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Effects of exposure in single and multiple contexts on fear renewal: The moderating role of threat-specific and nonspecific emotionality

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ABSTRACT

Background and objectives: The current study examines effects of exposure in multiple contexts on fear reduction and renewal and the moderating effect of baseline threat-specific and nonspecific emotionality.
Methods: Snake-fearful participants received a negative or neutral emotion induction and were randomized to video exposure to a snake in a single context, multiple context, or a no exposure control group.
Results: Anxiety in response to video presentations of a snake was significantly reduced in the two exposure groups compared to the control group, especially among those with heightened baseline threat-specific emotionality as indicated by snake anxiety ratings at baseline. Although the two exposure groups did not differ in responding when confronted with a novel snake, both exposure groups reported significantly lower snake anxiety and arousal than the control group. Subsequent analysis did show that compared to controls, the single context group demonstrated greater increase in anxiety and arousal from post-exposure to exposure to the novel snake among those with heightened snake anxiety at baseline. Furthermore, the multiple context group was less avoidant and less fearful than the single context group on a post-exposure behavioral test.
Limitations: The study used an analogue exposure paradigm with an analogue sample and findings may not be generalizable to a clinical population.
Conclusions: These findings suggest that baseline threat-specific emotionality influences fear reduction and renewal. The benefits of exposure in multiple contexts are discussed in relation to a distinct pattern of symptom change that is in line with an inhibitory learning approach.

1. Introduction

According to Rachman (1989, 1990), return of fear is the reappearance of fear that has undergone full or partial extinction and estimates of return of fear following exposure therapy for anxiety-related disorders range from 19% to 62% (Craske & Mystkowski, 2006). Evidence for the renewal effect has been observed in animal models. For example, the renewal effect occurs if rats undergo conditioning in one context, extinction in a second context, and are tested in a third context (ABC renewal; Bouton & Bolles, 1979). Context renewal has also been demonstrated in laboratory studies with human samples (Vansteenwegen et al., 2005). For example, Mystkowski, Craske, and Echiverri (2002) demonstrated that while exposure therapy significantly decreased fear of spiders from pre-to post-treatment, renewal effects were found when the one week follow-up test occurred in a context different from the exposure context. Similarly, Vansteenwegen et al. (2007) demonstrated that although spider fear was significantly reduced following repeated exposure to spiders, significant renewal of fear was found when participants were exposed to a spider in a new location.

The renewal effect highlights why learning that occurs in the therapy setting often does not generalize to other contexts (Vervliet, Craske, & Hermans, 2013). For example, if a snake phobic individual acquires the phobia in one setting (e.g., backyard), but is given exposure therapy in a single different setting (e.g., therapy office), fear may return if a snake is encountered in a context different to that presented during exposure therapy (Mineka, Mystkowski, Hladek, & Rodriguez, 1999). According to Finlay and Forsyth (2009), one possible reason why anxious patients show

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significant elevations in subjective fear in new contexts is that the settings wherein fears are acquired are almost always different from where they are treated with exposure-based therapies, which in turn, are distinct from many settings for follow-up assessment sessions. A change in context may signal a change in the fear eliciting functions of the conditioned stimulus, including perceptions of uncertainty, unpredictability, or uncontrollability. Given the effects of contextual change on enhancing return of fear, one solution may be to conduct exposure therapy in multiple contexts so that extinction memories can be activated by multiple contexts. Conducting exposure in multiple contexts is consistent with an inhibitory learning approach (Craske et al., 2008). Inhibitory learning refers to the observation that fear associations are not removed during extinction, but rather new learning about the feared stimulus occurs and competes with the old fear learning.

Animal studies have shown that extinction in multiple contexts attenuates the renewal effect (Laborda & Miller, 2013). However, this has not been an entirely consistent finding (Bouton et al., 2006). Inconsistent findings have also been observed with human studies. For example, Neumann, Lipp, and Cory (2007) examined ABA renewal in humans by using a fear conditioning procedure with an unpleasant shock US. Although a renewal of shock expectancy was found, it persisted when conducting extinction in multiple contexts. One interpretation of this literature is that some processes may moderate the extent to which exposure in multiple contexts effectively attenuates the renewal effect (Vervliet et al., 2013). One potential moderator that has received relatively little attention is the degree of negative emotionality before exposure. There is a large body of research showing that threat-specific emotional arousal during the initial phases of treatment is a core component of emotional processing that facilitates better outcome after treatment (Foa & Kozak, 1986). However, nonspecific negative emotional arousal during the initial phases of treatment may result in negative treatment outcomes (Forbes, Creamer, Hawthorne, Allen, & McHugh, 2003; Speckens, Ehlers, Hackmann, & Clark, 2006). Negative emotionality may also facilitate fear renewal. Consistent with this view, Rodriguez, Craske, Mineka, and Hladek (1999) found that high pretreatment general negative emotionality significantly predicted increased return of fear among spider fearful individuals. However, the extent to which pre-exposure emotionality that is threat-specific predicts fear renewal remains unclear.

