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Do Cognitive Reappraisal and Diaphragmatic Breathing Augment Interoceptive Exposure for Anxiety Sensitivity?

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Interoceptive exposure (IE) is an effective procedure for reducing anxiety sensitivity (AS) and the symptoms of panic disorder. However, considerable variance exists in how IE is delivered among clinicians, and the extent to which IE is enhanced by the concurrent use of cognitive reappraisal (CR) and diaphragmatic breathing (DB) is unclear. Participants ($N = 58$) with high AS were randomly assigned to one of four single-session interventions: (a) IE only, (b) IE + CR, (c) IE + CR + DB, or (d) expressive writing control. IE was superior to expressive writing in reducing AS and associated anxiety symptoms. The addition of CR and DB did not enhance the benefits of IE at either posttreatment or 1-week follow-up. These findings highlight the specific efficacy of IE in reducing AS and call into question the common practice of combining IE with cognitive and breathing strategies. Theoretical and clinical implications are discussed.

Keywords: interoceptive exposure; anxiety sensitivity; treatment; diaphragmatic breathing; cognitive reappraisal

Anxiety sensitivity (AS) refers to the fear of anxiety-related sensations based on beliefs about their harmful consequences (Reiss & McNally, 1985). A large body of research has demonstrated a specific and robust association between AS and panic-related

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psychopathology (McNally, 2002). Among the physical, cognitive, and social domains of AS, the fear of physical symptoms is a particularly strong predictor of fearful responding to sensation induction procedures (e.g., Brown, Smits, Powers, & Telch, 2003). Individuals with panic disorder exhibit higher AS in general and greater fears of physical anxiety-related symptoms in particular than those with other anxiety disorders (e.g., Deacon & Abramowitz, 2006). Reductions in AS appear to mediate improvement in cognitive behavioral therapy (CBT) for panic disorder (Smits, Powers, Cho, & Telch, 2004). Prospective studies implicate AS being a risk factor for the subsequent development of panic attacks (Hayward, Killen, Kraemer, & Taylor, 2000; Schmidt, Lerew, & Jackson, 1997, 1999).

Given the importance of AS in cognitive behavioral conceptualizations of panic disorder (e.g., Clark, 1986), a central aim of CBT for panic is to reduce catastrophic misinterpretations of benign arousal-related body sensations. Interoceptive exposure (IE) is a CBT procedure that accomplishes this aim via repeated confrontation with panic-related sensations (e.g., breathlessness, dizziness, racing heart; Abramowitz, Deacon, & Whiteside, 2010). In IE, the patient voluntarily induces feared sensations by engaging in various symptom induction exercises. For example, hyperventilation effectively induces breathlessness, dizziness, and tingling; running in place induces shortness of breath and heart palpitations; and standing in a dark room with a strobe light produces depersonalization/derealization sensations (Antony, Ledley, Liss, & Swinson, 2006; Lickel, Nelson, Lickel, & Deacon, 2008; Schmidt & Trakowski, 2004). IE is an effective treatment for reducing AS in nonclinical participants and panic symptoms in clinical samples (e.g., Gould, Otto, & Pollack, 1995; Smits, Berry, Tart, et al., 2008; Watt, Stewart, Birch, & Bernier, 2006).

The manner in which IE is delivered varies substantially across studies and practitioners. Clinical scientists have studied IE used as a stand-alone technique (e.g., Arntz, 2002), concurrently with cognitive reappraisal techniques (e.g., Carter, Marin, & Murrell, 1999), or in combination with cognitive reappraisal and diaphragmatic breathing (DB; e.g., Barlow, Gorman, Shear, & Woods, 2000). There is also considerable variance among exposure therapists in the use of this technique. In a survey of 73 therapists who use IE in the treatment of panic disorder (Lickel, Deacon, & Iverson, 2010), 72.1% reported using cognitive reappraisal techniques during IE, and 42.3% reported using DB during IE. Unfortunately, despite the popularity of using cognitive and breathing strategies alongside IE, the extent to which these strategies augment the benefits of IE is unclear.

Two investigations have examined the effects of different methods of delivering IE on AS. In one study, Carter et al. (1999) found that high AS participants who received IE (five 90-s trials of hyperventilation) plus cognitive reappraisal (CR) evidenced significant reductions in anxiety and catastrophic cognitions, whereas participants who received IE alone did not. However, given the relatively brief duration of IE in this study, it is unclear whether the relatively poor outcomes produced by IE alone were caused by the absence of CR or an insufficient dose of exposure. In the second study, Smits, Berry, Rosenfield, et al. (2008) compared a wait-list control condition to six 20-min treadmill running exposures either with or without CR. Participants in both IE conditions reported greater reductions in anxiety and AS than did the wait-list group, but no differences emerged between IE alone and IE with CR.

