Response to Hyperventilation and 5.5% CO_2 Inhalation of Subjects With Types of Specific Phobia, Panic Disorder, or No Mental Disorder

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Objective: This study tested the hypothesis that compared to other DSM-IV specific phobia types, situational specific phobias have more in common with panic disorder and agoraphobia. Method: Responses to hyperventilation and CO_2 inhalation were compared across groups of patients with the four main DSM-IV specific phobia types, a group with panic disorder, and a group of comparison subjects with no anxiety disorder (N=15 per group). Results: Although these challenges have been shown previously to distinguish patients with panic disorder from other groups, no groups differed significantly in their responses to hyperventilation. In addition, whereas the patients with panic disorder responded more to the CO_2 challenge than did the normal subjects, the specific phobia groups did not differ from one another or from the other groups on most measures. For the few CO_2 measures on which specific phobia groups differed, patients with situational and natural environment phobias showed the greatest response. Conclusions: Overall, these findings provided only limited support for the hypothesis that situational specific phobias are related to panic disorder.

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In DSM-IV, specific phobias are classified according to the following five types: animal, natural environment (e.g., heights, storms, water), blood/injection/injury, situational (e.g., flying, enclosed places, driving), and other. These types were introduced to reflect findings that specific phobias tend to covary within these types and that phobias from these types seem to differ on a variety of dimensions including age at onset, type of physiological response, and sex ratio (1, 2).

One pattern of findings that has been emphasized by some investigators (1) is the tendency for situational specific phobias to share more features with panic disorder and agoraphobia relative to other specific phobia types. In addition to the superficial similarities between situational specific phobias and panic disorder (i.e., patients with both diagnoses often avoid situations such as enclosed places, driving, and flying), the two diagnoses appear to share other features. For example, situational specific phobias and panic disorder have a similar mean age at onset (the mid-20s) (2, 3), are associated with similar physiological responses (e.g., panic attacks) to the phobic situation (4, 5), and share a relatively high level of sensation-focused apprehension (6). In addition, some investigators have reported that situational specific phobias are more likely than other phobias to begin with an unexpected panic attack (4, 7). These findings have led some researchers to suggest that situational specific phobias may be a variant of agoraphobia (1).

If situational specific phobias and panic disorder share a common underlying pathophysiology, it might be expected that they also share certain biological and psychological markers and might respond to similar treatments. Although studies have not yet tested the utility of standard treatments for panic disorder (e.g., medications, exposure to panic-related sensations) for treatment of situational specific phobias, a few studies have begun to examine the responses of individuals with different specific phobias to biological challenges that have been shown to distinguish among patients who have panic disorder and patients who have other anxiety disorders.

Numerous studies have shown that patients with panic disorder are more likely than other groups to panic during CO_2 inhalation and, to a lesser extent, during hyperventilation (8–11). Investigators have dis-

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TABLE 1. Age and Sex Composition of Study Groups With Specific Situational Phobias, Panic Disorder, or No Mental Disorder[a]

Variable	Height Phobia (N=15)	Animal Phobia (N=15)	Blood/ Injection Phobia (N=15)	Driving Phobia (N=15)	Panic Disorder (N=15)	No Mental Disorder (N=15)
Age (years)[b]						
Mean	49.07_{a}	$36.93_{b,c}$	29.40_{b}	$42.67_{a,c}$	32.47_{b}	30.87_{b}
SD	10.61	9.99	8.68	11.10	7.76	7.70
Range	28–62	21–65	18–44	19–58	24–52	20–46
Female sex[c]						
N	11	14	11	14	11	7
%	73	93	73	93	73	47

[a]Means sharing subscripts do not differ at $p<0.05$ (Tukey's test).
[b]Significant difference across groups (one-way analysis of variance: $F=9.95$, $df=5, 84$, $p<0.001$).
[c]Significant difference across groups ($\chi^2=12.48$, $df=5$, $p<0.05$).

agreed regarding the interpretation of these data. Whereas some authors have interpreted biological challenge data as supporting a biological etiology for panic disorder (8), other investigators have argued that psychological factors (e.g., perceived safety, perceived control) mediate patients' responses to these challenges and that cognitive theories of panic disorder can account for these findings (12). Regardless of which view one takes regarding the relative role of psychological and biological factors in panic induction studies, one might expect that a disorder sharing cognitive and physiological features with panic disorder should be associated with an enhanced response to challenges that are typically used to induce panic attacks in patients with panic disorder.

