for the development of interventions that *generate* bodily experiences rather than reflect on their disruption, in turn reducing dissociative symptoms. The continued development of more disorder- or symptom-specific body-based interventions is an important and necessary way forward, and a particularly promising route to target symptoms of dissociation.

CRediT author statement

L. S. Merritt Millman: Conceptualization, Methodology, Investigation, Formal analysis, Project administration, Writing – original draft, Writing – review & editing, Visualisation. **Elaine C. M. Hunter**: Methodology, Supervision, Writing – review & editing. **Devin B. Terhune:** Methodology, Supervision, Visualisation, Writing – review & editing. **Guido Orgs:** Conceptualization, Methodology, Supervision, Project administration, Writing – review & editing, Funding acquisition. All authors contributed to and have approved the final manuscript.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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