Research Article

FOR BETTER OR WORSE? STRESS INOCULATION EFFECTS FOR IMPLICIT BUT NOT EXPLICIT ANXIETY

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Background: *Severe early life stress (ELS) is associated with negative outcomes. It is not clear, however, what impact moderate ELS has. A growing stress inoculation literature suggests that moderate (vs. low or high) ELS is associated with diminished behavioral and physiological anxiety responses. At the same time, studies of trait anxiety suggest that moderate (vs. low) ELS is associated with greater self-reported anxiety. This study tested the hypothesis that stress inoculation effects are evident for implicit (nonconscious) but not explicit (conscious) aspects of anxiety.* **Methods:** *Ninety-seven healthy women were assessed for ELS and explicit anxiety using questionnaires and assessed for implicit anxiety using a version of the Implicit Association Test.* **Results:** *Results indicated a quadratic relation between ELS and implicit anxiety, such that moderate ELS was associated with lower implicit anxiety levels than low or high ELS. By contrast, the relation between ELS and explicit anxiety was linear.* **Conclusion:** *These findings support the stress inoculation hypothesis and suggest that stress inoculation applies for implicit but not explicit aspects of anxiety. Depression and Anxiety 26:831–837, 2009.*

Key words: *anxiety; anxiety disorders; emotions; physiological stress; psychological stress*

INTRODUCTION

Despite their prevalence and severity, the etiology of anxiety disorders is not well understood. Among the potential risk factors that may play an important causal role, early life stress (ELS) has received a great deal of attention. We now know that severe ELS, such as childhood physical and sexual abuse, is associated with physical[1] and mental[2] health impairments in adulthood. What is less clear, however, is whether moderate ELS is also harmful.

On the face of it, if high levels of ELS are associated with negative outcomes, moderate levels of ELS should also be associated with negative outcomes, although perhaps to a lesser extent than high ELS. This line of reasoning leads to the hypothesis that ELS and deleterious health outcomes are related by a continuous linear function, such that no dose of stress is ever beneficial. This hypothesis is consistent with studies that have found linear relationships between number of ELS events and self-reported trait anxiety.[3,4]

Another perspective on this issue, however, is suggested by cultural observers, who have increasingly raised the concern that we may be raising a "bubble-wrap generation" of overprotected children with limited resources for coping with stress.[5] In line with this concern, research on the development of resilience has emphasized that in some cases, ELS may have protective effects, "steeling"[6] or "toughening"[7] against the consequences of later stress.

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Indeed, research on "stress inoculation" in monkeys and humans has demonstrated that *moderate* ELS—ELS, which is significant, but not overwhelming—can have beneficial effects at the behavioral and neuroendocrine levels. In the course of investigating the deleterious effects of ELS in monkeys, researchers noted that, to their surprise, monkeys reared under conditions of occasional, brief maternal separation (previous studies had employed more frequent and prolonged separations) displayed smaller increases in peep calls and cortisol response during subsequent maternal separation compared to monkeys never separated from their mothers.[8] Subsequent a priori investigations of stress inoculation replicated and extended these findings. For example, infant monkeys randomly assigned to a stress inoculation condition (e.g., intermittent social separations or high-demand foraging conditions) showed decreased anxiety-like behavior, as evidenced by less maternal clinging and increased exploratory behavior in a novel environment[9] and diminished reactivity of the HPA axis in response to restraint stress[10] compared to monkeys raised under less stressful conditions. Mirroring the monkey literature, moderately stressed human children show diminished stress-induced adrenocortical activation compared to children with low or high ELS,[11] and nonparental care may decrease behavioral inhibition in inhibited children.[12]

Taken together, these findings suggest that ELS is linearly associated with self-reported trait anxiety, but nonlinearly associated with physiological and behavioral aspects of anxiety. One hypothesis that reconciles these findings is that conscious aspects of anxiety are linearly related to ELS while nonconscious aspects of anxiety are nonlinearly related to ELS, such that moderate ELS predicts lower nonconscious anxiety than low or high ELS. This idea derives support from previous work showing that while self-reported trait anxiety (referred to below as explicit anxiety) predicts self-reported stressfulness of a speech task, implicit anxiety measures—those that quantify the relative strengths of nonconscious associations between self-concept and anxiety–predict anxious behavior[13] and cardiovascular responding.[14]