To test the hypothesis that situational phobias have more in common with panic disorder than do animal phobias, Craske and Sipsas (6) compared responses to hyperventilation in 19 college students reporting a fear of either snakes or spiders, nine individuals fearful of enclosed places, and 18 nonfearful individuals. As expected, the claustrophobic individuals reported greater fear during hyperventilation than did the individuals who were fearful of snakes or spiders. In another study testing a similar hypothesis (13), 15 patients with specific phobias of either the situational or the natural environment type (mostly height phobias), 13 patients with animal phobias, and 30 nonfearful individuals underwent a CO_2 inhalation challenge. Consistent with the hypothesis, those with situational/natural environment phobias tended to respond more to the challenge than did those with animal phobias.

The present study was designed to examine further the question of whether patients with different types of specific phobias can be distinguished on the basis of their responses to hyperventilation and CO_2 inhalation. Unlike previous studies, all individuals in this study were diagnosed with the use of a structured interview that has been demonstrated to reliably diagnose and differentiate the anxiety disorders. In addition, this study included groups of patients representing each of the four main types of specific phobias in DSM-IV. Finally, in addition to a group with no anxiety disorder, a group of patients with panic disorder were included for comparison with those who had specific types of phobia.

In this study, responses to hyperventilation and CO_2 inhalation were assessed among individuals with height phobias (natural environment type), driving phobias (situational type), blood/injection phobias, animal/insect phobias, panic disorder, and no mental disorder. Measures included intensity of panic symptoms, intensity of fear, similarity to typical panic attacks, presence of DSM-III-R panic attacks, and changes in discomfort ratings from baseline. In addition, early termination of CO_2 or hyperventilation challenges was examined as a measure of response to these challenges. The patients with panic disorder were expected to react most to both challenges on each measure. The subjects with no mental disorder were expected to react least on all measures. Individuals with driving phobias were expected to react more strongly to the challenges relative to the other specific phobia groups.

METHOD

Ninety participants were assigned to six groups on the basis of their DSM-III-R diagnoses. These included 60 individuals meeting the criteria for one of the following prototypical phobias selected from the DSM-IV specific phobia types: 1) animal phobia (N=15), 2) height phobia (from the natural environment type; N=15), 3) blood/injection/injury phobia (N=15), and 4) driving phobia (from the situational type; N=15). In addition, individuals suffering from panic disorder with or without agoraphobia (N=15) and individuals with no mental disorder (N=15) were assessed for this study. In the panic disorder group, three individuals reported no agoraphobic avoidance, eight had mild agoraphobia, and four had moderate agoraphobia. As shown in table 1, the groups differed significantly with respect to age and sex composition.

The participants included patients referred for treatment at the Center for Stress and Anxiety Disorders, State University of New York at Albany; individuals recruited through the media (e.g., newspaper articles, radio and television interviews); and individuals who responded to posted announcements in the community. Patients were not paid for their participation, although they were offered treatment on a sliding fee scale subsequent to their participation in the study. The nonanxious participants were friends and acquaintances (but not spouses or relatives) of the clinic patients and were paid for their participation.

The participants' diagnoses were made with the use of the Anxiety Disorders Interview Schedule—Revised (14), a semistructured interview developed to diagnose DSM-III-R anxiety disorders and associated mood disorders. In addition, the interview screens for the presence of psychotic disorders, hypochondriasis, somatization disorder, bipolar disorder, and substance abuse. In accordance with clinic policy, a small number of patients (randomly chosen) received the interview twice. For cases in which interviewers disagreed about the appropriate diagnoses, official diagnoses were determined by group consensus during a weekly consensus case conference.

The interviews were conducted by doctoral-level psychologists and senior doctoral students in clinical psychology who were required to meet strict training criteria before being certified as interviewers with the Anxiety Disorders Interview Schedule—Revised (15). A reliability study of the instrument based on 267 double interviews yielded moderate to high reliability coefficients. Of importance to the present study, kappa coefficients were 0.79 for panic disorder with and without agoraphobia and 0.82 for simple phobia (15).

