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Dissociation and Pain Perception: An Experimental Investigation

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Dissociative symptoms and abnormalities in pain perception have been associated with a range of disorders. The authors tested whether experimentally induced increases in state dissociation would cause an analgesic response. Participants (N = 120) were randomized to a dissociation induction condition via audiophotic stimulation or a credible control condition and were compared on pre- and postchanges in subjective pain and immersion time in response to a standard cold pressor test. Unexpectedly, the dissociation induction led to small, but significant increases in subjective pain and did not lead to greater immersion time. An exploratory analysis revealed that increases in absorption and derealization significantly predicted increased subjective pain and increased immersion time, respectively.

Although dissociation has primarily been conceptualized as an alteration in subjective experience, individuals with a history of dissociative experiences have been found to display some psychophysiological abnormalities. For example, Sierra et al. (2002) found individuals with depersonalization disorder to have decreased galvanic skin responses to unpleasant and neutral pictures as compared to normal controls. In a comparison of rape victims who reported having experienced high or low levels of dissociation during the assault (peritraumatic dissociation), high dissociators were found to display a suppression of physiological responsivity when discussing the trauma (Griffin, Resick, & Mechanic, 1997), although a similar study of nonsexual assault trauma victims failed to replicate this finding (Nixon, Bryant, Moulds, Felmingham, & Mastrodomenico, 2005). In contrast with these findings associating dissociation with decreased responsivity, Ladwig et al. (2002) found that among survivors of a life-threatening cardiac event, those who had displayed high levels of peritraumatic dissociation later displayed higher electromyogram and skin conductance responses to a startle task relative to low dissociators. Thus, there appears to be some relationship between dissociation and variations in physiological arousal, although studies have yielded inconsistent findings.

Although these investigations explored physiological response differences between subjects who had differed in the frequency and intensity of previous dissociative experiences, it may also be that within-subject variations in state dissociation are associated with variations in physiological responding. In an investigation of borderline patients who were exposed to a series of startling tones, those displaying high-state dissociation exhibited a dampened startle response, whereas those displaying low-state dissociation exhibited a heightened startle response (Ebner-Priemer et al., 2005). Lanius et al. (2002) asked trauma victims to relive their traumatic experiences while undergoing functional magnetic resonance imaging (fMRI) and found that only those participants who did not dissociate during the procedure displayed an increase in heart rate.

Although these are the only known reports of physiological differences correlated with state dissociation, there

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may be others. One such potential correlate is pain perception. Just as increased levels of dissociative symptoms are observed across disorders, decreased sensitivity to experimentally induced pain has been reported among individuals with bulimia nervosa (de Zwaan, Biener, Bach, Wiesnagrotzki, & Stacher, 1996; de Zwaan, Biener, Schneider, & Stacker, 1996; Stein et al., 2002), schizophrenia (Blumensohn, Ringle, & Eli, 2002; Dworkin, 1994), and major depression (Dickens, McGowan, & Dale, 2003; Dworkin, Clark, & Lipsitz, 1994; for a review, see Lautenbacher & Krieg, 1994).

Because analgesia and dissociation both represent alterations in perception that are associated with other indicators of psychopathology, it bears asking whether there is a relationship between the two. Indeed, there is evidence that both dissociative symptoms and stress-induced analgesia (SIA) do co-occur. Among patients with borderline personality disorder (BPD), increased insensitivity to pain has been found to be positively associated with dissociative experiences (Bohus et al., 2000; Russ, Clark, Cross, Kemperman, Kakuma, & Harrison, 1996; Russ, Shearin, Clarkin, Harrison, & Hull, 1993), and levels of state dissociation have been found to be elevated during episodes of self-cutting (Kemperman, Russ, & Shearin, 1997).