The present study sought to replicate and extend the literature on the effects of exposure in multiple contexts on fear renewal. Though contextually based fear renewal has been observed in clinical samples, the extant work is characterized by inconsistent findings (Neumann et al., 2007), including a limited range of measures of fearful responding and failure to examine the moderating effect of baseline threat-specific and nonspecific emotionality. Accordingly, the present study examines the effects of exposure in multiple contexts among snake phobic participants on fear renewal as indexed by verbal and behavioral outcomes. It was predicted that relative to those receiving exposure in a single context and a no exposure control condition, those receiving exposure in multiple contexts will report significantly less anxiety and arousal during exposure to a novel threat cue. Those receiving exposure in multiple contexts were also predicted to display less fear and avoidance during a subsequent behavioral avoidance task. It was also predicted that exposure in a single context will be associated with a linear decline in anxiety whereas exposure in multiple contexts is predicted to be characterized by symptom reduction that does not decline smoothly from one trial to the next. Exploratory analyses were also conducted to examine the extent to which fear reduction and renewal is influenced by threat-specific and nonspecific emotionality. Threat-specific emotionality was defined by baseline anxiety ratings to the treat-relevant stimuli and nonspecific emotionality was defined by a mood induction that elicits a wide range of negative emotions, including disgust, fear, anger, and sadness.

2. Methods

2.1. Participants

Undergraduate courses at a southern university in the United States were screened and those scoring at least 1 SD above their respective gender mean ($n = 108$) on the *Fear of Snakes Questionnaire* (FSQ; Milosevic & Radomsky, 2008) were selected for participation.

2.2. Materials

The *FSQ* (Milosevic & Radomsky, 2008) is an 18-item measure of snake-related fears, preoccupation, and vigilance. The α-coefficient for the FSQ was 0.92 in the present study.

The *Anxiety Disorders Interview Schedule for the DSM-IV* (ADIS-IV; DiNardo, Brown, & Barlow, 1994) is a structured clinical interview used to diagnose anxiety disorders using DSM-IV criteria. The interview also provides ratings for *Fear*, *Avoidance*, and *Distress*. For the present study, the ADIS-IV specific phobia module was used to determine the presence/absence of snake phobia.

The *State-Trait Anxiety Inventory-Trait version*, *Form Y* (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) is a 20-item scale that measures the stable (trait) propensity to experience anxiety. The alpha coefficient for the STAI-T was 0.93 in the present study.

The *Disgust Scale-Revised* (DS-R; Olatunji et al., 2007) is a 25-item questionnaire assessing sensitivity to a range of disgust elicitors, including core, animal-reminder, and contamination disgust. The DS-R had an alpha coefficient of 0.89 in the present study.

The *Modified Differential Emotions Scale* (*MDES*; Gross & Levenson, 1995) was used to examine the effectiveness of the nonspecific threat emotion induction. The *MDES* consists of eight emotion items that corresponds to an emotion and is preceded by the phrase "I feel …": (1) amused, joyful, merry; (2) angry, irritated, mad; (3) contented, satisfied, comfortable; (4) disgusted, nauseated, repulsed; (5) fearful, scared, afraid; (6) neutral, impartial, disinterested; (7) sad, downhearted, blue; and (8) surprised, amazed, astonished. Participants rated the intensity of their response on a 9-point scale where 0 = "Do not feel the slightest bit of the emotion" and 8 = "The most I have ever felt in my life."

2.3. Nonspecific threat emotion induction

A video montage that consisted of six distinct 60s video clips containing either neutral (waterfalls) or negative (people vomiting; Viar-Paxton & Olatunji, 2012) content was used. The clips were followed by a blank screen inter-trial interval (ITI) of random durations (15s, 45s, or 75s).

2.4. Repeated exposure trials

A 29-min video montage comprised of 14 60s clips interspersed with 60s black screen ITIs was presented to participants (see Fig. 1). There were 3 versions of this video montage, each containing 3 common intervention anchor trials (pre, post, novel). Anchor trials 1 (pre) and 2 (post), represents 'context A', which is a clip of a snake slithering through the desert during the daytime. Anchor trial 3 (novel) presents participants with a new context, D, which depicts a sidewinder snake slithering through the desert at nighttime. Apart

Mood Induction	Exposure Context	Pre Exposure1	Exposure Trials										Post Exposure2	Novel Exposure3
Nonspecific Threat or Neutral	Control	Snake in Context **A**	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Context **A** without Snake	Snake in Context **A**	Snake in Context **D**
	Single	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **A**	Snake in Context **D**
	Multiple	Snake in Context **A**	Snake in Context **C**	Snake in Context **C**	Snake in Context **A**	Snake in Context **B**	Snake in Context **C**	Snake in Context **A**	Snake in Context **B**	Snake in Context **B**	Snake in Context **C**	Snake in Context **A**	Snake in Context **A**	Snake in Context **D**

Fig. 1. Course of the different trials during the experiment for the three exposure groups: control, single, and multiple.

from these commonalities, the 3 video montage versions varied with respect to the context in which snakes were presented between the anchor clips. The multiple context version presented snakes in 3 different scenarios (A - desert daytime; B - on a car; C - in a toilet) and the order of exposures to the 3 different scenarios was based on previous research using a similar design (Vansteenwegen et al., 2005; Viar-Paxton & Olatunji, 2012); the single context version presented the snake only in context A; the control version presented only context A without the snake. During the 60s ITI, participants responded to two questions regarding the content of the previous clip: 1) "How anxious did that last clip make you feel?" and 2) "How arousing was that last clip?" Participants responded on a scale from 0 ("not at all") to 100 ("extremely").