Individuals with the specific phobias being studied were excluded if they met the criteria for current additional phobias from other DSM-IV specific phobia types or if they met the criteria for another anxiety disorder. Individuals in the panic disorder group were excluded if they met the criteria for a current additional anxiety disorder (even at a subclinical level). Individuals in the group with no mental disorder did not meet criteria for any current or past DSM-III-R disorders evaluated by the Anxiety Disorders Interview Schedule—Revised. Participants in the specific phobia groups were not excluded if they reported additional *subclinical* fears (providing that the fears were judged not to cause clinically significant distress and/or functional impairment).

Although participants' diagnoses were based on DSM-III-R, examination of the simple phobia criteria in DSM-III-R and the specific phobia criteria in DSM-IV suggests that the criteria have changed very little. In fact, as argued elsewhere (M. Antony et al., manuscript submitted for publication), the DSM-IV criteria are slightly *more* inclusive than those in DSM-III-R, where anxiety focused on having panic attacks precludes a diagnosis of simple phobia. Therefore, it is likely that all simple phobia patients in the present study would have met the DSM-IV criteria for a specific phobia.

Participants were required to be between the ages of 18 and 65 years and could not show any evidence of substance abuse or dependence in the past 6 months, bipolar disorder, psychosis, current suicidal ideation, or organic brain damage. In addition, individuals with certain medical conditions such as migraine headaches, hypertension, cardiovascular disease, and respiratory problems were excluded because of potential risks from the hyperventilation and CO_2 inhalation challenges. Finally, individuals were excluded if they were taking psychotropic medications on a daily basis. Medications taken on an infrequent or as-needed basis were permitted; however, participants were instructed to refrain from taking these drugs during the 12-hour period preceding the hyperventilation and CO_2 challenges. Three individuals with panic disorder reported using medications (two used alprazolam and one used diazepam) as needed. One patient with panic disorder refused the entire CO_2 procedure and therefore was replaced by another individual. Twelve individuals who terminated either or both of the challenges prematurely still continued with the remaining parts of the assessment and were included in relevant analyses (see the Results section for a discussion of these patients).

The equipment used for CO_2 inhalation in this study was identical to that used in previous studies from our center (11, 16, 17). Specifically, a premixed, compressed solution of 5.5% CO_2, 21% oxygen, and 73.5% nitrogen was housed in a gas storage tank from which the gas was led through a vinyl tube to a large rubber balloon. Between the tank and the balloon was a container partially filled with water, used to moisten the gas mixture traveling into the balloon. From the balloon, vinyl tubing carried the gas mixture to a gas mask with continuous positive air pressure, worn by the participant, at a rate determined by the individual's own breathing. In addition, a Y valve was used by the experimenter to switch between CO_2-enriched air and room air when necessary.

Throughout the procedure, heart rate, respiration rate, and partial pressure of the CO_2 (P_{CO_2}) were monitored. However, because we previously failed to find group differences on these physiological measures (11), groups were predicted to be similar on these measures.

After administration of the Anxiety Disorders Interview Schedule—Revised, biological challenges were supervised by a registered nurse who was unaware of the experimental hypotheses and participants' diagnoses. Participants were first read standard instructions for the hyperventilation and CO_2 challenges; they are reproduced verbatim elsewhere (11). To summarize, the various phases of the study were described, and specific instructions were provided for each part of the assessment. For example, for the hyperventilation phase, participants were instructed to "take deep, hard breaths, as if you are blowing up a balloon," and the experimenter demonstrated three breaths to illustrate how to hyperventilate. In addition, the instructions included information regarding the types of symptoms that might be experienced during each phase. After hearing the instructions, participants provided written informed consent, as approved by the institutional review board at the State University of New York at Albany.

Next, the physiological assessment began with a 5-minute resting baseline period, followed by 90 seconds of hyperventilation. During hyperventilation, participants were instructed to increase or decrease their breathing rate to maintain their P_{CO_2} levels at around 50% of baseline levels. After the hyperventilation phase, participants underwent a 7-minute resting recovery phase followed by 15 minutes of CO_2 inhalation and another 7-minute recovery phase. During the hyperventilation and CO_2 challenges, participants rated their anxiety level on a "subjective units of discomfort scale" of 0–8 (0=no anxiety; 8=extreme anxiety) and reported these ratings by means of an intercom to the experimenter, who was seated in the adjacent room. Discomfort scale ratings occurred every minute during baseline, every 30 seconds during the recovery phases, and every 2.5 minutes during CO_2 inhalation.

