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Evidence for subjective emotional numbing following induced acute dissociation

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Abstract

The aim of the study was to examine the effects of acute dissociation on emotional responsivity in healthy individuals. We used a previously validated technique (mirror-gazing, Caputo, 2010) to experimentally induce acute dissociation in non-clinical participants and assessed post-induction subjective responsivity (ratings of valence and arousal) to standardized emotional images. Fifty non-clinical participants were randomised to either the dissociation induction (n=25) or control conditions (n=25). The dissociation manipulation effect was corroborated by a significant post-induction elevation in state dissociation in the dissociation-induction group relative to controls (p=.004). The dissociation-induction group rated negative (p=.028) and neutral (p=.025) stimuli as significantly less unpleasant than controls. There was also a non-significant trend for positive stimuli to be rated as less pleasant by the dissociation-induction group compared to controls (p=.060). These findings provide experimental evidence for the short-term alleviation (i.e., emotional numbing) of negative affect during dissociative states, which may serve as a coping mechanism for some individuals. However, this tendency of emotional numbing also reduced positive affective responses to pleasant stimuli to some extent. Further investigation of dissociative phenomena and their impact on emotional processing appears warranted.

Introduction

Dissociation is a disintegration of mental processes (e.g., emotion, perception, volition, memory, identity) and fractured consciousness or awareness (Gershuny & Thayer, 1999; Spiegel & Cardeña, 1991), occurring on a spectrum from nonpathological to pathological manifestations (Bernstein & Putnam, 1986; Holmes et al., 2005). Dissociative symptoms include absorption, depersonalization, derealization, emotional constriction, identity alterations and amnesia (Briere, Weathers, & Runtz, 2005; Oathes & Ray, 2008; Spiegel, Koopman, Cardeña, & Classen, 1996). Furthermore, impairments in voluntary control or awareness of action and somatic sensation (i.e., somatoform dissociation) include: conversion paralysis, sensory loss, and dissociative seizures (Holmes et al., 2005; Nijenhuis, Spinhoven, Van Dyck, Van Der Hart, & Vanderlinden, 1996).

Dissociation features prominently in several neuropsychiatric disorders such as post-traumatic stress disorder (PTSD), depersonalization/derealization disorder (DPD), borderline personality disorder (BPD) and functional neurological disorders (FND) (Gershuny & Thayer, 1999; Pick, Mellers, & Goldstein, 2017). There is empirical evidence that individuals with prominent dissociative symptoms show altered emotional processing, such as reduced accuracy and responsivity to emotional facial expressions and impaired mentalizing (Domes, Schulze, & Herpertz, 2009; Lemche et al., 2007; Pick, Mellers, & Goldstein, 2016; Schönenberg et al., 2015; Sierra, Senior, Phillips, & David, 2006). There is also evidence for altered emotional responding to more general affective images in individuals with DPD (Phillips et al., 2001) and dissociative seizures (Pick, Mellers, & Goldstein, 2018). Individuals with BPD and dissociative symptoms also show inhibited affective reactivity and impaired emotional learning (Barnow et al., 2012; Ebner-Priemer et al., 2009; Krause-Utz et al., 2018). Previous studies have shown that dissociation is associated with attenuated emotional processing in healthy individuals, whereas intellectual functioning remains intact (Giesbrecht, Lynn, Lilienfeld, & Merckelbach, 2008). Emotional processing hampered by dissociation can be described as overmodulating (Lanius et al., 2010) or emotional numbing (Medford et al., 2016; Phillips et al., 2001).

State dissociation can be induced using several techniques (Caputo, 2010; Leonard, Telch, & Harrington, 1999; Miller, Brown, DiNardo, & Barlow, 1994). Caputo (2010), for example, developed a mirror-gazing procedure that successfully induced dissociative states in non-clinical participants. Subsequent studies have used this procedure to explore the effects of acute dissociation on memory, attention and visual perception in non-clinical participants (Brewin, Ma, & Colson, 2013; Brewin & Mersaditabari, 2013). However, only a limited number of studies have explored the effects of induced dissociation on measures of emotional processing (Hagenaars, van Minnen, Holmes, Brewin, & Hoogduin, 2008; Holmes, Oakley, Stuart, & Brewin, 2006).