2.5. Post exposure behavioral avoidance task

A Behavioral Avoidance Task (BAT) with four steps increasing in difficulty was utilized to assess snake avoidance. Participants were presented with a cloth-covered habitat containing a snake (in reality, a fake snake they were led to believe was real). Participants were asked to: 1) "Look at the snake," 2) "Approach the snake habitat and snake," 3) "Open the snake habitat," and 4) "Touch the snake." In addition to recording if they completed a given step of the task, participants were also asked to assess their agreement with the following statement: 1) "This task made me feel afraid" on an 11-point scale ranging from 0 ("not true at all") to 10 ("very true").

2.6. Procedure

Participants completed the FSQ in undergraduate psychology courses, after which they were asked to volunteer for further testing in exchange for research credit. After obtaining written, informed consent, clinical phobic status was determined by a structured diagnostic interview adapted from the specific phobia section of the ADIS-IV. Participants then completed the STAI-T and DS-R. Participants were then randomized to a nonspecific threat emotion induction or a neutral emotion induction after which the MDES was completed. Participants were then randomly assigned to one of three exposure context conditions: multiple, single, or control, all of which shared common anchor trials (pre, post, novel; see Fig. 1). After the exposure trials, participants completed the BAT.

2.7. Data analytic overview

Because the functional form of change over trials differed greatly among the three exposure conditions the primary tests of the effects of the experimental manipulation were focused analyses on the *post-exposure* and *novel* trials. An Emotion (nonspecific emotion induction/neutral induction) X Exposure Context (single/multiple/no-exposure control) analysis of covariance (ANCOVAs) was conducted on anxiety and arousal. Participants' self-reported anxiety and arousal on pretrial 1 were used as covariates given the strong linear relation between affective responses on the initial trial and other time points.[1] Self-reported anxiety and arousal on pretrial 1 were also used as the measure of threat-specific emotionality. Accordingly, interactions between the experimental conditions and pre-exposure values were examined. Using an approach outlined by Huitema (2011), an omnibus test of parallelism was first conducted. When parallelism was not rejected on the omnibus test, an omnibus ANCOVA was conducted including all

[1] In such cases an ANCOVA approach is typically more powerful than other analytic alternatives (e.g., Huitema, 2011; Maxwell & Delaney, 2004).

Table 1
Descriptive characteristics of participants in the nonspecific threat and neutral emotion induction as a function of exposure context.

Experimental condition	Nonspecific threat induction-single context ($n = 17$)	Nonspecific threat induction-multiple context ($n = 19$)	Nonspecific threat induction-control context ($n = 17$)	Neutral induction-single context ($n = 18$)	Neutral induction-multiple context ($n = 19$)	Neutral induction-control context ($n = 18$)
Age	19.29 (1.21)	19.26 (1.19)	19.11 (1.36)	19.16 (1.20)	18.49 (1.10)	19.61 (1.09)
% Female	82.4	63.2	76.5	66.7	73.7	66.7
FSQ	94.29 (21.18)	88.31 (19.30)	101.29 (16.04)	94.38 (19.37)	93.66 (15.17)	95.66 (20.05)
ADIS-IV						
Fear	5.82 (1.66)	5.47 (1.21)	6.05 (1.02)	5.94 (1.39)	5.84 (0.95)	6.11 (1.18)
Avoidance	6.41 (1.97)	6.52 (1.83)	6.82 (1.66)	6.55 (1.58)	7.05 (1.17)	7.22 (1.11)
Distress	3.52 (2.60)	2.68 (1.73)	3.82 (2.37)	3.83 (1.82)	2.89 (2.62)	2.94 (2.18)
STAI-T	44.52 (10.22)	41.84 (8.33)	46.41 (11.79)	43.55 (9.20)	45.05 (11.49)	44.11 (11.25)
DS-R	61.88 (15.52)	55.94 (11.24)	58.47 (15.57)	58.05 (17.28)	59.16 (11.43)	53.22 (18.21)

Note. FSQ = Fear of Snakes Questionnaire, ADIS-IV = Anxiety Disorders Interview Schedule for the DSM-IV, STAI-T = State-Trait Anxiety Inventory-Trait version, DS-R = Disgust Scale-Revised.