To date, no studies have examined the effects of adding DB to IE. This is surprising given that many panic disorder treatment manuals prescribe the use of DB following IE trials, such as the popular *Mastery of Your Anxiety and Panic-4th Edition* protocol (*MAP-4*; Barlow & Craske, 2007). DB involves learning to inhale and exhale to a slow pace to counter hyperventilation and cope with the physical symptoms associated with panic. There are theoretical reasons to hypothesize that incorporating such breathing techniques could either enhance or detract from the effects of IE. On one hand, DB might enhance IE by bolstering self-efficacy for coping with physiologic

arousal. Because it provides a means of coping with (and reducing) anxiety-related body sensations, DB might also increase the acceptability and tolerability of IE. On the other hand, using DB to cope with or reduce feared body sensations might prevent the patient from fully learning that the feared sensations are temporary, harmless, and tolerable (Powers, Smits, Leyro, & Otto, 2007). Schmidt and colleagues (2000) found that DB did not add to the efficacy of a multicomponent CBT protocol that included psychoeducation, CR, IE, and in vivo exposure. On some outcomes, patients who received DB fared worse than those who did not. However, the effects of DB on the process and outcome of IE per se have not yet been examined.

Although research suggests that IE is an effective strategy for reducing AS and panic symptoms, the manner in which IE is optimally delivered has not yet been established. This ambiguity complicates efforts by treatment providers to incorporate research findings on IE into their clinical practice. This study was conducted to address this issue by examining the common practice of augmenting IE with CR and DB. Participants high in AS performed repeated trials of hyperventilation either alone (IE alone), with CR (IE + CR), or with both CR and DB (IE + CR + DB). These three treatment conditions were compared to a credible, nonspecific control intervention. We hypothesized that all IE conditions would produce substantial reductions in AS and anxiety from pretest to posttest, which would be maintained after 1 week; and that outcome of all IE conditions would be superior to control. We explored the extent to which augmentation of IE with CR and CR + DB affected improvement on indices of the fear of anxiety as well as treatment acceptability.

Method

Participants

Study participants ($N = 58$) were undergraduate students recruited from the University of Wyoming ($n = 49$) and the University of North Carolina at Chapel Hill ($n = 9$). All screening and laboratory procedures were identical between the two sites. Participants met the following inclusion criteria: (a) elevated AS specific to respiratory-related bodily sensations, as indexed by a score of at least 18 on the respiratory concerns subscale of the Anxiety Sensitivity Index-Revised (ASI-R; Taylor & Cox, 1998); (b) absence of physical conditions that contraindicate participation in hyperventilation (e.g., seizures, hypertension, heart problems, pregnancy, asthma); and (c) elevated fear following 2 min of hyperventilation, as indexed by a score of 50 or greater on a 100-point visual analog scale (VAS).

Participants were recruited from introductory psychology courses and selected via a two-stage screening process. Potential participants ($n = 1{,}769$) completed a Web-based version of the ASI-R respiratory concerns subscale, and individuals ($n = 489$) with scores at least one standard deviation above the mean obtained by the initial screened cohort of 430 students ($M = 9.5$, $SD = 7.6$) were invited to participate. Of these potential participants, 111 agreed to attend an individual lab visit. Fourteen were subsequently disqualified for having exclusionary medical conditions. Remaining individuals engaged in a behavioral screening task consisting of 2 min of hyperventilation at a rate of 45 breaths per minute in synchronization with a recorded voice. Participants ($n = 58$) who indicated levels of peak fear at or higher than 50 on a 100-point VAS were deemed sufficiently fearful of the exposure stimulus and were invited to participate. All eligible individuals agreed to participate and received course credit upon completion of the study.

The sample was composed primarily of women (75.9%) aged 18–54 years ($M = 20.1$, $SD = 5.15$). The racial breakdown of the sample was 81.0% White, 6.9% Hispanic, 3.4% Native American, 1.7% African American, 1.7% Asian American; 5.2% listed their ethnicity as "other." The mean ASI-R respiratory concerns subscale score (25.90; $SD = 7.67$) was comparable to

that obtained by treatment-seeking individuals with a principal diagnosis of panic disorder ($M = 25.56$, $SD = 11.53$; Deacon & Abramowitz, 2006).