We aimed to examine further the influence of acute dissociation on subjective emotional responsivity in healthy individuals. In the experimental group, acute dissociation was induced using the mirror-gazing procedure (Caputo, 2010) followed immediately by an emotional processing task which assessed subjective and behavioural responses (arousal and valence ratings, reaction times) to standardized emotionally salient images (International Affective Picture System (IAPS); Lang, Bradley, & Cuthbert, 1997). A control group completed the same procedures without the mirror-gazing manipulation. It was hypothesized that the dissociation-induction group would exhibit diminished emotional responsivity relative to the control group (i.e., lower ratings of valence/arousal, extended reaction times).

Post-induction state dissociation and affect were assessed with validated self-report measures, to confirm that the experimental manipulation successfully induced dissociation and to assess any alterations in affective state. We also measured participants' intelligence quotient (IQ) and post-induction working memory capacity (verbal and non-verbal) as control tests, to assess the independence or otherwise of emotional processing alterations to these cognitive variables. We included the measures of working memory because previous studies indicated that induced dissociation had an adverse impact on visual memory performance (Brewin et al., 2013; Brewin & Mersaditabari, 2013) and our emotional processing task required participants to rate their emotional responses after stimulus offset (i.e., a visual working memory requirement). We predicted that visual working memory would be impaired in the dissociation-induction group, but that emotional processing alterations would not be related to these deficits.

Method

Participants

Participants were 50 staff and students from universities in London, UK (5 males, 45 females) recruited through advertisement and word of mouth. They were compensated with £10. Individuals above 18 years old with no self-reported major psychiatric illness and no history of psychiatric treatment were included. Participants were randomly allocated to dissociation-induction (mirror-gazing; n=25) or control (no mirror-gazing; n=25) groups. Participants allocated to the dissociation-induction group had either normal or corrected vision.

Design

This experiment adopted a mixed between-group (condition: control, dissociation-induction) and within-group (stimulus valence: positive, negative, neutral) design. The dependent variables (DVs) were subjective ratings of valence (1 'unpleasant' to 9 'pleasant') and arousal (1 'low' to 9 'high') and reaction times (milliseconds, ms). State dissociation (Clinician Administered Dissociative States Scale (CADSS)) and state affect (Positive and Negative Affect Schedule (PANAS)) were measured post-induction to confirm that the manipulation had induced dissociation and to check for any alterations in affective state. Spatial and verbal working memory tests (i.e., spatial span and digit span subtests from the Wechsler Memory Scale-III (WMS-III)) were administered post-induction to examine whether these variables were affected by the dissociation-induction procedure and if they were related to performance on the emotional processing task.

Setting

All participants completed the task in a quiet testing room at the Institute of Psychiatry, Psychology and Neuroscience, King's College London. The experimenter (GIS) was in the room with each participant throughout the experiment except during the experimental manipulation (i.e., control, dissociation-induction).

Apparatus and materials

A table mirror sized 220x190mm and a LED touch light were used for the dissociation-induction procedure. Corsi's blocks (10 blocks) was used to test spatial working memory (WMS-III spatial span).

The emotional processing task used standardized affective image stimuli selected from the IAPS. Using IAPS norms (Lang et al., 1997), 15 images per stimulus valence condition (positive, neutral, negative) were selected (Supplemental File 1). The proportion of non-personal (food, animal, object, landscape) and interpersonal image stimuli was matched across valence conditions. Participants completed the valence and arousal ratings on the Self-Assessment-Manikin (SAM; Supplemental File 2). The 45 image stimuli were pseudorandomized and presented using E-Prime software (E-Prime 2.0 software®; Schneider, Eschmann, & Zuccolotto, 2002).

Self-report Measures

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988)

The PANAS consists of two 10-item scales corresponding to positive and negative affect on a five-point Likert scale (1 'very slightly or not at all' to 5 'extremely'). It is a consistent and reliable tool for examining dimensions of momentary mood state (Cronbach's alphas were .89 for positive affect and .85 for negative affect; Crawford & Henry, 2004).

Clinician Administered Dissociative States Scale (CADSS; Bremner et al., 1998)

The 19 self-report items were extracted from the 27-item CADSS, which are highly reliable (Cronbach's alpha=.94; Bremner et al., 1998) and valid. It was used here to measure state dissociation post-induction on a five-point Likert scale (0 'not at all' to 4 'extremely'). The subscales include Dissociative Amnesia, Depersonalization, and Derealization.

