Title
Extensive Interference Attenuates Reinstatement in Human Predictive Judgments

Journal
International Journal of Comparative Psychology, 18(3)

ISSN
0889-3675

Authors
García-Gutiérrez, Ana
Rosas, Juan M.
Nelson, James Byron

Publication Date
2005-12-31

DOI
10.46867/ijcp.2005.18.03.02

International Journal of Comparative Psychology, 2005, **18**, 240-248.

SHORT COMMUNICATION

Extensive Interference Attenuates Reinstatement in Human Predictive Judgments

Ana García-Gutiérrez, Juan M. Rosas
Universidad de Jaén, Spain

James Byron Nelson
College of Charleston, U.S.A.

An experiment assessed the impact of varying levels of interference on reinstatement in human causal learning. Participants studied fictitious customer files to learn relationships between foods and gastric illness in acquisition. During interference training, a new relationship was learned between the same foods and a different illness over 12, 15, or 18 trials. Prior to the test, presentations of either outcome in the absence of information about the food led to losses of the second-learned information and recovery of that learned first. This effect was reduced as the number of interference trials increased. Results are discussed in terms of their implications for theories of reinstatement and of the parallels with animal studies on renewal.

Reinstatement and renewal are two effects of importance in animal and human learning. Foremost, they show ways in which extinguished behavior can recover, an issue of theoretical (Bouton, 1994) and practical (e.g., Bouton, 2002) importance. Reinstatement and renewal studies are divided into three phases. In an acquisition phase, information about the relationship between stimuli is acquired, typically as the result of cue-outcome pairings. Acquisition is followed by an interference phase (e.g., extinction or counterconditioning, when a new relationship is learned), a manipulation, and a test. In a reinstatement study, the manipulation prior to the test involves the presentation of the outcome several times in the absence of the cue. In a renewal study, the manipulation involves conducting the test in a context that is different from that used during the interference phase. The result of these manipulations is evidence of a loss of the information acquired in the interference phase and a recovery of the learning from the acquisition phase.

To briefly illustrate the parallels, four studies, two with rat subjects (reinstatement demonstrated by Bouton & King, 1986; renewal demonstrated by Bouton & Ricker, 1994), and two with humans (García-Gutiérrez & Rosas, 2003; Rosas, Vila, Lugo, & López, 2001) will be discussed. In acquisition rats received tone-shock pairings in a context provided by a Skinner box until the tone elicited conditioned freezing. In the human studies participants studied fictitious files that indicated something various individuals had ingested (e.g., food, medicine) and the outcome of that ingestion (e.g., diarrhea, fever). These files also indicated the con-

The first author is now at Universidad Complutense de Madrid, Spain. These data were presented at the XV Congress of the Spanish Society of Comparative Psychology, Barcelona, 2002. This research was financially supported by research group HUM642 from the Junta de Andalucía, Spain, and by grant BSO2002-03398 from the Ministerio de Ciencia y Tecnología, Spain, and FEDER funds from the European Comunity. Correspondence concerning to this paper may be addressed to Juan M. Rosas, Departamento de Psicología, Universidad de Jaén, 23071 Jaén, Spain (jmrosas@ujaen.es).

text in which the ingestion had occurred (e.g., restaurant, hospital). These pairings led participants to indicate the probability of a particular outcome given the cue that had been ingested. In the interference phase, rats received presentations of the tone that were no longer followed by the shock, reducing conditioned freezing. Human participants studied files in which the ingested cue was now paired with an outcome different from that used in acquisition, resulting in a decreased judged likelihood of the original outcome given the ingested cue.

Following interference, in the two studies that demonstrate reinstatement (Bouton & King, 1986; Garcia-Gutiérrez & Rosas, 2003), the outcome present in acquisition was again presented, but in the absence of the cue. Rat subjects received shocks in the Skinner box in the absence of the tone. Human participants studied files in which the outcome used in acquisition had occurred, but no information about the ingested cue was provided. Both of these manipulations led to a loss of performance associated with the interference phase and a recovery of performance associated with acquisition when the cue was presented on test. Rats froze more to the tone than if unsignalled shocks had not occurred and human participants were more likely to judge the ingested food as causing the original outcome than if the outcome had not been presented again.