To test this hypothesis, we assessed a sample of healthy young women for ELS, explicit anxiety, and implicit anxiety. We constituted our sample to avoid the complexity of (a) gender differences in relations between implicit and explicit anxiety[15] and (b) psychopathology.[16]

MATERIALS AND METHODS

PARTICIPANTS

Participants were 97 healthy Caucasian females aged 18–25 (mean age: 21.6 years) recruited via advertisements and web-based listings on the Stanford University campus and in the San Francisco Bay Area. All potential participants were screened using an interview based on the Structured Clinical Interview for DSM-IV (SCID).[17] Eligible participants (a) were native speakers of English, (b) did not meet criteria for any psychiatric disorder within the past year, or for lifetime posttraumatic stress, bipolar, obsessive–compulsive, or psychotic disorders; and (c) were not currently using psychotropic medications. Overall, 503 potential participants completed the phone screen, 177 were eligible, and 97 participants completed the components of the study reported here. Of the 326 ineligible participants, 67 were disqualified based on demographics (e.g., participants were older than 25 years of age), 40 were disqualified for use of psychotropic medications, and the remainder were disqualified for current or past psychopathology as noted above.

PROCEDURE

As part of a larger study, eligible participants came to the laboratory and provided informed consent. Participants completed a battery of task-based and questionnaire measures during two laboratory sessions. Those relevant to this study are described below; each of these measures was administered during the first laboratory session.

MEASURING ELS

The Risky Family Questionnaire (RFQ)[18] was used to assess ELS. The RFQ is designed to assess family stress—operationalized as conflict, aggression, and chaos in the home as well as cold, unsupportive, and neglectful parenting—experienced between the ages of 5 and 15. The RFQ was employed because it is sensitive to moderate levels of ELS. While many other ELS scales specifically target severe forms of stress, such as physical or sexual abuse, the RFQ tracks milder forms of stress such as arguments between parents and occasional neglect. To clarify the ranges of stress, which might be beneficial, RFQ scores are expressed in terms of percent of maximum possible (POMP).[19]

MEASURING IMPLICIT ANXIETY

To assess implicit anxiety, we used a version of the Implicit Association Test (IAT).[20] More specifically, our task was adapted from the IAT-Anxiety,[13] which measures participants' implicit anxiety by comparing reaction times on a categorization task in two conditions of interest—one where calmness-related words are paired with self-related words and anxiety-related words are paired with other-related words, and another where anxiety words are paired with self words and calmness words are paired with other words. Increased speed in the self-anxiety condition relative to the self-calmness condition is interpreted as evidence of relatively stronger implicit association between one's self-concept and anxiety. The IAT-Anxiety shows good internal consistency and moderate test–retest reliability, and it is a good predictor of anxious behavior in stressful situations.[13]

Our task differed from the previous version in that instead of using 20 practice trials followed by 60 critical trials, we used only 20 trials in each condition of interest with no practice. This is in line with research showing that IAT scores calculated from the first 20 trials are comparable or superior to scores calculated from subsequent trials in terms of validity.[21] As has become standard for IAT users, we calculated *D* scores to reduce the correlation between average response latency and IAT effect size.[21]

MEASURING EXPLICIT ANXIETY

The State-Trait Anxiety Inventory-Trait Version (STAI-T)[22] was used to assess trait explicit anxiety. The STAI-T asks participants to describe themselves using statements such as: "I feel nervous and restless," "I feel secure," and "I make decisions easily." The STAI-T shows good internal consistency, temporal stability, and validity.

ANALYTIC STRATEGY

For implicit anxiety, previous findings showing inoculating effects of moderate stress[23] and detrimental effects of severe stress[24,25] on anxiety-related behavior and physiology led us to hypothesize a J-shaped relationship with ELS. For explicit anxiety, previous findings led us to expect a linear relationship with ELS. To test these possibilities, we used polynomial regression with standardized IAT-Anxiety and STAI-T as dependent variables. Standardized RFQ scores and squared standardized RFQ scores were used as independent variables. We expected implicit anxiety to be linked to the quadratic (squared) predictor and explicit anxiety to be linked to the linear predictor. To determine whether the quadratic relationship between ELS and IAT-Anxiety suggested a stress inoculation effect, we constructed a 95% confidence interval for the minimum of the quadratic. Next, to determine whether the relations between ELS and each type of anxiety were significantly different, we conducted tests of dependent regression coefficients. Finally, in secondary analyses, we repeated all the above analyses using alternate scaling for our variables to ensure that scaling differences were not responsible for our results.