Self-Assessment Manikin (SAM; Bradley & Lang, 1994)

The SAM was used to measure pleasure and arousal reactions to affective images. The nine-point rating scale used here ranged from 1 to 9. Its internal consistency and reliability were established by Backs and colleagues (Cronbach's alphas were .82 for valence and .98 for arousal ratings; 2005).

Cognitive tests

National Adult Reading Test (NART; Nelson & Willison, 1991)

Participants' intellectual ability (full-scale intelligence quotient (IQ)) was estimated from the number of errors made when participants read aloud 50 words. The words follow irregular pronunciation rules. The NART provides a valid estimate of cognitive functioning in the general adult population (Cronbach's alpha=.93).

Wechsler Memory Scale – Third Edition (WMS-III): Spatial and digit span (Wechsler, 1997)

The spatial and verbal working memory tests were used to measure participants' post-induction memory performance and yield age-scaled scores (Mean=10, SD=3). The reliability coefficients for the spatial (forwards and backwards) and digit span (total score) tests are 0.74, 0.72 and 0.86 respectively (Wechsler, 1997). The tests were used to determine whether there was any influence of the dissociation-induction procedure on memory performance and if any alterations in memory performance were related to subjective ratings in the emotional processing task.

Procedure

Ethical approval was obtained from the Psychiatry, Nursing and Midwifery Research Ethics Subcommittee at King's College London (reference: RESCM-17/18-5524). Pseudorandom numbers were generated to evenly allocate 50 participants to the control (n=25) or the dissociation-induction (mirror-gazing; n=25) groups.

The experimenter initially administered the NART, before giving instructions on the experimental manipulation. During the manipulation, participants in the control group sat in the room under normal illumination for 10 minutes with their eyes open. They were told to stay as attentive as possible and avoid any contact with electronic devices. Participants in the dissociation-induction group sat in the room under restricted illumination for 10 minutes, during which they were asked to continuously gaze into the mirror. Participants completed the PANAS and CADSS immediately after the experimental manipulation.

Next, participants completed the computerized emotional processing task. Each image was presented for 3 seconds onscreen, immediately after fixation on a cross-hair for 2 seconds. Following each image, participants were asked to indicate the valence (1-9; unpleasant-pleasant) and arousal (1-9; low-high) responses using the SAM screens. Participants were instructed to respond as quickly and accurately as possible. Responses were made using the numerical keys on the integrated laptop keyboard. Reaction times for ratings were recorded. Short-term spatial and verbal working memory were then assessed.

Statistical analysis

It was estimated that the sample size of 50 would allow 80% power to detect a medium effect size using a mixed ANOVA (α=.05). Variables relating to participant characteristics were compared between groups using t-tests, Mann-Whitney, or chi-squared tests as appropriate. Prior to analysis, approximately 1% of outlying experimental DVs except for CADSS scores were cut off relative to their conditions (i.e., control, dissociation-induction) using a benchmark of 2.5 of absolute *z*-scores. For reaction time data, the median values for each condition were calculated for each participant, to control for extreme latencies.

The experimental DVs were valence ratings, arousal ratings and reaction times, analysed with mixed ANOVAs. For each ANOVA, the experimental manipulation was the between-group factor and the within-group factor was the valence of emotional image stimuli. Significant main effects or interactions were followed with pairwise comparisons for the experimental dependent variables. The means (standard deviations) of the individual median reaction times were analysed by group / condition in these analyses.

Results

Participants' characteristics

The groups were matched for age, gender, and estimated full-scale IQ (Table 1).

Table 1. Demographic and characteristics

	Control	**Mirror-gazing**	**Test statistics (df) And *p*-Value (two-tailed)**
Age in years (Median, IQR)	24 (6)	23 (6)	*U* = 247, *p*=.201
Gender (N)			
Male	1	4	
Female	24	21	Fisher's exact *p*=.349
Ethnicity (N)*			
Caucasian	10	15	
Non-Caucasian	10	9	χ^2(1, N=44)=.695, *p*=.405
YoE (Median, IQR)	18 (3)	17 (2)	*U* = 222, *p*=.075
NART			
FSIQ (Mean, SD)	110 (5.73)	112 (4.90)	t(48) = -1.57, *p*=.124

IRQ, Inter-Quartile Range; N = frequency count; YoE, years of full-time education (or equivalent); NART, National Adult Reading Test

*ethnicity data unavailable for 6 participants

Experimental manipulation check

The dissociation-induction group reported significantly elevated post-induction subscale scores on the CADSS: Dissociative Amnesia, Depersonalization and Derealization (Table 2). Total CADSS scores were also significantly elevated in the dissociation-induction group. Conversely, there were no significant between-group differences on the PANAS subscales or the WMS-III spatial and digit span scores. There were no significant relationships between scores on these tests and performance on the emotional processing task described below.