Despite these findings, few investigators have examined SIA in the context of dissociative symptoms. However, there are some interesting parallels between the two constructs. Both peritraumatic dissociation (Birmes et al., 2003; Gershuny, Cloitre, & Otto, 2003; Ozer, Best, Lipsey, & Weiss, 2003; Punamaki, Komproe, Qouta, Elmasri, & de Jong, 2005; Spiegel, Koopman, Cardeña, & Classen, 1996; Tichenor, Marmar, Weiss, Metzler, & Ronfeldt, 1996) and SIA (Nishith, Griffin, & Poth, 2002) have been found to predict posttraumatic stress disorder (PTSD) status in trauma victims. Dissociation has been observed to occur in response to acute stressors (e.g., Kindt & van den Hout, 2003; Sterlini & Bryant, 2002) and it has been suggested that higher levels of trait dissociation should predict the magnitude of the dissociative response (Kihlstrom, Glisky, & Anguilo, 1994) to stressors. Similarly, SIA has been experimentally induced via exposure to acute stressors (Bandura, Cioffi, Taylor, & Brouillard, 1988; Janssen & Arntz, 2001) and by exposing traumatized individuals to trauma-related stimuli (Nishith et al., 2002; Pitman, van der Kolk, Orr, & Greenberg, 1990). During these SIA inductions, participants' analgesic responses may have been mediated by an increase in state dissociation. Finally, there appears to be a functional similarity between the two phenomena. Just as SIA serves to diminish the experience of physical pain, dissociation may be a stress response that protects from emotional upset (Kihlstrom et al., 1994; Shilony & Grossman, 1993; van der Kolk & van der Hart, 1989). Russ and colleagues (1996) suggested that individuals with BPD may "use dissociative mechanisms (reinterpreting pain sensations) to 'numb' or 'block out' pain" (p. 63).

One way to investigate the relationship between SIA and dissociation is to induce dissociative symptoms in the laboratory and measure changes in pain perception and pain tolerance. The experimental induction of dissociation offers several advantages over its naturalistic study. First, in contrast with naturally occurring stress-induced dissociation, such as that observed in emergency services personnel (Marmar, Weiss, Metzler, & Delucchi, 1996), a nonstressful laboratory induction allows us to investigate dissociative symptoms without the potentially confounding effects of hyperarousal, which often occurs in traumatic situations and may be related to both dissociation (Bryant & Panesetis, 2005; Friedman, 2000; Sterlini & Bryant, 2002) and SIA (Nishith et al., 2002). Second, the experimental induction of dissociation allows for stronger causal inference than a correlational examination. Finally, this approach helps ameliorate the potential confound of retrospective self-report bias that has been suggested as a limitation of prior dissociation research (Candel & Merckelbach, 2003; Marmar et al., 1994).

Methods for inducing dissociation in the laboratory have included dot-staring and silent repetition of one's own name (Miller, Brown, DiNardo, & Barlow, 1994), a Velten-style dissociative mood induction (Zoellner, Sacks, & Foa, 2003), stimulus deprivation (Leonard, Telch, & Harrington, 1999), and exposure to an aversive film (Kindt, van den Hout, & Buck, 2005). Another approach involves the use of pulsed audiophotic stimulation (APS), in which steadily flashing lights and pulsing tones are delivered through an eyepiece and an earpiece. Two previous investigations in our laboratory have suggested that this multimodal method induces dissociative symptoms more reliably and effectively than alternative methods (Leonard et al., 1999; Leonard, Telch, & Owen, 2000).

In the current study, we induced dissociative symptoms using APS to assess whether changes in state dissociation would lead to alterations in pain perception. We had 120 nonclinical participants undergo a cold pressor test, and then we randomized them to receive either APS or a credible control condition. We then asked them to complete a second cold pressor test. It was predicted that those receiving the dissociation induction would show greater improvements in cold pressor performance (as measured by immersion time and subjective pain) than those in the control condition.

Because individuals who have a history of traumatic experiences might be expected to respond more strongly to the dissociation induction procedure, we expected to find that those with a history of trauma would show greater increases in immersion time and greater decreases in reported pain than those with no history of trauma.

The degree to which individuals dissociated in response to a prior trauma may act as a marker of dissociability, indicating that these individuals tend to dissociate in response to stressors. If that is the case, then we might expect these individuals to show more of an analgesic response. Therefore, we considered whether levels of peritraumatic dissociation, which we indexed by the Peritraumatic Dissociative Experiences Questionnaire (PDEQ; Marmar et al., 1994) scores, moderated the effects of the dissociation induction. Because this analysis was necessarily limited to those individuals with a history of trauma, we oversampled these individuals.

METHOD

Participants

One hundred twenty undergraduates (90 women and 30 men) enrolled in an introductory psychology course at the University of Texas at Austin participated in this study to earn credit toward a research requirement. Participants ranged in age from 18 to 30 ($M = 20$, $SD = 2$) and consisted of diverse ethnic groups: White (62.5%), Asian/Pacific Islander (18.3%), Hispanic (7.5%), African American (6.7%), and other (5.0%). Because we were interested in peritraumatic dissociation as a potential moderator of analgesia, we oversampled individuals with a history of trauma. Sixty-eight of the 120 participants reported experiencing at least one traumatic event.