In the two studies concerning renewal (Bouton & Ricker, 1994; Rosas et al., 2001), testing took place in a context different from that used in interference. Rats were placed in a different skinner box and tested with the tone. Human participants were shown files in which an individual had ingested a medicine in a hospital that was different from the one where the interference trials had occurred. For rats, this manipulation led to a loss of performance associated with interference (extinction) and a recovery of freezing associated with acquisition. Likewise, when asked about a medicine ingested in a hospital different from the one where interference had occurred, participants were more likely to judge the medicine as resulting in the symptoms used in acquisition.

Bouton (1994) has suggested that reinstatement and renewal are two examples of the same phenomena. Both are the result of a failure to retrieve what was learned during interference as the result of a contextual change. He makes the common assumption that, during acquisition, an excitatory association between the relevant stimuli is formed. In interference, rather than unlearning this association, something new is learned that can be characterized as retrospective inhibition (see Nelson & Bouton, 2002). At this point, Bouton (1994) assumed that the background context becomes important in that the second-learned inhibition formed during interference becomes dependant on that context for retrieval (see also Nelson, 2002). Thus, a change in context following interference would cause a failure to retrieve what was learned in that phase leading to a renewal of performance associated with acquisition.

In a reinstatement study, the context is effectively changed during the unsignalled presentations of the original outcome. Bouton (1994) assumes that conditioning of the context is an attribute of the context, in much the same way as those directly observable such as stripes on the wall. Interference training takes place in a context increasingly free from the first outcome. The reinstatement treatment serves to condition a context→outcome association, functionally making the context different from that of interference. The result is a failure to retrieve the retrospective inhibition and an accompanying renewal of acquisition performance.

The present experiment provides an assessment of the idea that reinstatement is a special case of renewal. Denniston, Chang, and Miller (2003) have shown that extensive extinction attenuates the renewal effect. Following conditioning in acquisition, varying amounts of extinction (none, 160, or 800 trials) were administered in a different context and testing was conducted back in the acquisition context (Experiment 2) or in yet another context (Experiment 1). Renewal was expected in both as both test contexts were different from the extinction context. Renewal was observed, but its magnitude was attenuated as a function of the number of interference trials conducted in extinction (see also Tamai & Nakajima, 2000).

Table 1
Design of the Experiment.

Acquisition	Interference	Reinstatement	Test
A-O1 / B-O2	12 A-O2	Context-O1	A and B
	15 A-O2	Context-O2	
	18 A-O2	Context-alone	

Note. Only the relevant treatments are shown in the table. Contexts were fictitious restaurants, the Swiss Cow and Canadian Cabin, counterbalanced. A and B were garlic and cucumber, counterbalanced. The target cue was A. Acquisition consisted of 12 parings of A with O1 and B with O2 (O1 and O2 were diarrhea and constipation, counterbalanced). Interference consisted of 12, 15, or 18 pairings of A with O2. Reinstatement consisted of paring the Context with O1, O2, or presenting it alone. Predictive judgments were recorded before acquisition, after acquisition, and on the test. See text for details.

If reinstatement is a special case of renewal, then it should likewise be affected by the number of interference trials. The design, shown in Table 1, was a three by three between-subject factorial combining the three levels of interference shown under Interference with the three treatments shown under Reinstatement. Participants learned a food-outcome relationship during acquisition followed by either 12, 15, or 18 interference trials in which food was paired with a different outcome. Prior pilot work had shown that retroactive interference reaches asymptotic level with 12 trials in this task. The values of 15 and 18 were chosen so that they increased retroactive interference training beyond that asymptote while keeping participants engaged in the task. The reinstatement manipulation consisted of presentations of either outcome alone in the restaurant in the absence of the food cue. Since changing the associative status of the context from its status during the Interference phase should cause renewal, it should not matter which outcome is presented (García-Gutiérrez & Rosas 2003). Control conditions received no presentations of the outcomes alone. Recovery of the food-outcome predictive judgment from acquisition was expected, and that such recovery would decrease as the number of interference trials increased.

While A was being paired with an outcome in acquisition, participants also received pairings of B with another outcome in the acquisition phase to assess the impact of the reinstatement treatment on a noninterfering cue-outcome relationship. Participants also received irrelevant filler trials in each phase where other foods occurred with the outcomes and other contexts were encountered.

Method

Subjects

Participants were 144 undergraduate students from the University of Jaén between 18 and 25 years old and naive to the task, who received course credit for participation. Approximately 75% were women and 25% were men.