Table 2. Post-induction state dissociation, state affect and working memory scores

	Control	**Mirror-gazing**	**Test statistic (df)**	***p*-Value (two-tailed)**
CADSS (Median, IQR)				
Dissociative amnesia	0 (0)	1 (2)	*U* = 440.5	*p*=.003
Depersonalization	0 (0)	0 (2)	*U* = 395	*p*=.043
Derealization	0 (2)	2 (4)	*U* = 443.5	*p*=.009
Total	0 (2.5)	3 (8)	*U* = 459.5	*p*=.004
PANAS				
Positive affect (Mean, SD)	24.3 (8.3)	25 (8.2)	t(48) = -.291	*p*=.772
Negative affect (Median, IQR)	10 (1)	10 (2)	*U* = 365.5	*p*=.237
WMS-III (Median, IQR)				
Spatial span scaled scores	12 (2)	12 (1.5)	*U* = 318.5	*p*=.905
Digit span scaled scores	10 (3)	9 (3.5)	*U* = 252.5	*p*=.240

IQR, Inter-Quartile Range; CADSS, Clinician Administered Dissociative States Scale; PANAS, Positive and Negative Affect Schedule; WMS-III, Wechsler Memory Scale – Third Edition

Emotional processing task

All analyses reported in this section used a mixed design ANOVA.

Subjective valence ratings

The main effect of condition on valence ratings was not significant ($F(1, 44)=.728$, $p=.398$, $\eta_p^2=.016$), while the effect of stimulus valence on subjective valence ratings was significant ($F(1.38, 61.1)=432.6$, $p<.001$, $\eta_p^2=.908$). Pairwise comparisons (Table 3) showed that subjective valence ratings for positive, negative and neutral images were significantly distinct from one another (positive>neutral>negative).

Table 3. Paired samples t-tests to evaluate within-group differences in valence ratings

	Mean (SD)	Pair	Test statistic (df)	*p*-Value (two-tailed)
Valence rating (n=46)				
I Positive	6.99 (.837)	I vs II	t(45) = 21.6	*p*<.001
II Negative	2.85 (.658)	II vs III	t(45) = -21.7	*p*<.001
III Neutral	5.19 (.408)	III vs I	t(45) = -13.5	*p*<.001

An interaction between stimulus valence and condition was significant, (F(1.38, 61.1)=3.64, p=.014, η_p^2=.111). Pairwise comparisons (Table 4) suggested between-group differences in valence ratings for negative and neutral images, with both being rated as more pleasant (higher rating values) in the dissociation-induction group relative to controls. Furthermore, a non-significant trend indicated that the dissociation-induction group rated the positive stimuli as less pleasant than controls (lower rating values).

Table 4. Independent samples t-tests to evaluate between-group differences in valence ratings for each stimulus valence

	Control (n=22)	Mirror-gazing (n=24)	Test statistic (df)	*p*-Value (two-tailed)
Mean valence (Mean, SD)				
Positive	7.23 (0.61)	6.77 (0.96)	t(39.2) = 1.94	*p*=.060
Negative	2.63 (0.48)	3.05 (0.74)	t(44) = -2.28	*p*=.028
Neutral	5.05 (0.37)	5.32 (0.41)	t(44) = -2.33	*p*=.025

The analyses were repeated with YoE as covariate, due to the trend towards between-group differences on this variable. There was no significant main effect of YoE on subjective valence ratings (F(1, 43)=.119, p=.732, η_p^2=.003) and no significant interaction between YoE and stimulus valence (F(1.37, 58.7)=.482, p=.548, η_p^2=.011).

Subjective arousal ratings

The interaction between mean arousal ratings and condition (F(1.53, 70.6)=.895, p=.389, η_p^2=.019) and the main effect of condition (F(1, 46)=2.23, p=.143, η_p^2=.046) were not significant. The main effect of stimulus valence on subjective arousal ratings was significant (F(1.53, 70.6)=130.6, p<.001, η_p^2=.740). Pairwise comparisons across conditions (Table 5) showed that subjective arousal ratings for positive, neutral and negative images were significantly distinct from each other (positive<neutral<negative).