Procedure

All participants initially completed a battery of self-report measures (including a measure of state dissociation) and a cold pressor test. An equal number of participants was then assigned to receive 10 minutes of dissociation induction (APS) or a control induction. Groups were balanced according to participant gender and history of trauma, as indexed by the Posttraumatic Stress Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997). All participants then completed a second cold pressor test and a second measure of state dissociation (see Figure 1).

There were two primary dependent variables of interest: pain tolerance as indexed by immersion time and pain perception as indexed by the average of pain ratings given throughout the cold pressor trial.

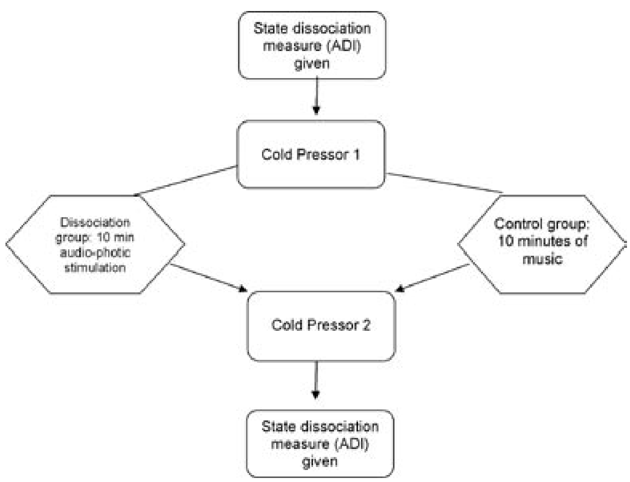

Figure 1. Design flow chart.

A plastic tank measuring 13" × 28" × 14" contained ice, water, and a small motorized water circulator. The water was kept between 0 and 2°C, and water temperature was measured immediately following each trial.

Pulsed audiophotic stimulation (APS) was produced using the digital audio/video integration device (DAVID), developed by Mind Alive Devices (Edmonton, Alberta, Canada). It is marketed as a relaxation device, although it has been found to induce dissociative symptoms (Leonard et al., 1999; Leonard et al., 2000). The device includes a headset and plastic mask, which are connected to a small console. The headset emits controllable ticking sounds, similar to those made by a metronome. The plastic mask resembles ski goggles and delivers pulsed orange lights at controllable rates. Based on the recommendations of the developer, the audio and video stimulus frequency was set at 12 Hz (cycles per second). This rate was selected to match brainwave alpha frequency, which is associated with relaxation and meditative states. In our previous investigations, this rate has been found to effectively induce dissociative symptoms (Leonard et al., 1999; Leonard et al., 2000).

Measures

The Acute Dissociation Index (ADI: Leonard et al., 1999) is a 26-item self-report scale that has been used to assess state dissociation during laboratory dissociation challenges (Leonard et al., 2000; Leonard et al., 1999; Zoellner et al., 2003) in which participants rate the severity of dissociative thoughts and sensations (e.g., "things around you seeming unreal") on an 11-point scale. The ADI was designed with the factor structure of the Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986) in mind, and the content of the items reflects that of the DES. Leonard et al. (1999) reported a 6-factor solution: amnestic experiences, gaps in awareness, depersonalization, derealization, absorption, and imaginative involvement. A total score can be obtained by averaging the 26 items; the subscale scores can be obtained by averaging the items included in each of the following subscales: amnestic experiences, items 1–5; gaps in awareness, items 6–7; depersonalization, items 8–13; derealization, items 14–16; absorption, items 17–23; imaginative involvement, items 24–26. Cronbach's alphas for the present sample were .85 (before dissociation induction) and .90 (after dissociation induction).

The DES (Bernstein & Putnam, 1986) is a 28-item self-report measure used to measure trait dissociation and to identify patients with severe dissociative disorders. The DES has shown good psychometric properties (Carlson & Putnam, 1993).

The PDEQ (Marmar et al., 1994) is an 8-item self-report questionnaire capturing retrospective reports of peritraumatic dissociation (dissociative experiences at the time of trauma). Participants rate the degree to which they experienced different aspects of dissociation (e.g., "sense of time change during event") on a 5-point Likert scale (1 = *not at all*, 5 = *extremely*). The PDEQ is scored as the total item response across all items, with a possible range of 8 to 40.

The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) is a 21-item self-report scale assessing recent symptoms of anxiety.