groups and conducted pairwise contrasts of adjusted means using the Fisher LSD procedure. When the omnibus test of parallelism was significant, follow-up parallelism tests were conducted comparing pairs of groups (e.g., single vs. multiple). When a significant covariate by exposure group was indicated for a specific pair of groups, Johnson-Neyman (JN; Johnson & Neyman, 1936) tests were employed to demarcate the range of values on the pre-exposure covariate on which the groups significantly differed.[2] Although pre exposure (trial 1) denotes the initial trial of the actual exposure sequence, we refer to trial 1 in the text below as 'pre-exposure' for the sake of brevity and clarity. Linear mixed effects models were specified within the two exposure conditions to evaluate the functional form of change in anxiety across exposure trials 1–13. Consistent with habituation, it was predicted that the single context condition would be associated with a uniform pattern of decline characterized by a single (i.e., global) polynomial function (e.g., linear, quadratic or cubic) imposed across all trials. Conversely, it was predicted that the multiple context condition would require specification of three separate habituation processes corresponding to each of the three stimuli to which participants were exposed. To test this hypothesis, piecewise polynomials (linear, quadratic, and cubic) were linked to each of the three contexts (A, B, and C). The contrast codes used for a give context were only non-zero on the trials on which the relevant film clip appeared. The contrast codes used for a give context were only non-zero on the trials on which the relevant film clip appeared. Thus, for example, the linear code for clip C was 3,2,1,0 on trials 2,3,6, and 11 (the trials on which C occurred) and 0 for all other trials. In addition, trials 2,3,6, and 11 received a unique intercept term (a constant value = 1) that took into account possible differential elevation of responses to the three stimuli and differentiated trial 11 from the other (non-C) trials that received a 0 code on the linear term. Using the same principles, intercept and slope terms were specified for contexts 'A' and 'B'. The fits of the piecewise models were compared to each other and to models that specified global polynomial functions identical to those imposed in the single context condition or a combination of piecewise and global polynomials. In addition, fit to a saturated mode in which a unique parameter estimated the mean for each of the thirteen trials were compared in both the single and multiple context conditions.

Maximum likelihood (ML) was used for estimation and general *F* statistics were used for tests of fixed effects. An autoregressive moving average (ARMA) (1,1) model was used to model the covariance structure of the repeated measures. Alternative models were compared using likelihood ratio (LR) tests in the case of nested models. However, because the specific codes used to denote piecewise polynomials resulted in some models that were not nested when compared to global polynomials, the Akaike Information Criterion (AIC) (Akaike, 1973) was used for model selection.

3. Results

3.1. Participant characteristics and group randomization check

The average age of the participants was 19.22 years ($SD = 1.19$), and 71% of the participants were female. Sixty-seven percent of the participants met full diagnostic criteria for snake phobia according to the specific phobia module of the ADIS-IV (DiNardo et al., 1994). Age and gender did not differ significantly among the groups ($p > 0.05$, see Table 1). No significant differences were observed between the groups on the symptom measures (see Table 1).

3.2. Nonspecific threat emotion induction manipulation check

As shown in Table 2, those assigned to the nonspecific threat induction condition reported feeling significantly more anger, disgust, fear, and sadness than the neutral condition. Those assigned to the nonspecific threat induction condition also reported feeling significantly less amused, content, and neutral than those in the neutral condition. Thus, the manipulation was successful.

3.3. Effect of nonspecific threat induction and exposure context on anxiety and arousal

Table 3 shows the observed means for anxiety and arousal levels at the pre-exposure (trial 1), post-exposure (trial 13) and novel trial

Table 2
Means (SD's) and F-values of the modified differential emotion scale (MDES) by emotion induction condition.

State affect	Emotion induction condition		*F*-value
	Nonspecific threat	Neutral	
Amused, joyful, merry	0.98 (2.06)	3.09 (2.03)	28.26**
Angry, irritated, mad	3.30 (2.55)	0.84 (1.68)	34.12**
Contented, satisfied, comfortable	0.94 (1.58)	4.20 (2.15)	79.03**
Disgusted, nauseated, repulsed	5.67 (2.14)	0.45 (1.23)	236.22**
Fearful, scared, afraid	2.35 (2.19)	0.88 (1.77)	14.43**
Neutral, impartial, disinterested	2.50 (2.27)	4.26 (2.47)	14.44**
Sad, downhearted, blue	1.35 (1.53)	0.62 (1.43)	6.52*
Surprised, amazed, astonished	2.24 (2.29)	1.62 (2.02)	2.19

Note: *$p < 0$ 02, **$p < 0.001$.

[2] Because simultaneous confidence intervals for the JN procedure that cover an infinite range of points can be rather wide and thus notably decrease power to detect effects, we set alpha levels to 0.05 on a point-wise basis.

Table 3
Self-reported anxiety and arousal for the snake clip at the beginning of extinction (pre), at the end of extinction (post), and in a new context (novel) by emotion induction and exposure context condition.

Experimental condition	Nonspecific threat induction-single context	Nonspecific threat induction-multiple context	Nonspecific threat induction-control context	Neutral induction-single context	Neutral induction-multiple context	Neutral induction-control context
Anxiety						
Pre	55.82 (31.99)	39.44 (28.51)	58.11 (25.02)	47.50 (31.44)	48.70 (25.84)	56.38 (26.66)
Post	14.70 (21.02)	21.72 (25.15)	48.23 (31.37)	10.83 (20.59)	15.64 (19.68)	50.72 (29.09)
Novel	50.29 (30.23)	39.83 (30.57)	59.47 (32.69)	45.16 (31.95)	42.58 (28.39)	63.61 (28.63)
Arousal						
Pre	58.52 (29.24)	36.61 (25.58)	46.29 (27.77)	41.94 (31.20)	49.00 (28.74)	54.44 (25.37)
Post	12.58 (19.94)	18.50 (22.20)	47.58 (32.27)	7.16 (17.87)	14.29 (19.17)	47.77 (27.18)
Novel	48.52 (29.08)	37.83 (29.46)	63.41 (30.83)	42.50 (32.95)	41.64 (28.21)	58.05 (27.01)

(trial 14). Examination of the 2 (Emotion Induction; Neutral, Nonspecific Threat) x 3 (Exposure Context: Control, Single, Multiple) ANCOVA revealed no main effects or interactions involving emotion induction and exposure conditions on pre-exposure anxiety (all *ps* > 0.20) or arousal (all *ps* > 0.07).