Measures

Anxiety Sensitivity Index-Revised Respiratory Concerns Subscale. The ASI-R (Taylor & Cox, 1998) is a 36-item measure of the fear of anxiety-related sensations. The 12-item respiratory concerns subscale provides an index of the fear of sensations associated with difficulty breathing, which can be provoked by voluntary hyperventilation (e.g., "When I feel like I'm not getting enough air I get scared that I might suffocate."). Total scores range from 0 to 48. In the present study, this subscale evidenced good internal consistency across assessment time points ($\alpha = .87$–$.93$).

Hyperventilation Questionnaire (HQ). The HQ (Rapee & Medoro, 1994) is a 33-item self-report measure of responses to interoceptive symptom induction exercises. The HQ contains 20 items assessing somatic responses (e.g., "breathlessness"), 7 items assessing affective responses (e.g., "fear"), and 6 items assessing cognitive responses (e.g., "feel like passing out"). Total scores range from 0 to 99. The HQ has good internal consistency and validity (Rapee & Medoro, 1994). In this study, HQ scores were used as an index of anxious responding to a straw breathing task (see following section). The HQ had excellent internal consistency across assessment time points for the straw breathing task ($\alpha = .92$–$.95$).

Straw Behavioral Approach Task. Prolonged breathing through a thin straw produces many of the same body sensations as hyperventilation (e.g., breathlessness, dizziness) and evokes comparable levels of anxiety (Antony et al., 2006; Schmidt & Trakowski, 2004). For this reason, a straw breathing behavioral approach task ("straw BAT") was used as an index of fear of respiratory-related body sensations. Participants were asked to breathe through a thin cocktail straw for 3 min at a rate of 30 breaths per minute. An audiotape repeating the words "in" and "out" was used to pace breathing. Participants reported their level of anxiety on a 100-point VAS (0 = *no fear*, 100 = *extreme fear or panic*) at each minute of the exercise. An index of straw BAT anxiety was calculated by averaging the three anxiety ratings. The straw task was completed at pretest, posttest, and 1-week follow-up. Participants completed the HQ immediately following the straw BAT.

Beck Anxiety Inventory (BAI). The BAI (Beck, Epstein, Brown, & Steer, 1988) assesses 21 common symptoms of clinical anxiety (e.g., sweating, fear of losing control) experienced during the past week. Total scores range from 0 to 63. The BAI has good reliability and validity (Beck et al., 1988). Because most of its items assess somatic anxiety symptoms, it provides an index of distress associated with the panic-like symptoms induced by hyperventilation. In this study, the BAI evidenced good internal consistency at each assessment time point ($\alpha = .86$ and .91, respectively).

The Credibility/Expectancy Questionnaire (CEQ). The CEQ is a well-established measure of treatment expectancy and acceptance of treatment rationale that possesses good test–retest reliability and internal consistency (Devilly & Borkovec, 2000). It consists of two parts, asking participants to report how much improvement they *think* will occur as well as how much improvement they *feel* will occur. This measure was administered immediately following presentation of the treatment rationale but before treatment was initiated.

In Vivo Ratings. Immediately following each hyperventilation trial, participants assigned to the three IE conditions first rated the intensity of their current body sensations on a 100-point VAS anchored by *not at all intense* and *extremely intense*. Second, participants reported their current level of anxiety on a 100-point VAS anchored by *no anxiety* and *extreme anxiety*. Third, participants rated the extent to which they felt "able to tolerate the body sensations associated with overbreathing" on a 100-point VAS anchored by *unable to tolerate them at all* and *completely*

able to tolerate them. Lastly, after all treatment trials had been completed, participants rated the aversiveness, acceptability, and extent to which they liked the treatment on 5-point scales ranging from 0 (*not at all*) to 4 (*extremely*).

Procedure

Participants were assigned to one of the four treatment conditions using a computer-generated randomization list. Participants attended two individual lab sessions spaced approximately 1 week apart. During the first 90-min session, pretest data were collected, the treatment rationale was presented followed by administration of the CEQ, the treatment was delivered, and posttest data were obtained. During the second 30-min session, follow-up measures were obtained and participants were debriefed. Participants completed the ASI-R respiratory concerns subscale and straw BAT at each assessment time point. The BAI was administered at the pretest and follow-up assessments.

Treatment Conditions

Interoceptive Exposure (IE) Only. Participants were instructed that the fear of body sensations is maintained by inaccurate threat beliefs, interoceptive conditioning, and habitual avoidance of feared sensations. IE was described as an effective method of overcoming the fear of body sensations by providing corrective information about threat, increasing self-efficacy in tolerating uncomfortable sensations, and demonstrating that habituation occurs with prolonged exposure to fear cues.