RESULTS

Descriptive results are presented in Table 1. Because our measure of ELS was somewhat skewed, outliers were recoded to 1.5 times the interquartile range beyond the first and third quartiles, but the pattern of results is the same if they are not recoded. As expected based on previous research, IAT-Anxiety was not significantly related to STAI-T, $r = .11$, $P = .28$. This finding is consistent with a growing literature, which suggests that implicit and explicit measures are often weakly correlated.[26]

IS THERE A QUADRATIC RELATION BETWEEN IMPLICIT ANXIETY AND ELS?

To test for a stress inoculation effect, we used polynomial regression, entering standardized RFQ scores and the square of the standardized RFQ scores as predictors. The overall model was significant, $F(2,94) = 6.8$, $R^2 = .13$, $P = .002$. The quadratic (squared) predictor was significant, $t(94) = 3.1$, $\Delta R^2 = .09$, $P = .003$, but the linear predictor was not significant, $t(94) = -0.7$, $\Delta R^2 = .005$, $P = .51$. These results indicate that a quadratic model fit the data better than a linear model, as shown in Figure 1.

Of course, a significant quadratic model does not necessarily support stress inoculation—a pattern in which there is no initial decrease but a rapid nonlinear increase would also be fit by a quadratic model (Fig. 2). Strong support for the stress inoculation model requires that a minimum level of implicit anxiety occurs at a value greater than the minimum possible score on the RFQ. To test this, we calculated a 95% confidence interval for the minimum of our model.[27] Expressed in POMP units, we obtained a 95% confidence interval of [13.0,35.8] for the vertex. Because this confidence interval does not include 0 (the minimum score in POMP units), our results are consistent with a stress inoculation interpretation. The largest confidence interval that did not include 0 was 98%, which is equivalent to a two-sided P of .02.

TABLE 1. Mean, standard deviations, and ranges for key measures

Measure	Mean	*SD*	Min	Max	Max (recoded)
Early life stress					
RFQ	20.7	5.5	13	42	33.6
RFQ (POMP)	19.7	14.1	0	74.4	52.9
Explicit anxiety					
STAI-T	33.9	7.3	21	56	N/A
STAI-T (POMP)	23.1	12.1	1.7	60	N/A
Implicit anxiety					
IAT-Anxiety *D*	−0.6	0.5	−1.7	0.6	N/A

RFQ, Risky Family Questionnaire; STAI-T, State-Trait Anxiety Inventory-Trait Version; IAT, Implicit Association Test.

IS THERE A LINEAR EFFECT FOR EXPLICIT ANXIETY?

To test whether the relationship between ELS and explicit anxiety, we again entered standardized RFQ scores and the square of these scores as predictors. The overall model was significant, $F(2,94) = 3.6$, $R^2 = .07$, $P = .03$, as was the linear predictor, $t(94) = 2.3$, $\Delta R^2 = .05$, $P = .02$, but the quadratic predictor was not significant, $t(94) = -0.6$, $\Delta R^2 = .004$, $P = .53$. These results suggested that explicit anxiety scores are linearly but not quadratically associated with ELS.