Finally, the Diagnostic Symptom Questionnaire (16, 17) was completed after hyperventilation and again after CO_2 inhalation. On the Diagnostic Symptom Questionnaire, participants rated the intensity (0–8-point scale) of each of the DSM-III-R panic attack symptoms experienced during hyperventilation and CO_2 inhalation. Fears of going crazy and of losing control were rated separately, as were faintness and dizziness, yielding a total of 15 symptoms (these symptom pairs are collapsed into single symptoms in DSM-III-R and DSM-IV). In addition, participants indicated whether they experienced a feeling of fear or panic and its intensity (0–8-point scale), as well as the similarity of these feelings to their naturally occurring panic attacks or anxiety (0–8-point scale). Finally, participants indicated which thoughts they had during the hyperventilation and CO_2 inhalation challenges from a list of six catastrophic thoughts (e.g., "I need help") and six noncatastrophic thoughts (e.g., "I feel relaxed").

The order of challenges in the study was not counterbalanced for reasons articulated in detail elsewhere (11). Because CO_2 inhalation is usually a more aversive challenge procedure than is hyperventilation, individuals are often reluctant to undergo a second challenge procedure after experiencing CO_2 inhalation. Therefore, a consistent order was chosen, with hyperventilation always administered first. Furthermore, as reviewed by Rapee et al. (11), CO_2 response appears to be similar regardless of whether individuals first undergo hyperventilation.

RESULTS

As a measure of response to the biological challenges, the frequency of requests to terminate the hyperventilation and/or CO_2 inhalation procedures early because of uncomfortable symptoms or elevated fear was considered. Overall, seven participants terminated the hyperventilation procedure early, and six terminated the CO_2 inhalation procedure early. The percentage of individuals in each group who terminated one or both challenges was as follows: animal phobia, 0%; height phobia, 27% (two participants terminated hyperventilation and two terminated CO_2); blood/injection phobia, 7% (one participant terminated hyperventilation); driving phobia, 27% (one participant terminated CO_2 and three terminated hyperventilation); panic disorder, 13% (one participant terminated CO_2 and one terminated both challenges); no mental disorder, 7% (one participant terminated CO_2). Differences between groups on this measure were not significant (χ^2=8.08, df=5).

Because we previously had failed to find differences between groups on physiological measures such as heart rate, respiration rate, and P_{CO_2} during similar biological challenges (11), the groups were not expected to differ on these measures in the present study. Nevertheless, we examined group differences on each of these variables during hyperventilation and during CO_2 inhalation with analyses of covariance, using rest-

TABLE 2. Responses of Subjects With Specific Situational Phobias, Panic Disorder, or No Mental Disorder During Hyperventilation

	Height Phobia (N=15)		Animal Phobia (N=15)		Blood/Injection Phobia (N=15)		Driving Phobia (N=15)		Panic Disorder (N=15)		No Mental Disorder (N=15)	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Intensity of physical symptoms	0.85	0.56	1.16	1.27	0.92	0.75	0.83	0.77	1.34	0.79	0.39	0.31
Intensity of cognitive symptoms	0.15	0.33	0.36	0.65	0.13	0.28	0.36	0.70	0.33	0.65	0.00	0.00
Number of catastrophic cognitions	0.80	0.94	1.40	1.99	0.73	1.57	0.53	0.99	1.33	1.54	0.06	0.26
Similarity to natural panic[a]	1.93	2.55	1.87	2.29	1.53	1.25	1.93	1.58	3.00	1.93	1.20	2.11
Intensity of fear/panic[a]	1.87	2.39	1.60	2.10	0.73	1.62	1.93	2.74	1.80	1.70	0.13	0.52
Change in discomfort scale score	2.43	2.06	1.67	1.11	1.93	1.27	1.13	1.68	2.57	1.34	1.00	1.41

[a]Scale of 0–8.