Participants completed a minimum of eight consecutive 60-s hyperventilation trials. Breathing was paced using an audio-taped voice repeating the words "in" and "out" at a rate of 45 breaths per minute. In vivo ratings (described previously) were completed during a 90-s resting period that followed each hyperventilation trial. IE trials were discontinued when participants' anxiety ratings dropped below 20 on the 100-point VAS. Participants were naive to this discontinuation criterion. This study used habituation as the discontinuation criterion rather than standardizing the number of hyperventilation trials to more closely approximate the manner in which exposure therapy is delivered in clinical practice (Abramowitz et al., 2010). A minimum of eight IE trials were used to ensure that all participants received a substantial dose of exposure. A maximum of 25 trials was set for purposes of time. Following the final exposure trial, participants provided treatment acceptability ratings and completed the posttreatment measures. A follow-up assessment session was scheduled 1 week later.

Interoceptive Exposure + Cognitive Reappraisal (IE + CR). The procedure for the IE + CR condition was identical to the IE only intervention with two exceptions. First, the experimenter assisted participants in identifying their most feared prediction associated with prolonged hyperventilation from a 10-item checklist provided by the experimenter. Most participants (88.6%) selected either "I will pass out" or "I will suffocate." Second, participants were instructed to consider whether or not their feared prediction came true following each trial, and to provide ratings of the probability that their feared prediction would occur during the subsequent trial.

Interoceptive Exposure + Cognitive Reappraisal + Diaphragmatic Breathing (IE + CR + DB). This condition was identical to IE + CR with the exception of an added breathing retraining component. Participants were taught DB using the instructions provided in Barlow and Craske's (2007) *MAP-4* client workbook. Participants were taught to breathe diaphragmatically while silently counting their inhalations and thinking "relax" during exhalations. Participants were informed that this technique would help them "deal with the physical symptoms produced by the overbreathing exercise." Following the *MAP-4* protocol, participants took 10 diaphragmatic breaths using the technique described previously during the rest period following each hyperventilation trial.

Expressive Writing. Participants were informed that the fear of body sensations stems from unresolved emotional issues, which create stress and persistent arousal-related body sensations. Expressive writing was described as a method of reducing stress and anxious arousal by working through unresolved emotional issues. During the treatment period, participants were asked to write for 25 min about unresolved emotional issues from their past. This duration approximated the average length of treatment for participants in the three IE conditions. Expressive writing was not expected to produce substantial reductions in AS and was used to control for the nonspecific effects of IE (e.g., expectancy).

Results

Comparisons at Baseline

There were no significant differences between study sites in participant demographics (all $ps \geq .20$) or pretest ASI-R respiratory concerns subscale scores, $t(56) = 1.58$, $p = .12$. Thus, data were collapsed across study sites. The four conditions did not differ with respect to age, $F(3, 54) = 0.39$, $p = .76$; ethnicity, $\chi^2\ (3) = 1.36$, $p = .72$; or sex, $\chi^2\ (3) = 1.73$, $p = .63$; nor did they differ on any baseline clinical measures (all $ps \leq .29$; see Table 1 for group mean scores). There were also no group differences on perceived credibility of the treatment, $F(3, 54) = 0.97$, $p = .41$; or on outcome expectancies, $F(3, 54) = 0.40$, $p = .75$. These data suggest that the randomization procedure was successful.

TABLE 1. Group Mean Scores on Clinical Measures at Pretest, Posttest, and Follow-up

	Treatment Condition							
	Control ($n = 14$)		IE only ($n = 14$)		IE + CR ($n = 15$)		IE + CR + DB ($n = 15$)	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
ASI-R respiratory								
Pretest	25.71	10.62	25.79	6.18	25.33	7.35	26.73	6.63
Posttest	19.86	10.99	15.57	8.22	14.20	5.18	14.67	8.30
Follow-up	21.29	11.54	16.38	10.99	14.13	4.36	17.47	8.48
Straw BAT HQ								
Pretest	36.36	17.10	32.57	18.16	36.73	18.38	31.27	12.58
Posttest	30.57	16.84	16.14	15.39	18.00	11.71	19.13	14.50
Follow-up	28.93	16.07	11.92	10.67	13.73	9.41	18.93	12.42
Straw BAT anxiety								
Pretest	77.79	22.67	66.38	14.30	75.40	20.61	76.87	20.43
Posttest	63.50	26.99	34.69	28.05	36.71	30.60	36.76	29.98
Follow-up	56.74	26.90	28.38	25.39	38.13	28.39	38.16	33.48
BAI								
Pretest	19.07	10.94	17.36	12.02	19.53	10.68	20.93	10.57
Follow-up	15.57	8.38	9.15	7.69	9.87	4.98	11.13	7.08

Note. IE = interoceptive exposure; CR = cognitive reappraisal; DB = diaphragmatic breathing; ASI-R = Anxiety Sensitivity Index-Revised; BAT = behavioral approach task; HQ = hyperventilation questionnaire; BAI = Beck Anxiety Inventory.