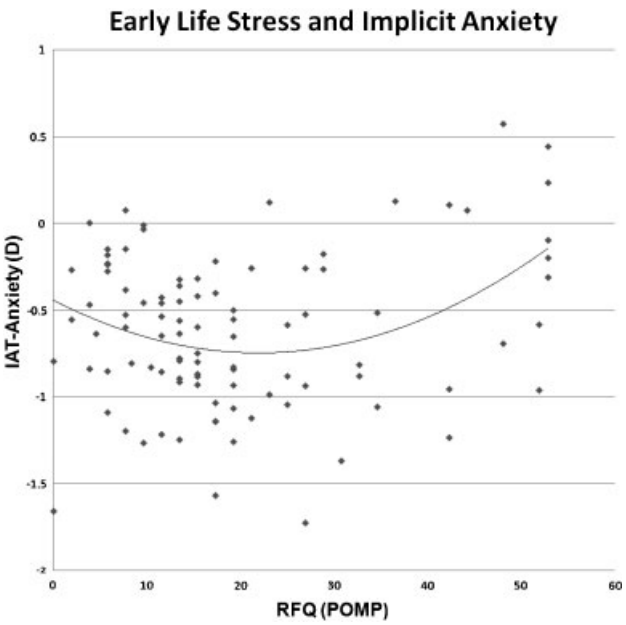

Figure 1. ELS, as assessed by the RFQ, is nonlinearly related to implicit anxiety as assessed by the IAT for Anxiety. POMP, percent of maximum possible.

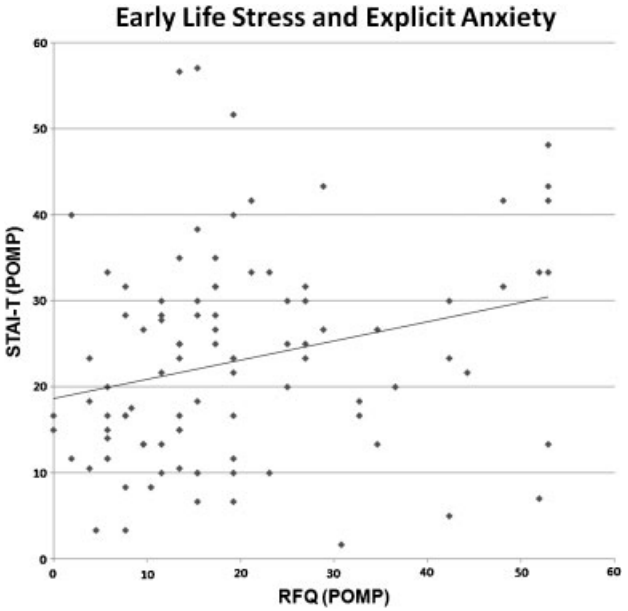

Figure 2. ELS, as assessed by the RFQ, is linearly related to explicit anxiety as assessed by the trait version of the State-Trait Anxiety Inventory (STAI-T). POMP, percent of maximum possible.

DOES ELS RELATE TO IMPLICIT AND EXPLICIT ANXIETY IN DIFFERENT WAYS?

The above results suggest that (a) ELS predicts implicit anxiety in a quadratic fashion and (b) ELS predicts explicit anxiety in a linear fashion. To test whether these relationships are significantly different from each other, we performed tests of dependent regression coefficients. Results confirmed that the quadratic component of ELS was a significantly better predictor of implicit than of explicit anxiety ($F(1,94) = 7.3$, $P = .008$) and that the linear component of ELS was a significantly better predictor of explicit than of implicit anxiety ($F(1,94) = 4.9$, $P = .029$).

ARE THE ABOVE RESULTS APPARENT UNDER DIFFERENT METHODS OF SCALING?

Because the measures used here have somewhat different distributions (see skewness and kurtosis information in Table 2), we performed secondary analyses on re-scaled versions of our variables to ensure that the above results are not simply due to scaling effects. We re-expressed the data in three ways: (a) taking the log base 10 of RFQ, then centering and squaring, leaving IAT and STAI intact, (b) using ranks of each variable with ties equal to the average, then centering and squaring RFQ, (c) "binning" observations of each variable into quintiles, so that the lowest 20% of the observations equal 1, the next 20% equal 2, etc., followed by centering and squaring RFQ. In each case, the results closely mirrored the results reported above, suggesting that they are not specific to one manner of expressing the data. Table 3 shows statistics and *P* values associated with each analysis for each re-expression of the variables.