TABLE 3. Subjects With Specific Situational Phobias, Panic Disorder, or No Mental Disorder Who Reported Experiencing Panic Attacks (Liberal or Conservative Definition) During Hyperventilation and CO_2 Inhalation

	Height Phobia (N=15)		Animal Phobia (N=15)		Blood/ Injection Phobia (N=15)		Driving Phobia (N=15)		Panic Disorder (N=15)		No Mental Disorder (N=15)	
Study Condition	N	%	N	%	N	%	N	%	N	%	N	%
Liberal definition of panic												
Hyperventilation	2	13.3	4	26.7	2	13.3	3	20.0	3	20.0	0	0.0
CO_2 inhalation[a]	6	40.0	4	26.7	3	20.0	4	26.7	11	73.3	1	6.7
Conservative definition of panic												
Hyperventilation	0	0.0	2	13.3	1	6.7	2	13.3	0	0.0	0	0.0
CO_2 inhalation	3	20.0	2	13.3	1	6.7	3	20.0	6	40.0	0	0.0

[a]Significant difference across groups in frequency of panic attacks (χ^2=17.95, df=5, p<0.01), reflecting the difference between subjects with panic disorder and those with no mental disorder.

ing levels of a corresponding variable as a covariate. As predicted, the groups did not differ with respect to P_{CO_2} and heart rate during either challenge. Nor did they differ with respect to respiration rate during the CO_2 inhalation challenge. However, group differences did emerge with respect to respiration rate during hyperventilation, which ranged from 42.85 breaths per minute (panic disorder) to 66.04 breaths per minute (animal phobia) (F=4.28, df=5, 80, p<0.01). This difference probably reflected differences in compliance with the hyperventilation instructions rather than differences in the response to these challenges.

Hyperventilation

To examine subjective response to hyperventilation, a multivariate analysis of variance (MANOVA) was conducted to compare groups on the following measures: mean intensity of Diagnostic Symptom Questionnaire cognitive symptoms (e.g., fears of dying, going crazy); mean intensity of Diagnostic Symptom Questionnaire physical symptoms (e.g., dizziness, pounding heart, breathlessness); number of catastrophic cognitions endorsed on the Diagnostic Symptom Questionnaire; intensity of fear during hyperventilation (from the Diagnostic Symptom Questionnaire); similarity to naturally occurring panic/anxiety (from the Diagnostic Symptom Questionnaire); and differences in discomfort scale ratings between the point immediately after hyperventilation and resting levels. Because baseline discomfort scale scores may have been influenced by anticipatory anxiety, and groups tended to differ with respect to baseline scores (F=6.04, df=5, 84, p<0.001), the last discomfort scale rating during the CO_2 recovery phase was used to estimate resting levels, as was done in our previous research (11).

Because collinearity (i.e., r>0.80) (18) was not evident for any two measures, all measures were included in the MANOVA. Using Wilks's lambda statistic, we found that the overall MANOVA was nonsignificant (F=1.23, df=30, 372), and no further tests were conducted on these measures. Results of the response measures during hyperventilation are presented in table 2.

To examine the occurrence across groups of DSM-III-R panic attacks during hyperventilation, chi-square tests were conducted in which liberal and conservative definitions of panic were used, as described by Rapee et al. (11). Although the conservative definition is probably a more accurate definition for panic (19), the liberal definition was included to be consistent with previous biological challenge studies. A panic attack was defined as the occurrence of four or more panic symptoms (from the Diagnostic Symptom Questionnaire), at least one of which was a cognitive symptom. In addition, the liberal definition required a Diagnostic Symptom Questionnaire fear intensity rating of 1 or more on the 0–8-point scale. The conservative definition of panic was identical, except that a fear intensity rating of 5 or more was required. As shown in table 3, the groups did not differ during hyperventilation with re-

TABLE 4. Responses of Subjects With Specific Situational Phobias, Panic Disorder, or No Mental Disorder During CO_2 Inhalation[a]