Effects of Interoceptive Exposure Versus Control

Pretest to Posttest. Group means on the study outcome measures at pretest, posttest, and follow-up are presented in Table 1. A series of 2 (condition: IE vs. control) × 2 (time: pretest vs. posttest) repeated measures of analyses of variance (ANOVAs) were used to test the hypothesis that participants in the IE conditions would evidence more improvement at posttest than those in the expressive writing condition. A significant main effect of time was observed on all outcome measures (all $ps < .01$), indicating improvement from pretest to posttest. As predicted, the time × condition interaction was significant for each outcome measure: (a) the ASI-R respiratory concerns subscale, $F(1, 55) = 7.21$, $p = .01$; (b) straw BAT HQ scores, $F(1, 55) = 5.69$, $p = .02$; and (c) straw BAT anxiety, $F(1, 55) = 7.85$, $p = .007$. In each analysis, greater improvement was observed among IE participants than those in the control group. Between-groups effect sizes (Morris & DeShon, 2002) ranged from medium to large (see Table 2). Within-group effect sizes indicated that each IE condition produced large effects on most indices of improvement.

The BAI was completed only at the pretest and follow-up. An additional 2 (condition: IE vs. control) × 2 (time: pretest vs. follow-up) repeated measures ANOVA was conducted to examine treatment effects on this measure. There was a significant effect of time, $F(1,55) = 16.95$, $p < .001$, and a marginally significant Condition × Time interaction, $F(1,55) = 3.44$, $p = .07$, indicating greater improvement for IE relative to expressive writing.

Posttest to Follow-up. To examine changes on outcome measures over the 1-week follow-up interval, we conducted a similar set of 2 (condition: IE vs. control) × 2 (time: posttest vs. follow-up) repeated measures ANOVAs. For all measures, the main effect of time was nonsignificant

TABLE 2. Within-Group and Between-Group Effect Size Estimates (*d*) for Treatment and Maintenance Phases

		Within-Group *d*			Between-Group *d*
Measure and Phase	Control	IE Only	IE + CR	IE + CR + DB	IE vs. Control
ASI-R respiratory					
Treatment	.55	1.65	1.51	1.82	1.14
Maintenance	−.13	−0.10	0.01	−0.34	−0.03
Straw BAT HQ					
Treatment	.34	0.90	1.02	0.97	0.62
Maintenance	.10	0.27	0.36	0.01	0.10
Straw BAT anxiety					
Treatment	.63	2.22	1.88	1.96	1.32
Maintenance	.25	0.22	−0.05	−0.05	−0.22
BAI					
Pretest to follow-up	.32	0.68	0.90	0.93	0.53

Note. Within-group *d* was calculated as the pretest mean minus the posttest mean divided by the pretest standard deviation (treatment phase), and the posttest mean minus the follow-up mean divided by the posttest standard deviation (maintenance phase). Negative within-group effect sizes denote change in the direction of increasing anxiety. Negative between-group effect sizes denote greater improvement in the control group than the IE conditions. IE, interoceptive exposure; CR, cognitive reappraisal; DB, diaphragmatic breathing; ASI-R = Anxiety Sensitivity Index-Revised; BAT = behavioral approach task; HQ = hyperventilation questionnaire; BAI = Beck Anxiety Inventory.

(all *ps* $\geq$ .16), indicating comparable scores at posttest and follow-up. Similarly, each ANOVA yielded a nonsignificant Time $\times$ Condition interaction (all *ps* $\geq$ .31), indicating comparable maintenance of gains across the treatment conditions.

Differential Effects of Interoceptive Exposure Conditions

Pretest to Posttest. Differential effects of the three IE conditions were explored via a series of 3 (condition: IE vs. IE + CR vs. IE + CR + DB) $\times$ 2 (time: pretest vs. posttest) repeated measures ANOVAs. Each analysis revealed a nonsignificant Condition $\times$ Time interaction (all *ps* $>$ .40), indicating no differences in the effects among the IE conditions on the ASI-R ($p = .73$), straw BAT HQ scores ($p = .47$), or straw BAT anxiety ($p = .70$). A separate 3 $\times$ 2 repeated measures ANOVA of BAI scores (pretest to follow-up) also demonstrated a nonsignificant condition $\times$ time interaction, $F(2, 41) = 0.11$, $p = .90$.