3.3.1. Post-exposure

The omnibus test of homogeneity of regression slopes indicated a significant exposure context X pre-exposure interaction on post-exposure anxiety, $F(2,93) = 7.37$, $p < 0.005$, and post-exposure arousal, $F(2,93) = 9.46$, $p < 0.0005$. Follow-up pairwise parallelism tests indicated that homogeneity of regression lines was *not* rejected for the comparison between the single and multiple context groups on anxiety [($F(1,96) = 1.88$, $p > 0.15$) and arousal ($F(1,96) = 2.75$, $p > 0.09$). The ANCOVA indicated that the single context group reported lower anxiety and arousal at post-exposure than the multiple context group [anxiety: $F(1, 65) = 5.51$, $p < 0.025$, arousal: $F(1,65) = 6.50$, $p < 0.015$]. Pairwise parallelism tests did indicate significant exposure condition X pre-exposure interactions on the comparisons between each of the two exposure groups (single and multiple) and the no-exposure control group [anxiety: multiple vs control, $F(1,96) = 5.47$, $p < 0.025$; single vs. control, $F(1,96) = 14.66$, $p < 0.0002$; arousal: multiple vs. control, $F(1,96) = 7.08$, $p < 0.01$, single vs. control, $F(1,96) = 19.72$, $p < 0.001$]. Follow-up Johnson-Neyman (JN) tests indicated that self-reported anxiety at post-exposure was significantly lower for the exposure groups, relative to the control groups as long as participants' pre-exposure anxiety was approximately one standard deviation (28.47) below the mean (50.91) or greater (see Fig. 2). Follow-up JN tests on arousal indicated a similar pattern of effects.

3.3.2. Novel exposure

Omnibus tests for parallelism were not significant for anxiety or arousal assessed during the novel trial (all *ps* > 0.40). The omnibus ANCOVA indicated a marginally significant effect on anxiety, $F(2, 98) = 3.05$, $p = 0.051$, and a significant effect on arousal, $F(2,98) = 8.74$, $p < 0.001$. Follow-up pairwise LSD comparisons indicated that the single and multiple context groups reported significantly lower anxiety and arousal than the control group (anxiety: single-control $p = 0.03$, multiple-control $p = 0.04$; arousal: single-control $p < 0.001$, multiple control $p < 0.001$). However, the two exposure context groups failed to differ from each other (both *ps* > 0.87).

3.3.3. Change from post-exposure to novel exposure

The effects of exposure context on changes in anxiety and arousal from the post-exposure to novel exposure were also examined. The omnibus test of homogeneity of regression slopes on post-exposure anxiety indicated a significant exposure context X pre-exposure interaction, $F(2,93) = 4.76$, $p < 0.025$. The only significant interaction yielded on follow-up pairwise parallelism tests involved the comparison between the single context group and the control group, $F(1,96) = 9.18$, $p < 0.005$. Follow-up J-N tests indicated that the single context group demonstrated a greater increase in anxiety from post-exposure to novel exposure as long as participants were in the top 75% of the distribution in pre-exposure anxiety scores. Comparisons of covariate-adjusted means when the assumption of parallelism was met indicated that, overall the multiple context group (adjusted $\overline{X} = 22.52$) demonstrated a greater increase in anxiety than the control group (adjusted$\overline{X} = 12.06$, $p < 0.025$) but a smaller increase in anxiety relative to the single context group (adjusted$\overline{X} = 34.96$, $p <= 0.005$) (overall ANCOVA $F(2,98) = 14.18$, $p < 0.0001$). The results of parallelism tests and ANCOVAs assessing changes in arousal corresponded to those for anxiety with the exception that there was an additional exposure context × covariate interaction for the comparison between the multiple context and control group (overall parallelism $F(2,96) = 9.24$, $p < 0.001$, multiple context vs. control parallelism $F(1,96) = 5.43$, $p < 0.025$). J-N tests indicated that the multiple context group demonstrated a greater increase in arousal than the control group among subjects who were at the 40th percentile or above on pre-exposure arousal.