TABLE 2. Distribution information (skewness and kurtosis) for key measures under four re-expressions

	Skewness	Kurtosis
Expression 1 (standard, with RFQ Winsorizing)		
RFQ	1.05	0.26
STAI-T	0.64	0.28
IAT-Anxiety	0.08	−0.06
Expression 2 (log-transformed RFQ)		
RFQ	0.72	0.08
STAI-T	0.64	0.28
IAT-Anxiety	0.08	−0.06
Expression 3 (Ranks)		
RFQ	0	−1.20
STAI-T	0	−1.20
IAT-Anxiety	0	−1.20
Expression 4 (Quintiles)		
RFQ	0.20	−1.23
STAI-T	0.02	−1.30
IAT-Anxiety	0.05	−1.28

RFQ, Risky Family Questionnaire; STAI-T, State-Trait Anxiety Inventory-Trait Version; IAT, Implicit Association Test.

DISCUSSION

Our findings suggest that moderate levels of ELS have different effects on implicit and explicit aspects of anxiety. With respect to implicit anxiety, our findings support the stress inoculation hypothesis, which holds that moderate ELS can lead to adaptive outcomes in adulthood compared to low ELS or severe ELS exposure. At the same time, our findings suggest that ELS is linearly related to explicit anxiety.

These results have two primary implications: (a) the stress inoculation hypothesis—the idea that moderate ELS can have beneficial effects compared to low ELS—was supported, and (b) the stress inoculation hypothesis does not contradict studies showing a linear relationship between ELS and explicit anxiety; indeed, these relationships can exist at the same time.

With regard to the first implication, it has been suggested that the impact of ELS on anxiety is moderated by the individual's ability to manage or master the stresses she encounters.[28] According to this theory, successful coping in challenging circumstances leads to resilience, while failure to cope leads to heightened anxiety. The stress inoculation hypothesis fits into this framework well, as moderate stress would be expected to be relatively easy to manage and would therefore offer an opportunity to develop resilience. Thus, it is possible that individuals who were exposed to relatively modest levels of ELS had more opportunities than those who were raised in low stress family environments to develop skills to cope with and

TABLE 3. Results of main analyses using four re-expressions

	Expression 1 (in text)	Expression 2 (log base 10 of RFQ)	Expression 3 (Ranks of all variables)	Expression 4 (Quintiles of all variables)
Overall model: implicit anxiety $F(2,93)$	6.8, $P=.002^{**}$	7.3, $P=.001^{**}$	4.9, $P=.01^{*}$	3.2, $P=.047^{*}$
Linear effect: implicit anxiety $t(94)$	−0.7, $P=.51$	0.02, $P=.98$	0.1, $P=.95$	−0.8, $P=.44$
Quadratic effect: implicit anxiety $t(94)$	3.1, $P=.003^{**}$	3.3, $P=.001^{**}$	3.1, $P=.002^{**}$	2.5, $P=.01^{**}$
Overall model: explicit anxiety $F(2,93)$	3.6, $P=.03^{*}$	4.2, $P=.02^{*}$	4.9, $P=.01^{*}$	5.4, $P=.006^{**}$
Linear effect: explicit anxiety $t(94)$	2.3, $P=.02^{*}$	2.6, $P=.01^{*}$	3.1, $P=.003^{**}$	3.3, $P=.002^{**}$
Quadratic effect: explicit anxiety $t(94)$	−0.6, $P=.52$	−0.1, $P=.91$	−0.5, $P=.65$	−1.2, $P=.22$
Difference in regression coefficients: linear term $F(1,94)$	4.9, $P=.03^{*}$	3.6, $P=.06+$	5.1, $P=.03^{*}$	9.1, $P=.003^{**}$
Difference in regression coefficients: quadratic term $F(1,94)$	7.3, $P=.008^{**}$	6.1, $P=.02^{*}$	7.1, $P=.009^{**}$	8.1, $P=.006^{**}$
Two-sided P that vertex of implicit anxiety model is not zero	$P=.02^{*}$	$P=.01^{*}$	$P=.004^{**}$	$P=.02^{*}$

Note: $+P<.1$; $^{*}P<.05$; $^{**}P<.01$. RFQ, Risky Family Questionnaire.

tolerate unpredictability, emotional instabilities, and disorder. Our results suggest that these benefits are manifested nonconsciously but not consciously.