Posttest to Follow-up. A series of 3 (condition: IE vs. IE + CR vs. IE + CR + DB) $\times$ 2 (time: posttest vs. follow-up) repeated measures ANOVAs similarly revealed nonsignificant Condition $\times$ Time interactions for all outcome measures (all *ps* $\geq$ .30), indicating similar maintenance of treatment gains across the three IE conditions.

Treatment Process in Interoceptive Exposure Conditions

Pattern of Habituation. All participants in the IE-only condition met the discontinuation criterion following the eighth trial. In contrast, 11 of 15 (73.3%) participants in the IE + CR condition and 10 of 15 (66.7%) in the IE + CR + DB condition met the discontinuation criterion by trial eight. This difference was statistically significant, χ^2 (3) = 10.20, $p = .02$. Four participants in the IE + CR condition required 9, 12, 18, and 25 trials, respectively, to reach the discontinuation criterion. In the IE + CR + DB condition, five participants required 9, 11, 14, 18, and 21 trials, respectively.

Decline in Anxiety. A series of hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002) analyses were conducted to examine the pattern of improvement for participants in the IE conditions across the first eight hyperventilation trials. HLM is useful in analyzing repeated measures data (Level 1 data) nested within subjects (Level 2 data; Bryk, Raudenbush, & Congdon, 1996). HLM was used to compare the rate of improvement between the three IE conditions in self-reported ratings of anxiety, self-efficacy, and body sensations across the hyperventilation trials (depicted in Figure 1).

A two-level HLM was conducted with anxiety as the outcome variable, trial as the Level 1 predictor, and treatment group as the Level 2 predictor, with exposure only as the reference group. Initial anxiety ratings were significantly nonzero, $\beta = 76.50$, $t(346) = 8.45$, $p < .001$, with no differences between treatment conditions (*ps* $>$ .60). Anxiety significantly declined in the IE-only group, $\beta = -9.21$, $t(346) = 7.20$, $p < .001$. A priori comparisons between conditions were conducted to assess intergroup differences. These comparisons revealed no significant differences between IE + CR and IE + CR + DB in anxiety decline slope, $t(236) = -0.31$, $p = .70$, with IE + CR and IE + CR + DB each showing significant anxiety decline over the course of treatment, $\beta = -7.31$, $t(236) = -4.86$, $p < .001$ and $\beta = -6.73$, $t(236) = -6.26$, $p < .001$, respectively. Likewise, no difference was observed on anxiety decline slopes between IE and IE + CR + DB, $t(220) = -0.96$, $p = .34$. Finally, there was no significant difference in anxiety decline slopes between the IE and IE + CR conditions, $t(236) = -1.49$, $p = .14$.

Decline in Body Sensations. An identical two-level HLM was conducted, as described previously, with self-reported intensity of body sensations immediately following the hyperventilation exposure as the outcome variable. Initial level of sensations was significantly nonzero in IE only, $\beta = 88.90$, $t(346) = 14.16$, $p < .001$. No differences were observed on initial sensation between