Table 5. Paired samples t-tests to evaluate within-group difference in arousal ratings

	Mean (SD)		**Pair**		**Test statistic (df)**	***p*-Value (two-tailed)**
Valence rating (n=46)						
I Positive	4.38 (.752)	I	vs	II	t(47) = -12.7	p<.001
II Negative	6.38 (.704)	II	vs	III	t(47) = 14.5	p<.001
III Neutral	5.02 (.464)	III	vs	I	t(47) = 5.32	p<.001

Reaction times

For valence rating reaction times, there was no significant stimulus valence and condition interaction (F(1.86, 83.9)=.967, p=.379, η_p^2=.021), and no main effect of condition (F(1, 45)=2.68, p=.109, η_p^2=.056) or stimulus valence (F(1.86, 83.9)=.091,

p=.901, η_p^2=.002).

The reaction times for arousal ratings did not show any significant main effect of condition (F(1, 46)=1.47, p=.232, η_p^2=.031) and there was no interaction between condition and stimulus valence (F(2, 92)=.721, p=.489, η_p^2=.015). However, a significant main effect of stimulus valence on reaction times for the arousal ratings was found (F(2, 92)=37.9, p<.001, η_p^2=.452).

Pairwise comparisons (Table 6) indicated that participants, regardless of condition, took longer rating the degree of arousal for negative images compared to positive and neutral images. In addition, the ratings for positive images were also slowed compared to the ratings for neutral images (negative>positive>neutral).

Table 6. Paired samples t-tests to evaluate within-group differences in arousal rating reaction times

	Mean of median RTs (SD)		**Pair**		**Test statistic (df)**	***p*-Value (two-tailed)**
Arousal rating RT (n=48)						
I Positive	1828 (677)	I	vs	II	t(47) = -3.77	p=.001
II Negative	2060 (658)	II	vs	III	t(47) = 7.82	p<.001
III Neutral	1402 (784)	III	vs	I	t(47) = -5.23	p<.001

RT, reaction time (milliseconds, ms)

Discussion

The aim of this study was to examine subjective emotional responsivity in healthy (non-clinical) individuals after the induction of acute dissociation relative to a control group, who did not receive the dissociation-induction procedure. The significant difference in total state dissociation scores between the dissociation-induction group and the control group revealed successful induction of acute dissociation by the mirror-gazing technique. Altered post-induction subjective emotional responsivity in valence ratings was observed, supporting the hypotheses of the study. The dissociation-induction group rated negative and neutral images as significantly less unpleasant and showed a non-significant tendency to perceive positive images as less pleasant, relative to the controls.

The findings relating to the negative stimuli are in accordance with a dampened sensitization to detection of threat and aversive stimuli in the DPD population (Byrne & Eysenck, 1995; Montagne et al., 2007; Phillips et al., 2001). However, the constriction of subjective valence experienced (i.e., emotional numbing) also appears to reduce positive emotional responses to pleasant stimuli, whilst increasing the pleasantness of neutral stimuli. Therefore, the induced dissociative state appeared to have both adaptive and maladaptive effects on subjective emotional experience.

The results suggest that emotional numbing associated with acute dissociation reflects a generalized reduction in capacity to experience emotions. Furthermore, we show that such alterations occur in non-clinical participants in an acute dissociative state. Therefore, emotional numbing may be a relatively non-pathological response to dissociation-inducing situations, supporting the proposal that dissociation can occur on a spectrum (Briere et al., 2005; Holmes et al., 2005; Oathes & Ray, 2008; Spiegel et al., 1996).

There was no significant difference in arousal ratings between the groups. This contradicts other findings relating to disparate physiological arousal responses to affective stimuli in patients with dissociative symptoms compared to healthy individuals (Dewe, Watson, & Braithwaite, 2016; Ebner-Priemer et al., 2009; Pick et al., 2016; Sierra et al., 2002) . However, this discrepancy could relate to the measures used: the previous studies observed differences on autonomic measures of physiological arousal, whereas we assessed subjective arousal only.

In this study participants took relatively similar times to respond across conditions and stimulus valence when rating valence. Our results diverged from the findings on altered reaction times to emotionally salient stimuli associated with attentional biases in dissociative individuals (Bakvis et al., 2009; Pick et al., 2018). This may be due to the stimuli used and the conditions under which they were presented; the above studies observed attentional biases in dissociative groups for emotional faces under subliminal presentations while the current stimuli were more varied affective scenes presented for 3 seconds, allowing conscious/explicit processing.