Apparatus

All stimulus presentations and data recording were conducted with a computer. The apparatus was identical to that used by García-Gutiérrez and Rosas (2003) and will only be briefly described here. The foods cucumber and garlic were counterbalanced as cues A and B. Caviar, corn, eggs, and tuna fish served as cues in filler trials (cues C, D, E, and F, respectively). Diarrhea and constipation were counterbalanced in their role as two different outcomes (O1 and O2). Restaurant names, "The Swiss Cow" and "The Canadian Cabin" served as contexts X and Y. All relevant training and testing took place in one context (X). The use of two contexts simply provided filler trials and maintained consistency with the procedures of García-Gutiérrez and Rosas (2003).

Procedure

Participants were randomly assigned to one of nine groups (n = 16) in a 3 x 3 factorial design crossing three levels of interference (12, 15, or 18 trials) with the use of three different outcomes (O1, O2, or context alone) during reinstatement. The same instructions and procedures used by García-Gutiérrez and Rosas (2003) were used here. As such, the procedures will only be generally summarized for this brief report.

Participants sat at a computer screen and were presented instructions explaining the task by informing them that they were serving as fictitious experts to identify foods that lead to some type of illness. During training, "files" were presented on screen that indicated the food a person had ingested and the restaurant where it was eaten. Each participant was asked to choose the outcome they believed occurred from a list presented in the middle of the screen. After choosing, the actual outcome was presented on the next screen for 1.5 s.

Probability judgment testing took place by presenting customer files that showed what food the customer had eaten and the restaurant in which it was eaten. The possible outcomes were presented at the bottom of the screen and the participant was asked to rate the probability of each outcome occurring on a 100 point Likert scale broken into 21 equal intervals (0-100), with the following question, "What is the probability of this food causing this outcome?" The order in which the questions about foods were asked was counterbalanced.

Pretest. The study began with a pretest where participants made their probability judgments for each of cues A and B.

Acquisition. Following the pretest, participants received 33 trials in three identical blocks in two contexts. In each block in context X, they received four trials each of A-O1 and B-O2 and one trial each of C alone, E-O1, and F-O2, randomly intermixed. In each block in context Y they received 5 trials of each combination of E-O1 and F-O2, and one C alone trial. Changes between contexts were initiated with the sentence, "Now you should analyze the files of people who ate at (name of restaurant)." The order in which blocks of trials and contexts were presented was counterbalanced between participants (XYYXXY or YXXYYX). At the end of acquisition, the participants had received 12 pairings of each of the relevant stimuli and outcomes (A-O1, B-O2) in Context X. Probability judgments were gathered at the end of the acquisition phase for each of cues A and B.

Interference. The interference phase was identical to acquisition with three exceptions. First, the outcome following A was changed from O1 to O2. Second, no further B-O2 pairings occurred. A new cue, D, was introduced. Groups receiving 12 interference trials received a total of 12 pairings of A with O2 in this phase and 6 parings of D with O2. Groups receiving 15 interference trials received 15 A-O2 pairings and 3 pairings of D with O2, and Groups receiving 18 interference trials received 18 A-O2 pairings. The use of D-O2 pairings was to ensure that each condition had equal exposure to O2.

Reinstatement. The reinstatement manipulation began immediately after the last trial of the interference phase. Participants received 8 trials in which screens appeared with the sentence, "This person ate at the (restaurant name)" appearing near the top of the screen and the sentence, "This person had (name of outcome)" appearing below it. For groups receiving context-O1 parings, the outcome presented in the second sentence was the outcome paired with A in acquisition (O1). For the groups receiving context-O2 pairings, the outcome was the outcome paired with A in interference (O2). For the Context-alone groups, the screen indicated the restaurant in which the customer had eaten and that the customer had no problems. Immediately after each presentation, a screen appeared which presented the possible outcomes and the sentence, "Click on the problem suffered by the person" to ensure that participants were paying attention in this phase. At the end of this phase, participants were tested again as in the pre- and postacquisition tests. Screens lasted 1.5 s. Probability judgments were gathered for cues A and B.