Regarding the second implication, it is possible that while nonconscious elements of anxiety (physiology, behavior, and implicit anxiety) track the development of skills to cope with anxiety as argued above, conscious ratings of anxiety may be sensitive to the frequency with which participants have been anxious in the past. Our measure of explicit anxiety, the STAI-T, asks participants to rate the frequency with which they generally feel anxiety symptoms.[22] As such, explicit anxiety may reflect the frequency of past stressful experiences. If this is so, we would expect that the frequency of past stressful experiences (ELS) should be positively correlated with levels of explicit anxiety.

Another explanation for ELS's divergent relations to implicit and explicit anxiety comes from previous research on the development of implicit vs. explicit attitudes, which has found that implicit attitudes are highly influenced by childhood experiences, while explicit attitudes are more strongly influenced by recent events.[29] This is consistent with the fact that in this sample, we found larger effect sizes linking ELS to implicit anxiety ($R^2 = .13$) than to explicit anxiety ($R^2 = .07$). It is possible that while ELS affects both implicit and explicit anxiety, its effects on explicit anxiety are diluted by more recent events, leading to weaker effects and eventual loss of the quadratic curve shape. If this is so, ELS might be quadratically related to explicit anxiety in childhood (when ELS and recent life stress are synonymous) and become gradually less strongly linked to explicit anxiety over time, but the quadratic relationship between ELS and implicit anxiety should remain stable across the lifespan.

One limitation of this study is our use of young, healthy Caucasian women, which limited both the range of our analyses and the generalizability of our results. For example, while the confidence interval we derived for the vertex of our model (and thus the point of maximum stress inoculation) was centered above the mean of our sample, it is possible that this range would be centered below the mean amount of ELS in the population, as our stringent requirements for current psychological health may have selectively excluded individuals with high levels of ELS. Further, it is not clear whether these effects would be observed among people of different ages, ethnic groups, or among people suffering from psychopathology. While our strategy allowed us to avoid a number of important confounds, future studies should expand on this one by sampling from different populations as appropriate.

A second limitation arises from our design, which was correlational and relied on retrospective, self-report measures. This approach leaves open the possibility that current anxiety influences the recall of ELS exposure, providing an alternate explanation for our results. In particular, it is possible that individuals high in explicit anxiety may over-report ELS, leading to an observed correlation in self-report measures that is inflated compared to the true relationship between ELS and explicit anxiety in the population. Because we cannot rule out this possibility, the conclusions that ELS leads to increased explicit anxiety in a linear fashion and that this relationship differs from the ELS-implicit anxiety relationship should be treated cautiously. Because IAT procedures are less susceptible to conscious control than self-report measures,[30] the stress inoculation effect observed for implicit anxiety is less vulnerable to the limitations associated with self-report assessment of ELS. While previous studies suggest that our ELS measure (the RFQ) is not influenced by current psychosocial functioning,[18] prospective studies are necessary to allow stronger inferences.

Future prospective studies should assess coping skills and resources in childhood, as stress inoculation theory defines moderate stress as stress that does not overwhelm one's resources. As such, the level of stress that is beneficial should depend on one's ability to cope. Because the level of stress that might be beneficial is not well-understood, further studies should imitate this

one by sampling from the general population and not exclusively from populations who have experienced very low and very high levels of ELS, as many previous studies have done. While these studies were invaluable for understanding the effects of severe ELS, approaching ELS as a continuous variable allows the identification of a level of stress that might be beneficial without a priori hypotheses about its precise location.

If future research replicates the results of this study, many other questions remain to be answered, most importantly: How do we interpret the overall adaptiveness of moderate ELS exposure, given that it may have divergent effects on nonconscious and conscious anxiety? How is each type of anxiety related to physical and mental well being? Determining how each of these is related to risk for anxiety-related health problems, including anxiety disorders, mood disorders, somatization, and health risk behaviors, is an important direction for future research. While there are indications that both implicit and explicit anxiety are increased in individuals with anxiety disorders and decreased by psychotherapy,[16] the roles of implicit and explicit anxiety in the etiology of anxiety disorders are not well understood. Our results suggest that understanding the roles played by implicit and explicit anxiety in the development of anxiety disorders and other forms of psychopathology might also shed light on the role played by ELS in these processes.

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