Contrary to our prediction and the findings of previous studies (Brewin et al., 2013; Brewin & Mersaditabari, 2013), WMS-III spatial and digit span scores did not differ between groups, nor were scores on these measures related to performance on the emotional processing task. We can infer that cognitive function stayed intact in our sample and that the observed alterations in emotional processing were not due to cognitive deficits or failure in encoding the emotionally salient stimuli. However, working memory testing was not administered immediately after the dissociation-induction in our experiment, differing from the approach adopted by Brewin and colleagues (2013).

Limitations

Our participants comprised of five males and 45 females who were mostly students and research staff from universities in London; therefore, future studies should include balanced proportion of males and females, with more diverse socioeconomic status and educational backgrounds. In addition, psychiatric history was elicited by self-report only, without the use of a formal psychiatric screening tool or structured interview; therefore, it is not possible to conclude definitively that psychiatric symptoms were absent in the sample.

Due to the single-blind randomization procedure, there may have been experimenter effects. An additional experimenter, blind to allocation of conditions, could be included in further studies. A final limitation is that the WMS-III subscales were administered after the other measures, possibly when the dissociative state had dissipated. In future studies, randomization or counterbalancing of post-induction task order could be undertaken.

Implications and directions for future research

Our findings are consistent with the view that dissociative states are associated with inhibited affective responses (i.e., emotional numbing) (Medford et al., 2016; Phillips et al., 2001). Further studies exploring alterations in psychological and/or somatoform dissociation using dissociation-induction techniques might yield additional insights into the mechanisms underlying dissociative experiences and the consequences of acute dissociation on cognitive and affective processes.

Replicating and extending the current experimental methods to include objective measures of emotional responsivity (e.g., skin conductance responses, heart rate) may highlight the possible neurobiological processes associated with altered emotional processing during acute dissociation.

Clinically, there is a need for psychological interventions targeting dissociative symptoms specifically in populations in which such symptoms are a core difficulty. Graded use of dissociation-induction procedures, combined with other therapeutic techniques (e.g., grounding, emotion- or soma-focused attention training), could be considered for use as therapeutic tools to facilitate identification and management of dissociative symptoms (Schäflein, Sattel, Schmidt, & Sack, 2018).

Conclusion

Our findings show that heightened state dissociation elicits anomalous subjective emotional responses to emotional stimuli in healthy individuals. The inhibited subjective reaction to aversive (and to a lesser extent positive) stimuli demonstrated that acute dissociative states result in emotional numbing. The most marked effects were for unpleasant stimuli, supporting numerous clinical and theoretical assumptions. Dissociative phenomena and their subsequent impact on emotional processing warrants further investigation.

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Conflict of Interest

The authors declare no conflict of interest.

References:

Backs, R. W., da Silva, S. P., & Han, K. (2005). A Comparison of Younger and Older Adults' Self-Assessment Manikin Ratings of Affective Pictures. *Experimental Aging Research, 31*(4), 421-440. doi:10.1080/03610730500206808

Bakvis, P., Roelofs, K., Kuyk, J., Edelbroek, P. M., Swinkels, W. A., & Spinhoven, P. (2009). Trauma, stress, and preconscious threat processing in patients with psychogenic nonepileptic seizures. *Epilepsia, 50*(5), 1001-1011.

Barnow, S., Limberg, A., Stopsack, M., Spitzer, C., Grabe, H. J., Freyberger, H. J., & Hamm, A. (2012). Dissociation and emotion regulation in borderline personality disorder. *Psychological Medicine, 42*(4), 783-794. doi:10.1017/S0033291711001917

Bernstein, E. M., & Putnam, F. W. (1986). Development, reliability, and validity of a dissociation scale. *Journal of nervous and mental disease*.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry, 25*(1), 49-59.

Bremner, J. D., Krystal, J. H., Putnam, F. W., Southwick, S. M., Marmar, C., Charney, D. S., & Mazure, C. M. (1998). Measurement of dissociative states with the clinician-administered dissociative states scale (CADSS). *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies, 11*(1), 125-136.

Brewin, C. R., Ma, B. Y., & Colson, J. (2013). Effects of experimentally induced dissociation on attention and memory. *Consciousness and Cognition, 22*(1), 315-323.

Brewin, C. R., & Mersaditabari, N. (2013). Experimentally-induced dissociation impairs visual memory. *Consciousness and Cognition, 22*(4), 1189-1194.