The PDS (Foa, Cashman, Jaycox, & Perry, 1997) is a 49-item self-report scale that assesses *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*; American Psychiatric Association, 1994) symptoms of PTSD. Although primarily used for measuring PTSD diagnostic criteria and symptom severity, the PDS has also been used to assess trauma history (Sloan, Marx, & Epstein, 2005), as it contains an extensive checklist of traumatic events to assess the participant's history of traumatic experiences. We considered participants to have experienced a trauma if they endorsed any of the events.

The Dissociation Sensitivity Index (DSI; Leonard et al., 2000) is a 22-item questionnaire measuring the degree of fear people would have if they experienced a number of dissociative symptoms, many of which are adapted from the DES. Participants record their level of fear in response to each item using a 5-point Likert scale ranging from 0 (*no fear*) to 4 (*extreme fear*). Although the DSI has not yet been subjected to rigorous validity testing, it showed excellent internal consistency in this sample ($\alpha = .94$, split-half reliability $r = .87$).

Procedure

All data were collected in a single session. After giving informed consent, all participants completed a packet of self-report questionnaires, including the state dissociation measure (ADI). They then completed the first cold pressor test, which was administered using standard procedures (Hilgard, Morgan, & McDonald, 1975; Wolf & Hardy, 1941). Participants were instructed to immerse their dominant arm up to their elbow and to keep it motionless; they were to remove their arm whenever they felt that the pain or discomfort was unbearable. During the task, participants were prompted to report the degree of pain they were experiencing from 0 (*no pain at all*) to 10 (*the most pain ever*) at 30-s intervals and again at the moment they removed their arm from the water. After completing the cold pressor test, participants were then randomly assigned to the dissociation induction or music control condition, both of which lasted 10 minutes. Immediately following the dissociation or control condition, participants completed a second cold pressor test that was procedurally identical to the first. Because we felt it important to have the participants complete the second cold pressor while still experiencing any increased dissociative symptoms, we instructed them to complete the cold pressor before filling out the 26-item ADI.

Participants receiving APS were fitted with the DAVID and were told to close their eyes, relax, and await further instructions. The DAVID was set to factory preset program number 11, which delivers pulsed stimulation at 7.8 Hz. The DAVID was turned on, and participants were left alone in the room for 10 minutes. The experimenter then returned to the room and had the participant undergo a second cold pressor procedure, identical to the first. The DAVID apparatus continued to run during this test. After the completion of this test, the DAVID was turned off and removed. The participant completed the posttest state dissociation measure (ADI) and was debriefed.

Participants in the music control condition performed an identical procedure to those in the dissociation induction condition. However, the DAVID was not turned on, and participants listened to a classical music piece. Music was used because it was thought that complete silence would amount to sensory deprivation, which has been shown to induce mild increases in state dissociation (Leonard et al., 1999).

RESULTS

Equivalence of Experimental and Control Groups at Baseline

A series of t tests revealed no significant differences between the dissociation induction and control conditions on the variables BAI, DES, PDEQ, DSI, and the number of traumatic events (PDS items 1–12). A pretreatment difference was found for premanipulation ADI scores, $t(112) = 2.52$, $p < 01$, which were consequently included as covariates in subsequent analyses.

Effects of the Dissociation Induction on State Dissociation

We examined differences in state dissociation between the dissociation induction and control groups from pre- to postinduction by performing a series of 2 (Induction: dissociation, control) × 2 (Time: pre- and postinduction) repeated measures ANOVAs, first for the composite ADI score and then for each of the individual subscales.

There was a significant increase in state dissociation total scores from pre- to postinduction across both groups $F\ (1, 109) = 48.99$, $p < .001$, partial $\eta^2 = .296$. There was also a significant Induction × Time interaction, $F\ (1, 109) = 6.96$, $p < .01$, partial $\eta^2 = .050$, indicating that participants receiving APS showed a greater increase in state dissociation than those in the control group (See Table 1).[1] These findings suggest that the APS manipulation was successful in producing heightened state dissociation.

1 Because the ADI scores were nonnormally distributed, this test was performed using log-linear transformations of these data.