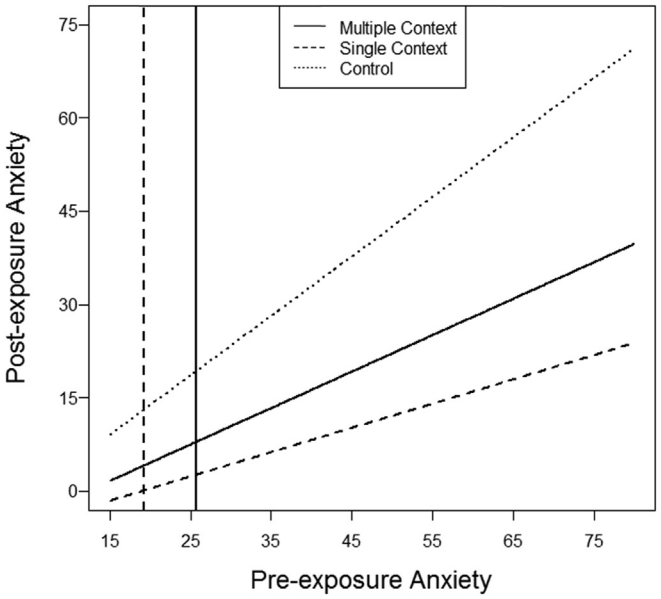

Fig. 2. Johnson-Neyman regions of significance for group differences on post-test anxiety across values of pre-test anxiety. Vertical lines denote cutoff points above which the multiple and single context groups differ from the control group.

3.3.4. Within-group patterns of change

As indicated in Fig. 3, the pattern of change in anxiety across the

single exposure group indicated a smooth pattern of decline with a rate of change that progressively decelerated across trials. An almost identical pattern was observed when arousal was assessed. The top portion of Table 4 presents a summary of log likelihood and AIC values for linear, quadratic, cubic, and saturated models in the single-context group. Across both anxiety and arousal, the cubic model fit significantly better than the linear ($ps < 0.0001$) and quadratic ($ps < 0.005$) models and was not significantly worse than the substantially less restrictive saturated model ($ps > 0.05$). Consistent with these conclusions, the cubic model has the smallest AIC values for both anxiety and arousal.

In contrast to the single-context condition, the pattern across trials for the multiple contexts group was not smooth, largely due to stimulus-specific patterns of habituation linked to the particular trials on which the three target stimuli appeared (see bottom panel of Fig. 3). As indicated by the AIC values shown in Table 4, for both anxiety and arousal, linear, quadratic, and cubic piecewise models all dramatically fit better than their corresponding global polynomial representations. Among the piecewise models, the quadratic piecewise model fit best according to the AIC. Consistent with this result, likelihood ratio tests indicated that the quadratic piecewise model did not compromise fit relative to the more complex piecewise cubic ($p > 0.50$), or saturated ($p > 0.50$) models. Fig. 3 displays the quadratic piecewise fit superimposed on the observed data values.

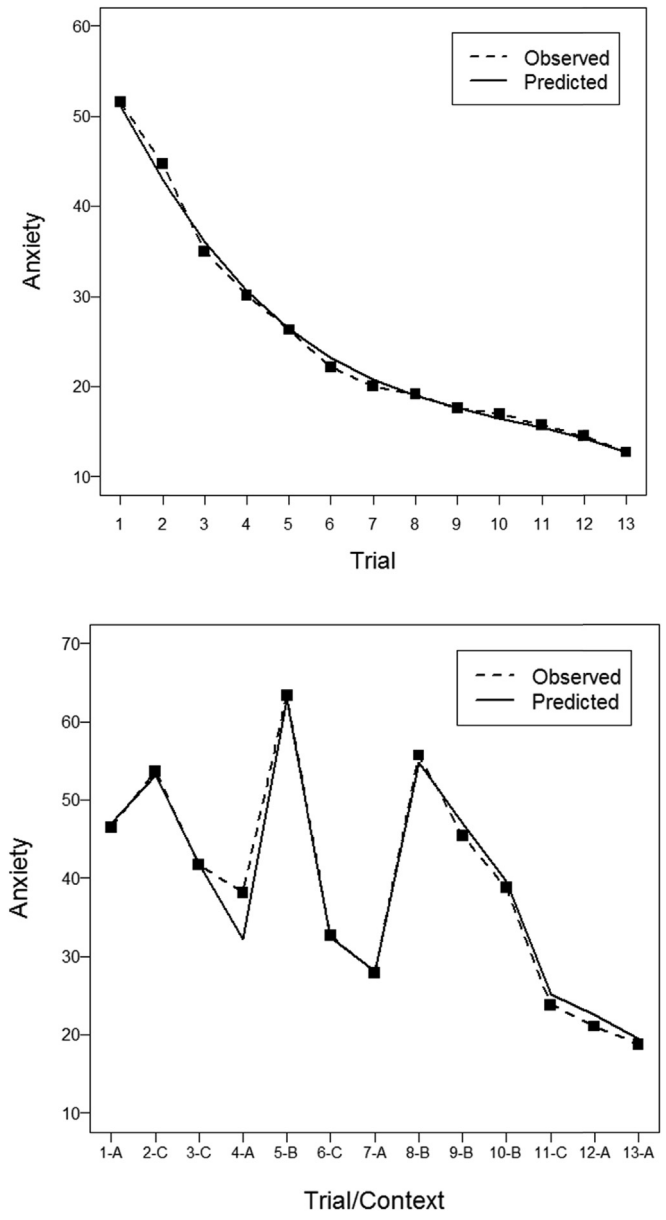

Fig. 3. Top panel: Pattern of change across exposure trials for the single context group. Predicted values are derived from a cubic polynomial model. Bottom panel: Pattern of change across exposure trials for the multiple context group. Predicted values are derived from a piecewise quadratic model.