Measure	Height Phobia (N=15)		Animal Phobia (N=15)		Blood/ Injection Phobia (N=15)		Driving Phobia (N=15)		Panic Disorder (N=15)		No Mental Disorder (N=15)		Analysis	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F (df=5, 84)	Effect Size (η^2)
Intensity of physical symptoms	$1.58_{a,b}$	1.22	$1.57_{a,b}$	1.50	$1.09_{a,b}$	0.93	$1.28_{a,b}$	0.92	2.04_{a}	1.28	0.51_{b}	0.43	3.35**	0.17
Intensity of cognitive symptoms	0.91	1.60	0.78	1.90	0.22	0.43	0.42	0.80	1.18	0.99	0.04	0.17	2.13	0.11
Number of catastrophic cognitions	$1.87_{a,b}$	1.55	$1.60_{a,b}$	1.99	0.93_{b}	1.58	$1.27_{a,b}$	1.33	2.67_{a}	1.91	0.47_{b}	0.92	3.49**	0.17
Similarity to natural panic[b]	$2.93_{a,b,c}$	2.71	$1.80_{b,c,d}$	1.74	$1.60_{b,c,d}$	1.30	$3.07_{a,b,c}$	2.28	4.47_{a}	1.88	0.80_{d}	1.70	6.49***	0.28
Intensity of fear/panic[b]	$3.00_{a,b}$	2.83	$2.33_{a,b}$	2.77	1.47_{b}	1.81	$2.67_{a,b}$	2.53	4.53_{a}	2.53	0.73_{b}	1.45	4.57**	0.21
Change in discomfort scale score	$2.70_{a,b}$	1.99	$2.09_{a,b}$	1.80	$1.60_{a,b}$	1.13	$1.84_{a,b}$	1.96	3.19_{a}	1.25	1.34_{b}	1.34	2.65*	0.14

[a]Means sharing subscripts do not differ at $p<0.05$ (Tukey's test).
[b]Scale of 0–8.
*$p<0.05$. **$p<0.01$. ***$p<0.001$.

spect to panic frequency with use of the liberal definition ($\chi^2=4.74$, df=5, n.s.) or the conservative definition ($\chi^2=6.14$, df=5, n.s.).

CO_2 Inhalation

To examine the subjective response to CO_2 inhalation, a MANOVA was conducted to compare groups on the same measures used in the analyses of response to hyperventilation. Because collinearity was not evident for any two measures, all measures were included in the MANOVA. Using Wilks's lambda statistic, we found the overall MANOVA to be significant (F=1.52, df=30, 372, $p<0.05$), and we followed it with univariate analyses of variance (ANOVAs). Significant ANOVAs were in turn followed by Tukey's test.

As indicated in table 4, the groups differed significantly on all measures except intensity of cognitive symptoms, for which differences approached significance ($p<0.07$). For some measures (i.e., intensity of physical symptoms, changes in discomfort scale ratings), overall significant findings reflected differences between participants with panic disorder and those with no mental disorder; specific phobia groups did not differ from one another or from either of the other two groups. However, this pattern differed for three of the measures. Patients with blood/injection phobias reported significantly lower levels of fear and significantly fewer catastrophic cognitions than did patients with panic disorder. In addition, patients in the driving and height phobia groups rated the experience as more similar to naturally occurring anxiety than did participants with no mental disorder. Individuals with animal phobias, blood/injection phobias, and no mental disorder rated the experience as significantly less similar to naturally occurring anxiety than did patients with panic disorder.

To examine the frequency across groups of DSM-III-R panic attacks during CO_2 inhalation, chi-square tests were conducted in which the liberal and conservative definitions of panic were used, as described earlier. As shown in table 3, the groups differed in panic frequency when a liberal definition of panic was used. Follow-up tests with Goodman's simultaneous confidence interval schedule (20) did not yield significant differences between any two groups, although the difference between the panic disorder and no mental disorder groups approached significance ($p<0.10$). Group differences approached significance when the conservative definition was used ($\chi^2=10.31$, df=5, $p<0.07$), with a higher percentage of panic disorder patients (40%) than subjects with no mental disorder (0%) reporting panic attacks.