Data Analysis

Data consisted of the probability judgment ratings for A and B. Participants were eliminated if they failed to learn the A→O1 relationship in the acquisition phase. All participants for whom A-O1 ratings were not higher after acquisition than during the preassessment were eliminated from the data set. Remaining probability ratings from the pre, acquisition, and reinstatement tests were analyzed with mixed factorial analysis of variance (ANOVA). Simple effects were conducted using error terms and degrees of freedom derived by pooling the relevant terms from the overall ANOVA following the methods discussed by Howell (1987). The rejection criterion was set at $p < 0.05$. Unlike in previous reports using a difference score (García-Gutiérrez & Rosas, 2003; Rosas et al., 2001), a full description of all the probability ratings is provided to better characterize the nature of the findings.

Results

Data screening eliminated seven participants. In the conditions that received context-O1 pairings during reinstatement one participant in the 12-trials condition was eliminated, and two were eliminated from each of the 15- and 18-trials conditions. In the context-alone condition, two were eliminated from the 18-trials condition. A chi-square test of independence showed that elimination was not related to the experimental conditions, $\chi^2 = 0.12$.

Probability ratings for O1 and O2 are shown separately in the left and right panels, respectively, of Figure 1. The first analysis was to determine if there were any effects related to the use of O1 or O2 in the reinstatement procedure. Phase (pre, acquisition, test) by Interference trials (12, 15, or 18) by Outcome analyses using only the context-O1 and context-O2 conditions (solid circles vs. triangles in the figures) were conducted separately on O1 ratings and O2 ratings. Those analyses showed no effects involving Outcome, Fs < 1. Thus, groups receiving context-O1 and context-O2 pairings were pooled as one group receiving a reinstatement outcome. All subsequent analyses began with Phase by Interference Trials by Reinstatement (Context-Outcome pairings, or Context-Alone) ANOVAs.

O1 Ratings

Analysis of the O1 ratings showed effects of phase, $F(2, 262) = 197.33$, reinstatement, $F(1, 131) = 7.47$, and a phase by reinstatement interaction, $F(2, 262) = 9.62$. No other effects were reliable, Fs < 1.88. Although the phase by interference by reinstatement three-way interaction was nonsignificant, there were a priori reasons to expect an effect of interference in the reinstatement groups on the test. An interference analysis of the reinstatement groups on the test showed an effect of interference, $F(2, 392) = 3.81$. The groups receiving 12 and 15 interference trials did not differ from each other, $F < 1$. Both showed increased O1 ratings relative to the group receiving 18 trials, Fs(1, 392) > 7.61.

The context-alone condition shows the effect of the interference trials in the absence of a reinstatement treatment. An analysis of these conditions showed no effect of interference, $F < 1$. Twelve, 15, or 18 interference trials were equally effective in reducing O1 ratings from what was seen at the end of acquisition. In comparison to the corresponding context-alone condition, the reinstatement treatment increased O1 ratings when the treatment occurred after 12 or 15 trials, Fs(1, 392) > 25.14, but not when it occurred after 18 trials, $F < 1$.

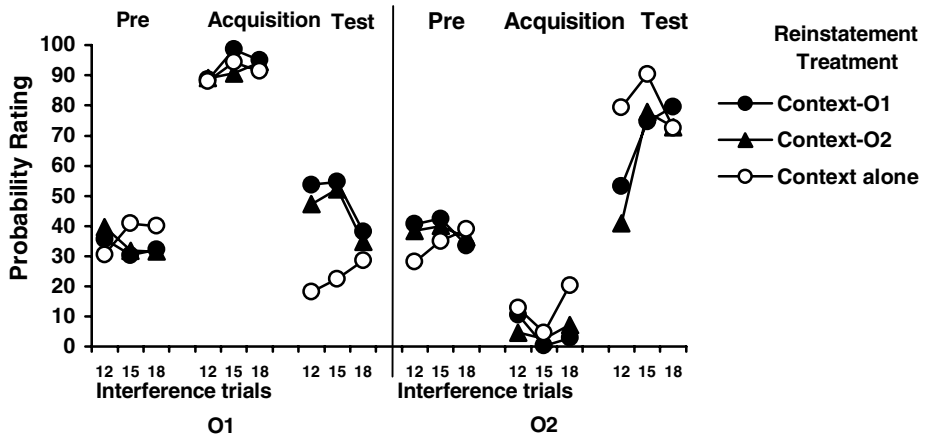

Figure 1. Probability ratings of outcomes given cue A during **pre-**acquisition, post-**acquisition,** or during **test** . Participants learned an A→O1 causal relationship in acquisition followed by 12, 15, or 18 A-O2 pairings in an interference phase. Participants then received parings of the context with O1, O2, or received simple context exposure prior to test. Probability of O1 shown at left. Probability of O2 shown at right. See text for details.