3.4. Effects on BAT

3.4.1. Number of steps completed

The Emotion Induction X Exposure Context cumulative logit model on number of BAT steps completed indicated a significant main effect for Exposure Context, $\chi^2_2 = 7.91, p = 0.02$ (see Table 5). Participants in the multiple exposure group completed a larger number of steps ($M = 2.94$) than those in the single exposure group ($M = 2.09$; odds ratio for advancing beyond a given step $= 3.39$) ($\chi^2_1 = 7.84, p = 0.005$). The control group performed midway between the two context groups (M # of steps $= 2.43$) and failed to differ significantly from each ($ps > 0.10$).

3.4.2. Fear

The Emotion Induction X Exposure Context X Trial mixed effects ANOVA on self-reported fear yielded only a significant effect of trial ($F(2,297) = 72.97$, $p < 0.0001$). However, a planned contrast indicated that the single context group reported greater fear across trials ($M = 6.53$) than the multiple context group ($M = 5.31$, $F(1,100) = 4.40$, $p = 0.04$) (control $M = 6.29$) (see Table 5).

4. Discussion

The current study found that although the single and multiple contexts groups reported significantly lower anxiety and arousal than the control group when exposed to a novel snake, the exposure groups failed to differ from each other. Drawing from previous research (e.g., Rowe & Craske, 1998), fear renewal in the present study was also operationalized as the magnitude of change from post-exposure to novel exposure. Examination of these data revealed that the multiple context group reported a significantly smaller increase in anxiety from the post-test to novel trial compared to the single context group. Although this finding is consistent with recent theoretical developments and research suggesting that conducting exposure in multiple contexts improves the generalizability of extinction in fear-based disorders (see Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014 for review), close examination of the means in Table 3 suggests that the greater renewal in anxiety among those in the single context group may be due to significantly reduced anxiety at post-exposure. Accordingly, the observed changes in anxiety and arousal from the post-test to novel trial should be interpreted with caution as the single context group had more range to move on anxiety and arousal because of the lower ratings at post-exposure.

One factor that may influence the effects of exposure in multiple contexts on fear renewal is how context is operationalized. Bouton and Swartzentruber (1991) contend that context may be defined by any background event or stimulus in which target learning and memory events are embedded. The complexity and intensity of that stimulus then determines the context-specific nature of memory for that stimulus. In the present study, post-exposure 'context A' consisted of a snake slithering through the desert during the daytime and the novel 'context D' consisted of a different snake slithering through the desert at nighttime. Because the similarity

Table 4
Model comparisons for within-group patterns of change.

Condition	Model	# Fixed effect parameters	Anxiety		Arousal	
			-2LL	AIC	-2LL	AIC
Single context	Linear	2	3060.0	3070.0	3152.0	3162.0
	Quadratic	3	3024.5	3036.5	3111.2	3123.2
	Cubic	4	3015.2	**3029.2**	3096.3	**3110.3**
	Saturated	13	2999.7	3031.7	3083.1	3115.1
Multiple context	Linear	2	4099.1	4109.1	4088.4	4098.4
	Quadratic	3	4077.9	4089.9	4074.4	4086.4
	Cubic	4	4071.0	4085.0	4070.3	4084.7
	Piecewise Linear	6	3793.4	3811.4	3790.6	3808.6
	Piecewise Quadratic	9	3786.6	**3810.6**	3783.9	**3807.9**
	Piecewise Cubic	12	3784.7	3814.7	3783.4	3813.4
	Saturated	13	3784.4	3816.4	3783.1	3815.1

Note: Single Context $N_{subjects} = 35$, Total $N_{Observations} = 455$, Multiple Context $N_{subjects} = 38$, Total $N_{Observations} = 474$. All models were fit via maximum likelihood. Piecewise models included separate components for each of the three contexts used in the multiple context condition. The saturated model was a classic repeated measures model that estimated a unique parameter for each of the 13 trials. The total of fixed effects parameters per model includes any intercept terms. In addition to the fixed effects parameters, all also included three variance or covariance parameters that fit a first-order autoregressive moving average (ARMA(1,1)) to the residual matrix of the repeated measures. $-2LL = -2$*(the maximum of the log likelihood function. AIC = Akaike Information Criterion. The AIC assesses model fit while also penalizing for the number of parameters estimated. Lower values of -2LL and the AIC denote better fit. Bold values denoted the optimal values of the AIC within each combination of context (single/multiple) and dependent measure (anxiety/arousal).

Table 5
Mean behavioral avoidance task outcomes by emotion induction and exposure context condition.

Experimental condition	Nonspecific threat induction-single context	Nonspecific threat induction-multiple context	Nonspecific threat induction-control context	Neutral induction-single context	Neutral induction-multiple context	Neutral induction-control context
# of Steps	2.00 (1.17)	3.05 (0.89)	2.29 (1.21)	2.16 (1.33)	2.83 (0.92)	2.55 (1.29)
Fear	6.83 (2.76)	5.17 (2.74)	6.85 (2.64)	6.47 (2.99)	5.31 (1.93)	5.72 (3.22)

between the two videotapes may not have allowed for sufficient differentiation of contex, it might partially account for the failure to observe the more robust return of fear that was predicted for the single, but not the multiple context group, when exposed to the novel threat cue. Examination of the effects of exposure in multiple contexts on fear renewal may require more robust distinctions between contexts as well as greater differentiation of threat-relevant contextual features. Accordingly, the present study also employed a behavioral measure of return of fear that may overcome the limitation of an exclusive reliance on a verbal measure of fear. Those in the multiple context group completed more steps and reported less fear on a post-exposure BAT after exposure than those in the single context group. The BAT may represent a novel context that can be sufficiently differentiated from the videotaped exposure context employed in the present study.