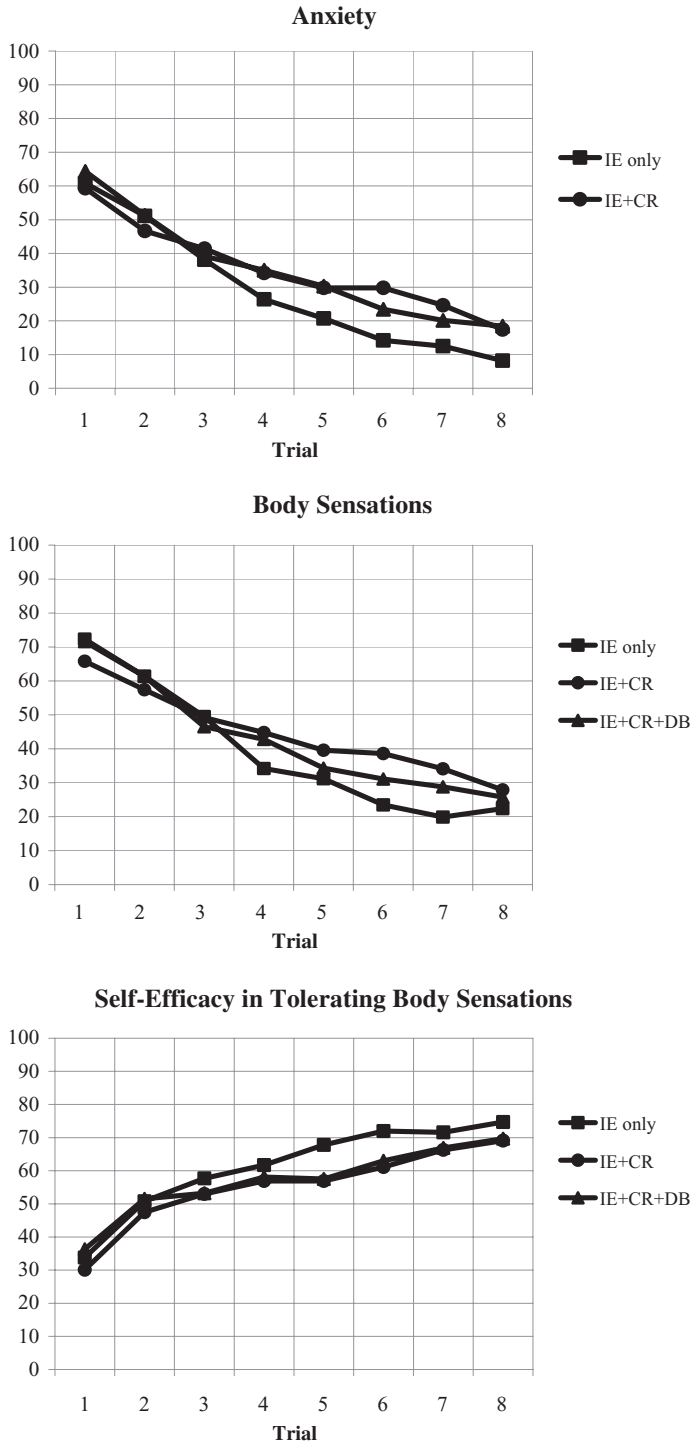

Figure 1. Change in anxiety, body sensation intensity, and self-efficacy in tolerating body sensations across the hyperventilation. IE = interoceptive exposure; CR = cognitive reappraisal; DB = diaphragmatic breathing.

groups ($ps > .45$). Sensation ratings significantly declined in the IE condition, $\beta = -9.18$, $t(346) = -7.24$, $p < .001$. This level of decline did not significantly differ from that of the IE + CR + DB group, $t(346) = 0.54$, $p = .59$. Although sensations did significantly decline in the IE + CR group, $\beta = -5.78$, $t(346) = -4.54$, $p < .001$, the sensation decline slope was marginally less steep in the IE + CR condition compared to the IE-only condition, $t(236) = 1.89$, $p < .06$. However, no differences were observed in sensation decline slope between IE + CR and IE + CR + DB ($p = .22$).

Increase in Self-Efficacy. The same two-level HLM model with self-efficacy as the outcome variable was used to assess whether self-efficacy improved across trials, and whether this change differed between IE conditions. Initial self-efficacy was significantly nonzero in IE, $\beta = 62.72$, $t(346) = 9.31$, $p < .001$, with no differences between groups ($ps > .66$). Self-efficacy significantly increased in the IE condition, $\beta = 6.81$, $t(346) = 7.03$, $p < .001$, with no between-group differences (all $ps > .10$).

Treatment Acceptability. Mean aversiveness ratings for IE only ($M = 2.07$, $SD = 1.14$), IE + CR ($M = 2.13$, $SD = 0.92$), and IE + CR + DB ($M = 1.67$, $SD = 0.82$) were in the moderate range and did not differ significantly, $F(2, 41) = 1.03$, $p = .37$. Similarly, mean acceptability ratings were in the "moderate" to "very" acceptable range for IE only ($M = 2.57$, $SD = 1.16$), IE + CR ($M = 2.93$, $SD = 0.59$), and IE + CR + DB ($M = 3.20$, $SD = 0.68$) and did not differ significantly between conditions, $F(2, 41) = 2.05$, $p = .14$. Ratings of treatment likeability did not differ significantly between conditions, $F(2, 41) = 2.44$, $p = .10$, although mean ratings were higher in the IE + CR + DB condition ($M = 2.40$, $SD = 1.18$) than the IE + CR ($M = 1.80$, $SD = 1.15$) and IE-only ($M = 1.50$, $SD = 1.02$) conditions.

Discussion

The present findings support the efficacy of intensive IE in reducing AS. Repeated trials of hyperventilation produced substantial improvement in respiratory-related AS, fearful responding to a novel BAT, and general anxiety symptoms. Improvement was maintained during the 1-week follow-up period. This pattern of results was evident regardless of whether or not IE was accompanied by CR, or the combination of CR and DB. Together, the single-session IE interventions examined in this study yielded a controlled effect size on AS exceeding that typically obtained by CBT interventions for AS observed in both clinical and nonclinical samples (Smits, Berry, Rosenfield, et al., 2008). The superior efficacy of IE for AS relative to a credible control condition in this study highlights the specificity of this treatment.