DISCUSSION

This study provided only partial support for the hypothesis that specific phobias from the situational type share more features with panic disorder than do other specific phobia types. Consistent with previous studies, individuals with panic disorder responded more to CO_2 inhalation than did participants in the group with no mental disorder. However, specific phobia types did not differ from one another or from either of the other two groups on most CO_2 challenge measures. For the few measures on which they did differ (number of catastrophic cognitions, intensity of fear, similarity to naturally occurring panic/anxiety), differences were in the predicted direction, with driving phobia associated with responses more similar to those of panic disorder patients. However, this pattern was also found for patients with height phobia, raising the possibility that height phobia might be better classified as a type of situational phobia. This is consistent with other recent findings showing that in comparison with other phobia types, individuals with height phobias share several features typically associated with panic disorder, including more intense cognitive panic symptoms during expo-

sure to the phobic situation, more sensation-focused apprehension, and an older age at onset (17). In addition, factor analytic studies have often found that height phobias tend to cluster with the situational phobias (21, 22).

Despite our previous finding (11) that patients with panic disorder show a stronger subjective response to hyperventilation challenges than do patients with other anxiety disorders and nonanxious individuals, the present study found no differences among groups on measures of response to hyperventilation. One explanation is the possibility that the panic disorder patients in this study had milder symptoms than the subjects in our previous research. This may have occurred for two reasons. First, patients with additional anxiety disorders were excluded from the present study, whereas patients in the Rapee et al. study (11) were not excluded for having multiple diagnoses. Presumably, patients with several additional diagnoses might have had more severe levels of pathology, as has been reported in previous studies (23). Second, patients taking psychotropic medications were excluded in the present study but not in the study by Rapee et al. Data from our center suggest that patients with panic disorder who are taking medications tend to have more severe symptoms than those who are not taking medications (24).

Another explanation for the lack of differences on hyperventilation measures is the possibility that hyperventilation is not a reliable way of inducing panic, relative to other methods. A variety of studies have shown that differences between individuals with and without panic disorder on measures of panic during hyperventilation challenges are considerably weaker than similar findings for CO_2 challenges (8, 9, 11). In addition, individuals in the group who had panic disorder appeared to be less compliant with the hyperventilation instructions than were the other groups (i.e., they were breathing at a slower rate during the hyperventilation phase).

Several additional factors may have blurred the differences between specific phobia types in this study. For example, although subjects with each specific phobia type were not permitted to meet criteria for another clinically significant phobia, they were not excluded for having additional subclinical fears. To the extent that these fears were associated with responses to hyperventilation and CO_2 inhalation, this may have made it more difficult to detect group differences on these measures.

In addition, to the extent that sex and age affect response to hyperventilation and CO_2 challenges, group differences on these measures may have affected the findings. Patients with height and driving phobias tended to be older than individuals in the other groups. This is likely because of the older age at onset associated with these phobias (M. Antony et al., manuscript submitted for publication). In addition, individuals in the no mental disorder group had a relatively even ratio of men to women, whereas the other groups were predominantly female. It is not clear whether these differences may have affected the results; however, no previous studies have reported effects of age or sex on response to biological challenges.

Finally, a variety of methodological issues may have affected the results of this study. For example, as in previous studies, our measures of response to the challenges were mostly subjective and therefore may not have adequately assessed response to hyperventilation and CO_2 inhalation. Also, small group sizes relative to those in the Rapee et al. study (11) may have limited the power to detect significant differences for some analyses.

Addressing this issue, the relatively small effect sizes for most of the CO_2 analyses suggest that the lack of significant differences among specific phobia types reflected a true lack of discrepancies among population means. Furthermore, group sizes in the present study were similar to those in other studies using biological panic challenges in patients with specific phobias (1, 13). Finally, the power estimate for the MANOVA on variables measuring response to hyperventilation was 0.85, suggesting that there was enough power to detect significant findings. Similarly, power estimates for the univariate analyses of response to CO_2 were almost all above 0.80, confirming that group size was probably adequate for these analyses.

Nevertheless, it is likely that with a larger study group, additional group differences might have been detectable, particularly between the panic disorder patients and those in the other groups. For example, differences in the occurrence of conservatively defined panic attacks during CO_2 inhalation would probably have been significant with more participants.

The typing of specific phobias in DSM-IV was based on literature reviews of studies that were not developed to specifically test typing schemes. Thus, studies prospectively testing the validity of typing schemes on a variety of markers may be important in attempts to untangle the core features of these heterogeneous conditions. Therefore, additional studies along the lines of the present one should be forthcoming.

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