Table 1. Acute Dissociation Inventory (ADI) Subscale Means, Immersion Time, and Subjective Pain at Pre- and Postinduction by Experimental Condition

	Dissociation		Music control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
ADI Total*						
Pre-	4.22	3.80	6.82	6.65	5.62	5.64
Post-	11.15	10.15	9.96	7.77	10.54	8.99
Amnesic experience						
Pre-	4.33	5.52	5.97	6.82	5.21	6.28
Post-	7.46	11.25	7.17	11.75	7.31	11.47
Gaps in awareness[a]						
Pre-	7.10	10.35	12.11	13.48	9.79	12.34
Post-	18.30	11.61	15.40	16.60	16.76	14.48
Depersonalization						
Pre-	0.42	1.58	1.46	3.83	0.98	3.04
Post-	5.60	8.46	4.43	7.36	4.98	7.89
Derealization[a]						
Pre-	0.61	1.71	1.41	4.92	1.04	3.80
Post-	9.35	14.75	5.34	8.73	7.23	12.06
Absorption						
Pre-	8.66	9.44	13.66	12.40	11.34	11.36
Post-	19.59	15.89	20.88	14.16	20.28	14.95
Imaginative involvement						
Pre-	4.06	5.70	7.29	12.75	5.80	10.21
Post-	5.71	12.69	7.37	13.57	6.58	13.13
Immediate time (seconds)						
Pre-	133.10	110.89	144.84	113.80	139.36	112.12
Post-	136.99	103.70	145.90	110.91	141.74	107.24
Pain (0–10)						
Pre-	5.88	1.76	6.22	1.95	6.06	1.86
Post-	6.03	2.08	5.99	2.13	6.01	2.09

[a]Repeated measures ANOVA revealed a Time × Condition interaction to be significant at $p < .05$.

Significant Time × Induction differences were found for two of the six ADI subscales: gaps in awareness, $F(1, 116) = 9.62$, $p < .001$, partial $\eta^2 = .217$, and derealization, $F(1, 116) = 5.50$, $p < .05$, partial $\eta^2 = .045$. For each of these subscales, those receiving APS displayed greater increases than those receiving the control induction (See Table 1).[2]

Effects of the Dissociation Induction on Cold Pressor Performance

Means and standard deviations for immersion time and subjective pain during the cold pressor challenge are presented in Table 1[3] (also see Figure 2). Our central hypotheses concerning the effects of dissociation induction and trait dissociation on cold pressor performance and pain perception were tested using a 2 (Induction: dissociation, control) × 2 (Trauma history: trauma, no trauma) × 2 (Time: pre- and postinduction) ANOVA, with repeated measures

[2] Because the ADI subscale scores were nonnormally distributed, we attempted to perform square root and log-linear transformations of these data. These transformations failed to normalize the distributions of these scores and they did not result in a different pattern of results across the ANOVAS. Therefore, we have reported the untransformed scores.

[3] Because the immersion time data were not normally distributed, square root and log-linear transformations were attempted.

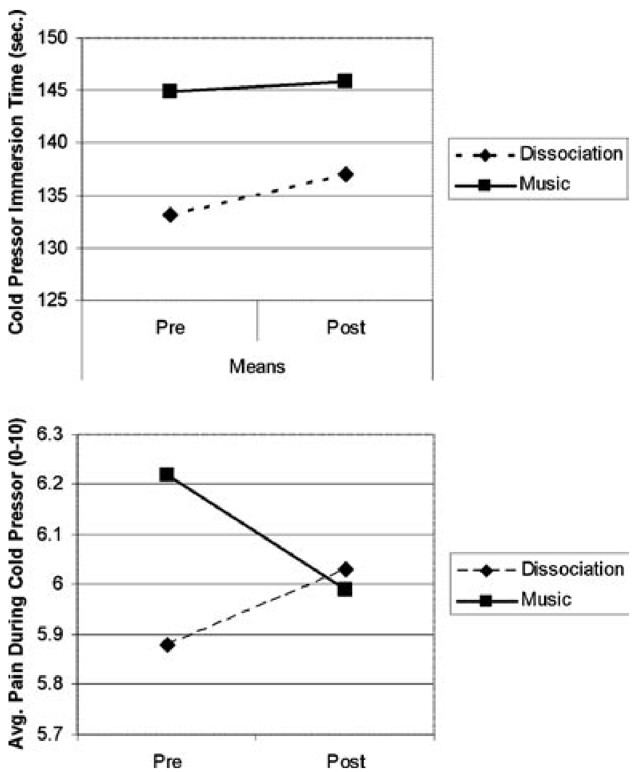

Figure 2. Immersion time and average pain by experimental condition.

on the Time factor, including premanipulation ADI scores as a covariate.

With immersion time as the dependent measure, no significant interaction effects were found for Induction × Time, $F < 1$, Trauma history × Time, $F < 1$, or Induction × Trauma history × Time, $F < 1$.