O2 Ratings

Analysis of the O2 ratings showed effects of phase, $F(2, 262) = 232.84$, reinstatement, $F(1, 131) = 4.20$, phase by reinstatement, $F(2, 262) = 5.03$, phase by interference, $F(2, 262) = 3.74$, and phase by interference by reinstatement, $F(2, 262) = 3.64$. No other effects were significant, Fs < 1.79. An interference analysis of the reinstatement groups on the test showed an effect of interference, $F(2, 384) = 14.06$. The groups receiving 12 interference trials showed reduced O2 ratings relative to the groups receiving 15 and 18 trials, Fs(1, 384) > 32.50 The latter two conditions did not differ from each other, $F < 1$.

The context-alone conditions showed the effect of the interference trials on O2 ratings in the absence of reinstatement. An analysis of these conditions showed no effect, $F(2, 384) = 1.96$. Twelve, 15, or 18 interference trials were equally effective in increasing O2 ratings from what was seen at the end of the acquisition phase. In comparison to the corresponding context-alone conditions, the reinstatement treatment reduced O2 ratings when the treatment occurred after 12 or 15 trials, Fs(1, 384) = 27.90 and 5.39, respectively, but not after 18 trials $F < 1$.

B-Outcome Ratings

As with the A-Outcome ratings, initial Phase x Interference x Outcome (context-O1 or context-O2) ANOVAs were conducted on the O1 and O2 data. There were no effects involving outcome, Fs < 1.98. As with the ratings given to A, groups receiving context-O1 and context-O2 pairings were pooled as one group receiving a reinstatement treatment.

B-O2 Ratings. The Phase x Interference x Reinstatement ANOVA on the O2 ratings showed only an effect of phase, $F(2, 262) = 261.09$. Ratings after acquisition (mean = 89.23) and on test (mean = 83.80) were higher than during the preassessment (mean = 33.35).

B-O1 Ratings. The Phase x Interference x Reinstatement ANOVA on the O1 ratings showed an effect of phase, $F(2, 262) = 46.86$, and, surprisingly, a phase by interference interaction, $F(4, 262) = 2.45$. The main effect of interference approached significance, $F(2, 131) = 2.5$, $p = .09$. No other effects approached significance, Fs < 1. O1 ratings to B averaged 33.40 on the preassessment and did not differ between groups, $F < 1$. After B-O2 pairings in acquisition, O1 ratings decreased to an average of 5.91, and did not differ between groups, $F < 1$. Differences between groups emerged on the test, $F(2, 392) = 7.18$. On the test, B-O1 ratings averaged 25.74, 9.57, and 18.86, for the groups receiving 12, 15, and 18 interference trials, respectively. After 15 interference trials B-O1 ratings were less than after 12 or 18 trials, Fs(1, 392) = 13.44 and 4.3, respectively. There was no difference in ratings after 12 or 18 trials, $F(2, 392) = 2.38$. Initial acquisition of B-O2 seemed to cause a transient decrease in B-O1 ratings. As time passed between the B-O2 pairings and the test, that decrease was alleviated as a U-shaped function of the number of context-outcome pairings in interference.

Discussion

The present experiment demonstrates two important findings. First, it replicates the work of García-Gutiérrez and Rosas (2003) demonstrating reinstatement in human causal learning. Second, it shows that, like some cases of renewal in the animal literature, reinstatement in human causal learning is affected by the number of trials conducted during interference training.

Participants learned multiple relationships between a type of food and the outcomes of eating that food across phases. Simple parings of either outcome with the experimental context (the restaurant) reduced the judged probability of the food causing the outcome present in the interference phase, and increased the judged

probability of the food causing the outcome that was present in acquisition. Importantly, it did not matter which outcome was presented during the reinstatement phase. This fact is consistent with interpretations of the reinstatement effect as a special case of renewal. During reinstatement, the associations with the outcome conditioned directly to the context can be considered as a feature of the context, making the design in the present study, and that of García-Gutiérrez and Rosas (2003), analogous to an XXY renewal design (see Ricker & Bouton, 1996) where conditioning and extinction take place in the same context (X) and testing in a different context (Y). In the acquisition and interference phases here, the cues are presented in a context that is weakly associated with outcomes, hence the contexts are similar in that respect (e.g., both X). During reinstatement, the context is now associated with an outcome and, thus, dissimilar from acquisition and interference (e.g., Y). The result of this presumed change in context is a loss of the second-learned cue-O2 relationship, and some recovery of the first-learned cue-O1 information. Both of these effects were observed in the present study.