An important process that may influence the effects of exposure in multiple contexts on fear reduction and renewal is the level of pre-exposure emotionality. Indeed, prior research has shown that higher levels of pretreatment negative emotion predict negative treatment outcomes for anxiety-related disorders (Forbes et al., 1991; Speckens et al., 2006) and greater return of fear (Rodriguez et al., 1999). However, it is unclear if threat-specific and nonspecific emotionality differ with regards to their effects on fear reduction and renewal. The present study found no discernable differences between those assigned to a neutral emotion induction and those assigned to a nonspecific threat emotion induction. Furthermore, when pre-exposure threat-specific anxiety was low, the three groups did not differ in anxiety at post-exposure. Conversely, when pre-exposure threat-specific anxiety was high, anxiety at post-exposure was significantly lower for the two exposure groups relative to the control group. This is consistent with previous research showing that those who evidenced *more* intense fear during the initial stages of treatment benefit more from exposure-based treatment than those who have less intense fear (Foa, Riggs, Massie, & Yarczower, 1995).

It has been proposed that effective emotional processing requires activation of the fear structure, which then allows for the incorporation of corrective information (Foa & Kozak, 1986). Heightened threat-specific emotionality in the present study may be a strong indicator that the fear structure was accessed, resulting in a reduction in post-exposure anxiety. However, the present findings also revealed there was a greater increase in anxiety from post-exposure to novel exposure especially in the single context group when pre-exposure anxiety and arousal was high. This finding suggests that heightened threat-specific emotionality before exposure-based treatment may be differentially related to fear reduction and fear renewal. This view is consistent with previous research showing that while those experiencing heightened threat-specific emotionality benefitted most from exposure-based treatment (Foa et al., 1995), those same individuals may also be at risk for the return of fear (Rodriguez et al., 1999). Future research is needed to clarify the extent to which elements such as threat-specific emotionality differentially predict who responds well to treatment and who also experiences the return of fear.

An important aim of the present study was to characterize the potentially distinct patterns of change in anxiety during exposure for those in the multiple context compared to those in the single context. For the single context group, the pattern of change reflected a smooth decline with a rate of change that progressively decelerated across trials. In contrast, the best fit for the multiple context group was a piecewise quadratic function that consisted of three separate quadratic functions each linked only to one context stimulus. That is, the pattern of change reflected stimulus-specific patterns of habituation linked to the particular trials on which the three target stimuli appeared. This variability is crucial during exposure as it models the different contexts in which threat-relevant stimuli may be encountered after treatment. Indeed, previous research has shown that variability in the stimuli used during

exposure led to positive outcomes in terms of spontaneous recovery in anxious samples (Lang & Craske, 2000; Rowe & Craske, 1998). Variability in the stimuli used during exposure may lead to greater variability in fear levels throughout exposure (i.e., repeated increases following decreases in trial to trial fear levels), a process that has been found to be a positive predictor of treatment outcome (Culver, Stoyanova, & Craske, 2012; Kircanski, Lieberman, & Craske, 2012). This pattern of emotional processing may account for why the multiple context groups was less avoidant and less fearful on the BAT compared to the single context group.

Evidence presented here suggests that there may be some benefits to conducting exposure in multiple contexts. However, these findings should be interpreted in the context of the study limitations. For example, the present study is limited by the use video images of snakes as this may not allow for the most salient meaning propositions (e.g., 'if I see a snake, it will bite me') of the fear structure. Future research will benefit from replication and extension of this work using exposure to real snakes as this will more strongly activate the underlying fear structure, which may then yield more definitive data as to the effects of conducting exposure in multiple contexts. The use of different videos of snakes as the primary manipulation of context is also an important study limitation. The exclusive use of videos may have resulted in relatively weak distinctions between contexts. However, using different videos may be considered as an analogue to using multiple contexts as both methods will increase the generalization of what is learned during exposure (e.g., Rowe & Craske, 1998; Vansteenwegen et al., 2007). Interestingly, some benefits of conducting exposure in multiple contexts were observed in the present study even with the use of different videos that may lack contextual discrimination. That being said, future research may benefit from greater distinctions between contexts and manipulation of contextual features. Another limitation is the nonspecific negative emotional induction, which was found to have virtually no effect on fear reduction and renewal in the present study. The negative emotion induction consisted of exposure to people vomiting and resulted in significant increases in fear, disgust, anger, and sadness. However, the use of broader nonspecific negative cues, rather than a specific disgust-relevant cue, as the emotion induction may yield the predicted moderating effects. Attention to these various methodological considerations in future research may facilitate a more precise understanding of the effects of exposure in multiple contexts on fear reduction and renewal as well as the role of emotion in moderating these outcomes.

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