With pain as the dependent measure, our analysis revealed a significant Induction × Time interaction, $F(1, 107) = 4.14$, $p < .05$, partial $\eta^2 = .037$, such that participants receiving the dissociation induction reported greater increases in reported pain than did participants receiving the music induction. No interaction effects were found for Trauma history × Time, $F < 1$, or for Induction × Trauma history × Time, $F(2, 107) = 1.11$, *ns*.

PDEQ as a Moderator of Cold Pressor Performance

We examined whether level of peritraumatic dissociation during a past traumatic event predicted cold pressor performance using a 2 (Induction: dissociation, control) × 2 (Time: pre- and postinduction) ANCOVA, including PDEQ and ADI at Time 1 as covariates and a PDEQ × Induction interaction term, with repeated measures on the Time factor. Because only individuals with a history of trauma could have had peritraumatic dissociative experiences, this analysis was limited to those 68 participants. Contrary to prediction, we did not find PDEQ to predict changes in immersion time or pain perception.

Exploratory Analyses

Based on previous reports of an association between indices of psychopathology and differences in pain perception (e.g. Dickens et al., 2003; Lautenbacher & Krieg, 1994; Russ et al., 1993), we conducted exploratory analyses in an attempt to identify whether any of the clinical measures predicted changes in cold pressor performance. Because higher levels of dissociation sensitivity have been found to predict greater levels of anxiety in response to a dissociation challenge (Leonard et al., 2000), we considered whether DSI scores predicted responses to the cold pressor task. We also considered whether DES scores were predictive of cold pressor performance because trait dissociation has been found to moderate response to the DAVID dissociation induction (Leonard et al., 1999). Finally, because our dissociation induction only led to changes in two of the six ADI subscales, we examined whether subscale-specific changes would predict changes in cold pressor performance.

We conducted a series of hierarchical multiple regression models with postinduction immersion time and subjective pain as the dependent variables. Independent variables were entered in a series of blocks. The first block contained the Time 1 cold pressor indices (preinduction immersion time and subjective pain). The second block included the three clinical measures (BAI, DES, and DSI) and the third included the residualized change scores for state dissociation (one for each of the six subscales of the ADI).

On Block 2 of the model predicting postinduction immersion time (adjusted $R^2 = .67$), the only significant predictor of immersion time at postinduction was immersion time at preinduction, $\beta = .80$, $p < .05$ (see

Table 2. Summary of Hierarchical Regression Analysis Predicting Immersion Time at Postinduction ($N = 114$)

	Step 1			Step 2			Step 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Immediate time pre-	0.76	0.06	.79*	0.77	0.06	.80*	0.79	0.06	.82*
Average pain pre-	−2.81	3.38	−.05	−2.71	3.37	−.05	−0.62	3.47	−.01
BAI				0.72	0.84	.05	0.92	0.86	.07
DSI				0.79	0.4	.11	0.62	0.41	.09
DES				−0.45	0.24	−.11	−0.47	0.24	−.12*
ADI (amnesic experiences) Res. Ch.							0.24	0.63	.03
ADI (gaps in awareness) Res. Ch.							−0.69	0.49	−.08
ADI (depersonalization): Res. Ch.							−0.56	1.49	−.04
ADI (derealization): Res. Ch.							1.89	0.89	.20*
ADI (absorption): Res. Ch.							0.18	0.58	.02
ADI (imaginative Involvement): Res. Ch.							−0.73	0.55	−.09

Note. BAI = Beck Anxiety Inventory; DSI = Dissociation Sensitivity Index; DES = Dissociative Experiences Scale; ADI = Acute Dissociation Index; Res. Ch. = Residual Change.
*$p < .05$.

Table 2). In Block 3, trait dissociation significantly predicted lower postinduction immersion time, $\beta = -.12$, $p < .05$, and the residualized change score of the derealization subscale of the ADI was found to be a significant positive predictor of immersion time, $\beta = .20$, $p < .05$. The inclusion of the ADI subscale change scores explained an additional 1.7% of the variance. The overall model was highly significant, adjusted $R^2 = .68$; $F(11, 105) = 23.80$, $p < .001$, indicating that a substantial portion of the variance was accounted for by these predictor variables.