Encouraging patients to attend to and process the nonoccurrence of feared outcomes might be expected to facilitate corrective learning during exposure and produce superior outcomes (Powers et al., 2007). However, consistent with the results of Smits, Berry, Rosenfield, et al. (2008), cognitive reappraisal did not augment the benefits of IE in this study. It is possible that intensive IE alone may provide powerful disconfirmation of maladaptive appraisals of threat. Individuals with high AS typically fear that the experience of intense autonomic arousal will result in imminent catastrophe, such as loss of consciousness or suffocation. In contrast to other common fears that are less subject to immediate disconfirmation during exposure (e.g., acquisition of a disease from a potential contaminant), the nonoccurrence of feared outcomes during IE is unambiguous. As a result, formal cognitive techniques may not be necessary for patients to learn that feared outcomes are unlikely to occur during IE.

There is little evidence to support the use of breathing retraining in CBT for panic disorder (Schmidt et al., 2000). This study extends previous research by failing to demonstrate an incremental benefit of DB in the context of IE. No significant differences were evident between IE with

or without DB (and CR) on any outcome or process measure. Descriptive statistics suggested a possible (albeit nonsignificant) advantage of augmenting IE with DB and CR with respect to measures of treatment acceptability, but between-group differences on these variables were not particularly large. In contrast to the popular perception among clinicians that DB enhances patients' self-efficacy (Lickel et al., 2010), between-trial ratings of self-efficacy in tolerating body sensations failed to demonstrate any additive benefit of augmenting IE with CR and DB. Notably, we did not find any detrimental effects of augmenting IE with DB, which suggests that DB did not interfere with corrective learning in the context of our intensive IE intervention. Future research is needed to clarify the extent to which DB may serve as a potentially harmful safety behavior for some patients who undergo exposure-based CBT. At present, there appears to be little empirical evidence supporting the common practice of using DB in conjunction with IE (e.g., Barlow & Craske, 2007) in the treatment of AS and panic.

Strengths of this study include the two-stage recruitment of participants with specific fears of respiratory sensations, use of a credible expectancy control condition, assessment of treatment outcome and process variables at multiple time points, and use of a novel BAT that assessed the fear of anxiety in an untreated context. This study also has several limitations. Participants were undergraduate students with clinically elevated levels of respiratory-related AS, and this analog approach precludes direct conclusions about the effects of IE augmentation strategies among patients with panic disorder. We note that elevated AS, with or without the presence of panic attacks or panic disorder, is considered a psychological problem deserving of treatment (Smits, Berry, Tart, et al., 2008). Our single-session IE intervention is unrepresentative of the manner in which CBT is delivered in clinical practice. The techniques examined in this study may be less effective when delivered in isolation from the broader therapeutic context in which they are typically implemented. Conversely, studying IE in isolation avoids the ambiguities inherent in evaluating large treatment packages composed of diverse procedures (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). The relatively small sample size limited our ability to detect significant differences between treatment conditions. Similarly, the risk of Type I error is inflated in this study because of the large number of outcomes examined. Despite the large number of statistical comparisons between the three IE conditions in this study, only one significant finding emerged, and few efficacy analyses revealed trends that may have achieved traditional levels of significance with the inclusion of additional participants.

In summary, this study provides further support for the efficacy of intensive IE in treating AS and questions the value of augmenting this technique with CR and DB. Our findings stand in contrast to the popularity of cognitive and breathing techniques among therapists who practice IE (Lickel et al., 2010). It is possible that therapists' use of additional techniques in the context of IE reflects concerns that IE alone is lacking in one or more respects. For example, therapists may consider IE to be too aversive without the use of DB, or insufficiently powerful in eliciting cognitive change without cognitive therapy techniques. The present findings are inconsistent with these notions and suggest that IE alone is tolerable and broadly effective in reducing AS, and does not require the use of additional therapy techniques to make it so. The therapeutic benefits produced by the intensive form of IE in this study are notable given that IE is often provided in a less intensive manner by practicing clinicians (Lickel et al., 2010). For example, the *MAP-4* protocol (Barlow & Craske, 2007) prescribes the delivery of IE via a small, fixed number of exposure trials accompanied by CR, DB, and a lengthy rest period. Future studies should examine the relationship between intensity and outcome within IE. Such research may clarify the extent to which the efficacy of IE varies as a function of characteristics such as the number and duration of trials, use of concurrent arousal-reduction techniques, and the length of the between-trial rest period. Additional research in this area has the potential to improve the efficacy and acceptability of CBT interventions for AS and panic disorder.

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