Briere, J., Weathers, F. W., & Runtz, M. (2005). Is dissociation a multidimensional construct? Data from the Multiscale Dissociation Inventory. *Journal of Traumatic Stress, 18*(3), 221-231. doi:doi:10.1002/jts.20024

Byrne, A., & Eysenck, M. W. (1995). Trait anxiety, anxious mood, and threat detection. *Cognition & Emotion, 9*(6), 549-562.

Caputo, G. B. (2010). Apparitional experiences of new faces and dissociation of self-identity during mirror gazing. *Perceptual and Motor Skills, 110*(3_suppl), 1125-1138.

Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43*(3), 245-265. doi:doi:10.1348/0144665031752934

Dewe, H., Watson, D. G., & Braithwaite, J. J. (2016). Uncomfortably numb: new evidence for suppressed emotional reactivity in response to body-threats in those predisposed to sub-clinical dissociative experiences. *Cognitive neuropsychiatry, 21*(5), 377-401.

Domes, G., Schulze, L., & Herpertz, S. C. J. J. o. p. d. (2009). Emotion recognition in borderline personality disorder—A review of the literature. *23*(1), 6-19.

Ebner-Priemer, U. W., Mauchnik, J., Kleindienst, N., Schmahl, C., Peper, M., Rosenthal, M. Z., . . . Bohus, M. (2009). Emotional learning during dissociative states in borderline personality disorder. *Journal of psychiatry & neuroscience : JPN, 34*(3), 214-222.

Gershuny, B. S., & Thayer, J. F. (1999). Relations among psychological trauma, dissociative phenomena, and trauma-related distress: A review and integration. *Clinical psychology review, 19*(5), 631-657.

Giesbrecht, T., Lynn, S. J., Lilienfeld, S. O., & Merckelbach, H. (2008). Cognitive processes in dissociation: an analysis of core theoretical assumptions. *Psychological bulletin, 134*(5), 617.

Hagenaars, M. A., van Minnen, A., Holmes, E. A., Brewin, C. R., & Hoogduin, K. A. (2008). The effect of hypnotically induced somatoform dissociation on the development of intrusions after an aversive film. *Cognition and Emotion, 22*(5), 944-963.

Holmes, E. A., Brown, R. J., Mansell, W., Fearon, R. P., Hunter, E. C. M., Frasquilho, F., & Oakley, D. A. (2005). Are there two qualitatively distinct forms of dissociation? A review and some clinical implications. *Clinical psychology review, 25*(1), 1-23.

Holmes, E. A., Oakley, D. A., Stuart, A. D., & Brewin, C. R. (2006). Investigating peri-traumatic dissociation using hypnosis during a traumatic film. *Journal of trauma & dissociation, 7*(4), 91-113.

Krause-Utz, A., Winter, D., Schriner, F., Chiu, C.-D., Lis, S., Spinhoven, P., . . . Elzinga, B. M. (2018). Reduced amygdala reactivity and impaired working memory during dissociation in borderline personality disorder. *European archives of psychiatry and clinical neuroscience, 268*(4), 401-415. doi:10.1007/s00406-017-0806-x

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). International affective picture system (IAPS): Technical manual and affective ratings. *NIMH Center for the Study of Emotion and Attention*, 39-58.

Lanius, R. A., Vermetten, E., Loewenstein, R. J., Brand, B., Schmahl, C., Bremner, J. D., & Spiegel, D. (2010). Emotion modulation in PTSD: Clinical and neurobiological evidence for a dissociative subtype. *American Journal of Psychiatry, 167*(6), 640-647.

Lemche, E., Surguladze, S. A., Giampietro, V. P., Anilkumar, A., Brammer, M. J., Sierra, M., . . . Phillips, M. L. (2007). Limbic and prefrontal responses to facial emotion expressions in depersonalization. *NeuroReport, 18*(5), 473-477. doi:10.1097/WNR.0b013e328057deb3

Leonard, K. N., Telch, M. J., & Harrington, P. J. (1999). Dissociation in the laboratory: A comparison of strategies. *Behaviour Research and Therapy, 37*(1), 49-61.

Medford, N., Sierra, M., Stringaris, A., Giampietro, V., Brammer, M. J., & David, A. S. (2016). Emotional Experience and Awareness of Self: Functional MRI Studies of Depersonalization Disorder. *Frontiers in Psychology, 7*(432). doi:10.3389/fpsyg.2016.00432

Miller, P. P., Brown, T. A., DiNardo, P. A., & Barlow, D. H. (1994). The experimental induction of depersonalization and derealization in panic disorder and nonanxious subjects. *Behaviour Research and Therapy, 32*(5), 511-519.