On Block 2 of the model predicting postinduction pain (adjusted $R^2 = .74$), average pain at preinduction, $\beta = .82$, $p < .001$ (see Table 3), and immersion time at preinduction, $\beta = -.14$, $p < .001$, were significant predictors of postinduction pain. In Block 3, greater changes in the absorption subscale significantly predicted higher subjective

Table 3. Summary of Hierarchical Regression Analysis Predicting Average Pain at Postinduction ($N = 114$)

	Step 1			Step 2			Step 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Immediate time pre-	0.00	0.00	−.14	0.00	0.00	−.14	0.00	0.00	−.12
Average pain pre-	0.90	0.06	.80	0.92	0.06	.82	0.94	0.06	.84
BAI				0.00	0.02	−.01	0.01	0.02	.02
DSI				−0.01	0.01	−.06	−0.01	0.01	−.05
DES				−0.01	0.00	−.06	−0.01	0.00	−.06
ADI (amnesic experiences) Res. Ch.							0.00	0.01	−.01
ADI (gaps in awareness) Res. Ch.							−0.01	0.01	−.08
ADI (depersonalization): Res. Ch.							−0.05	0.03	−.16
ADI (derealization): Res. Ch.							0.01	0.02	.07
ADI (absorption): Res. Ch.							0.02	0.01	.13
ADI (imaginative involvement): Res. Ch.							0.00	0.01	−.02

Note. BAI = Beck Anxiety Inventory; DSI = Dissociation Sensitivity Index; DES = Dissociative Experiences Scale; ADI = Acute Dissociation Index; Res. Ch. = Residual Change.
*$p < .05$.

Table 4. Intercorrelations Between Pain, Dissociation, and Anxiety Measures

Measure	2.	3.	4.	5.	6.	7.	8.	9.
1. Average pain pre-	.85**	−.36**	−.34**	.12	.18	.00	.13	.14
2. Average pain post-		−.42**	−.40**	.04	.12	−.04	.06	.05
3. Immediate time pre-			.80**	.00	−.07	.06	−.05	.01
4. Immediate time post-				.10	.05	.05	.02	−.09
5. ADI Total pre-					.51**	.49**	.21*	.54**
6. ADI Total post-						.43**	.24*	.39**
7. BAI Total							.31**	.44**
8. DSI Total								.25**
9. DES Total								

Note. ADI = Acute Dissociation Index; BAI = Beck Anxiety Inventory; DSI = Dissociation Sensitivity Index; DES = Dissociative Experiences Scale.
*$p < .05$. **$p < .01$.

pain in response to the cold pressor challenge, $\beta = .13.$, $p < .05$. For the final step of the model, the adjusted R^2 was .75, $p < .001$, indicating that a substantial portion of the variance was accounted for by these predictor variables.

For both regression models, an examination of the intercorrelations (see Table 4) and the tolerances of the individual variables found them to be acceptably high, indicating an absence of multicollinearity.

DISCUSSION

In the present study, we sought to investigate experimentally the relationship between dissociation and pain perception. Contrary to prediction, the induction of dissociation did not lead to greater pain tolerance, and actually led to significantly greater reports of pain, although the effect size for this finding was very small (partial $\eta^2 = .037$). What might account for these findings, in light of prior research suggesting a co-occurrence of dissociation and analgesia (Bohus et al., 2000)? One possibility is that there actually is no direct positive association between dissociation and pain perception, but they share common risk factors (e.g., psychiatric disorders) or common triggers (e.g., exposure to trauma-related stimuli). Dissociative symptoms may not necessarily be contributing to analgesia, but merely occurring concurrently with it. It may also be that there are multiples of types of dissociation, which may have multiple or distinct triggers.

Another possibility is that the dissociation induction differed too greatly from natural dissociation. Indeed, this is an inherent limitation of the use of laboratory analogues. In designing the study, we considered the induction of dissociation in the absence of hyperarousal to be an advantage. However, several authors have made the case that hyperarousal is an important pathway to dissociation (Bryant & Panesetis, 2005; Friedman, 2000; Sterlini & Bryant, 2001), and hyperarousal may be necessary for the elicitation of analgesia.

Alternately, although audiophotic stimulation did produce greater increases in dissociative symptoms than the control condition, it may be that these symptoms were simply not strong enough to elicit a significant analgesic response. The dissociation induction was continuing during the cold pressor test, and the cold pressor test may have reduced the dissociative symptoms experienced by those receiving the dissociation manipulation, thereby reducing the potency of the manipulation. In addition, the measures of both dissociation and pain perception displayed a large degree of variance, which would have reduced the likelihood of seeing significant results. Perhaps dissociative symptoms contribute to the experience of analgesia, but only when state dissociation reaches a magnitude that is comparable to what occurs during a traumatic event. Because the ADI has not been normed on individuals immediately following trauma, it is not possible to judge the degree of similarity between the dissociative symptoms induced through our dissociation challenge (i.e., pulsed audiophotic stimulation) and those that occur during real traumas.