The reinstatement effect observed after 8 context-outcome pairings decreased as the number of interference trials increased. This result is also consistent with the suggestion that reinstatement is a special case of renewal in that similar manipulations affect renewal in the same way. Denniston et al. (2003) have shown with rats that the magnitude of a renewal effect decreases as a function of the number of extinction (interference) trials. Importantly, such an effect was also demonstrated in an XXY renewal design analogous to that used here (Tamai & Nakajima, 2000). Some studies have shown renewal after using extensive extinction (e.g., Bouton & Swartzentruber, 1989), but these studies did not manipulate the actual number of extinction trials to allow an assessment of whether renewal might have been decreased.

There are several explanations for why either the reinstatement or renewal effects might be sensitive to the amount of interference. First, extending the interference training might make for a stronger A→O2 association allowing it to generalize better to a different context (see Denniston et al., 2003, for a similar argument). In the present study, participants who received more interference trials had more exposure to the interference context. Such exposure may have allowed them to sample more elements from it (e.g., Estes, 1955) that would be present on the test, reducing the impact of the context-outcome reinstatement pairings. Recently Thomas and Ayres (2004) have suggested that extinction actually causes some unlearning of the original association. It would follow that more interference would cause more unlearning of the A→O1 relationship. The observation that following the reinstatement procedure A-O1 probability judgments increased only slightly above the preassessment baseline would be consistent with this argument.

References

Bouton, M. E. (1994). Context, ambiguity, and classical conditioning. *Current Directions in Psychologycal Science,* **3**, 49-53.

Bouton, M. E. (2002). Context, ambiguity, and unlearning : Sources of relapse after behavioral extinction. *Biological Psychiatry*, **52**, 219-231.

Bouton, M. E., & King, D. A. (1986). Effect of context on performance to conditioned stimuli with mixed histories of reinforcement and nonreinforcement. *Journal of Experimental Psychology: Animal Behavior Processes*, **12**, 4-15.

Bouton, M. E., & Ricker, S. T. (1994). Renewal of extinguished responding in a second

context. *Animal Learning and Behavior,* **22**, 317-324.

Bouton, M. E., & Swartzentruber (1989). Context effects on conditioning, extinction, and reinstatement in an appetitive conditioning preparation. *Animal Learning and Behavior,* **17**, 188-189.

Denniston, J. C., Chang, R. C., & Miller, R. R. (2003). Massive extinction treatment attenuates the renewal effect. *Learning and Motivation*, *34 (1)*, 68-86.

Estes, W. K. (1955). Statistical theory of spontaneous recovery and regression. *Psychological Review*, **62**, 145-154.

García-Gutiérrez, A., & Rosas, J. M. (2003). Context change as the mechanism of reinstatement in causal learning. *Journal of Experimental Psychology: Animal Behavior Processes*, **29**, 292-310.

Howell, D. C. (1987). *Statistical methods for psychology.* Boston, MA: Duxbury Press.

Nelson, J. B. (2002). Context specificity of excitation and inhibition in ambiguous stimuli. *Learning and Motivation*, 33, 284-310.

Nelson, J. B., & Bouton, M.E. (2002). Extinction, inhibition, and emotional intelligence. In L. Feldman-Barrett & P. Salovey (Eds.), *The wisdom in feeling: Psychological processes in emotional intelligence* (pp. 60-85). New York: Guilford Press.

Rosas, J. M., Vila, N. J., Lugo, M., & López, L. (2001). Combined effect of context change and retention interval upon interference y causality judgments. *Journal of Experimental Psychology: Animal Behavior Processes*, **27**, 153-164.

Tamai, N., & Nakajima, S. (2000). Renewal of formerly conditioned fear in rats after extensive extinction training. *International Journal of Comparative Psychology*, **13**, *137-146*.

Thomas, B. L., & Ayres, J. J. B. (2004). Use of the ABA fear renewal paradigm to assess the effects of extinction with co-present fear inhibitors or excitors: Implications for theories of extinction and for treating human fears and phobias. *Learning and Motivation*, **31**, 22-52.

Received September 9, 2004.
Revision received January 28, 2005.
Accepted March 1, 2005.