Montagne, B., Sierra, M., Medford, N., Hunter, E., Baker, D., Kessels, R. P. C., . . . David, A. S. (2007). Emotional memory and perception of emotional faces in patients suffering from depersonalization disorder. *British journal of psychology (London, England : 1953), 98*(Pt 3), 517-527. doi:10.1348/000712606x160669

Nelson, H. E., & Willison, J. (1991). *National adult reading test (NART)*: Nfer-Nelson Windsor.

Nijenhuis, E. R. S., Spinhoven, P., Van Dyck, R., Van Der Hart, O., & Vanderlinden, J. (1996). The development and psychometric characteristics of the Somatoform

Dissociation Questionnaire (SDQ-20). *Journal of nervous and mental disease, 184*(11), 688-694. doi:10.1097/00005053-199611000-00006
Oathes, D. J., & Ray, W. J. (2008). Dissociative tendencies and facilitated emotional processing. *Emotion, 8*(5), 653-661. doi:10.1037/a0013442
Phillips, M. L., Medford, N., Senior, C., Bullmore, E. T., Suckling, J., Brammer, M. J., . . . David, A. S. (2001). Depersonalization disorder: thinking without feeling. *Psychiatry Research: Neuroimaging, 108*(3), 145-160. doi:https://doi.org/10.1016/S0925-4927(01)00119-6
Pick, S., Mellers, J. D., & Goldstein, L. H. (2016). Emotion and dissociative seizures: a phenomenological analysis of patients' perspectives. *Epilepsy & Behavior, 56*, 5-14.
Pick, S., Mellers, J. D., & Goldstein, L. H. (2018). Implicit attentional bias for facial emotion in dissociative seizures: Additional evidence. *Epilepsy & Behavior, 80*, 296-302.
Pick, S., Mellers, J. D. C., & Goldstein, L. H. (2017). Dissociation in patients with dissociative seizures: relationships with trauma and seizure symptoms. *Psychological Medicine, 47*(7), 1215-1229. doi:10.1017/S0033291716003093
Schäflein, E., Sattel, H., Schmidt, U., & Sack, M. (2018). The enemy in the mirror: self-perception-induced stress results in dissociation of psychological and physiological responses in patients with dissociative disorder. *European Journal of Psychotraumatology, 9*(sup3), 1472991. doi:10.1080/20008198.2018.1472991
Schneider, W., Eschmann, A., & Zuccolotto, A. (2002). E-Prime (Version 2.0. 8.90). Pittsburgh, PA: Psychology Software Tools. In: Inc.
Schönenberg, M., Jusyte, A., Höhnle, N., Mayer, S. V., Weber, Y., Hautzinger, M., & Schell, C. (2015). Theory of mind abilities in patients with psychogenic nonepileptic seizures. *Epilepsy & Behavior, 53*, 20-24. doi:https://doi.org/10.1016/j.yebeh.2015.09.036
Sierra, M., Senior, C., Dalton, J., McDonough, M., Bond, A., Phillips, M. L., . . . David, A. S. (2002). Autonomic response in depersonalization disorder. *Archives of General Psychiatry, 59*(9), 833-838.
Sierra, M., Senior, C., Phillips, M. L., & David, A. S. (2006). Autonomic response in the perception of disgust and happiness in depersonalization disorder. *Psychiatry Research, 145*(2), 225-231. doi:https://doi.org/10.1016/j.psychres.2005.05.022
Spiegel, D., & Cardeña, E. (1991). Disintegrated experience: The dissociative disorders revisited. *Journal of Abnormal Psychology, 100*(3), 366-378. doi:10.1037/0021-843X.100.3.366
Spiegel, D., Koopman, C., Cardeña, E., & Classen, C. (1996). Dissociative Symptoms in the Diagnosis of Acute Stress Disorder. In L. K. Michelson & W. J. Ray (Eds.), *Handbook of Dissociation: Theoretical, Empirical, and Clinical Perspectives* (pp. 367-380). Boston, MA: Springer US.
Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Pers Soc Psychol, 54*(6), 1063-1070.
Wechsler, D. (1997). *WAIS-III and WMS-III Technical Manual*: San Antonio, TX: Psychological Corporation.