It also appears that the dissociation induction affected individuals inconsistently, leading to significantly greater increases than the music control in only two of the six subscales: derealization and gaps in awareness. This is consistent with our previous findings that APS led to greater increases in derealization than did stimulus deprivation and dot staring. However, we cannot offer an explanation as to why only these particular scales displayed these increases. Although dissociation has at times been conceptualized as a unidimensional construct (Bernstein, Ellason, Ross, & Vanderlinden 2001; Bernstein & Putnam, 1986), and pathological dissociation as a categorical taxon (Simeon, Knutelska, Nelson, Guralnik, & Schmeidler, 2003; Waller, Ohanian, Meyer, Everill, & Rouse, 2001; Waller, Putnam, & Carlson, 1996) other authors have suggested that dissociation is a multidimensional construct (e.g., Holmes, Brown, Mansell, Fearon, Hunter, Frasquilho, et al., 2005). Our data support such a conceptualization. Because the changes in derealization and absorption subscales were found to predict changes in cold pressor performance, it may be that a dissociation induction more specifically targeted at one or more of those dimensions would cause a more dramatic change in cold pressor performance. Future investigations of dissociative pathology may benefit from the use of multiple dissociation induction techniques targeting differing subscales.

Another factor that may have reduced the power of our manipulation was the use of music as a control condition. Although music was preferable to silence (because stimulus deprivation has been shown to cause dissociative symptoms; Leonard et al., 1999), the control condition did produce significant increases in dissociation, and it may have caused changes in mood. We also considered the possibility that the DAVID dissociation-induction manipulation was introducing distraction as a confound. However, we consider this unlikely because the DAVID presents a steady stimulus that does not induce a cognitive load.

Contrary to our expectations, we did not find the dissociation induction—pain perception relationship to be moderated by trauma history or degree of prior peritraumatic dissociation. Our inability to find trauma as a predictor may have been related to our dichotomous measure of trauma exposure, which did not account for differences in trauma severity and time since trauma, both of which may be important variables to consider. Moreover, even though we oversampled individuals with a history of trauma, our use of a nonclinical college student population may have produced a sample with a narrow range of previous exposure to trauma. We were also surprised to find that PDEQ did not moderate the relationship between dissociation and pain perception. This may result from the use of a retrospective measure of dissociation because, as mentioned earlier, retrospective reporting of traumatic experiences is thought to be unreliable (Candel & Merckelbach, 2003; Marmar et al, 1994). Because persistent dissociation has been found to be a more significant predictor of dissociative responding than peritraumatic dissociation (Briere, Scott, & Weathers, 2005; Panesetis & Bryant, 2003), future investigations should account for this variable.

Although our exploratory analyses may have been hindered by a lack of power and should be interpreted with caution, there were several interesting findings. Despite our finding that the dissociation induction did not lead to increases in cold pressor immersion time, we did find that increases in the derealization subscale of the ADI were associated with increases in immersion time. It may be that changes in derealization are causally related to alterations in pain perception, but that this difference was not of a sufficient magnitude to elicit a significant difference between groups. This finding is consistent with our prediction that increases in dissociative symptoms would be associated with increases in pain tolerance. Moreover, it is consistent with theoretical accounts linking depersonalization and derealization with alterations of pain perception (Sierra & Berrios, 1998). More surprising is the finding that greater increases in absorption predicted greater levels of reported pain. Although it is consistent with our finding that the dissociation condition showed slight, but significant increases in pain, both of these findings were contrary to prediction. Individuals in the dissociation condition did not show reduced immersion time in the presence of seemingly greater pain; this suggests that they may have been experiencing pain in a different, less distressing way. Indeed, several investigators have measured pain as a multifactorial construct, differentiating between the intensity and unpleasantness of the pain (Bohus et al., 2000; Charron, Rainville, & Archand, 2006), and it is unfortunate that we used a unitary measure of pain. Finally, we were surprised to see that higher DES scores predicted lower immersion times at postinduction. This finding is difficult to explain, although it may result from the DES measuring pathological distress, in addition to experience of dissociative symptoms (indeed, in this sample it was positively correlated with BAI, $r = .44$, $p = .00$). Future investigations of dissociation could benefit from the use of more detailed measurement of prior and ongoing dissociative experiences.

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