THE AFTEREFFECTS OF ANTICIPATING NOISE EXPOSURE

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INTRODUCTION

During the 1973 conference in Dubrovnik, David C. Glass and Jerome E. Singer reported data from their classic series of experiments on the post-stimulation effects of exposure to noise (Glass & Singer, 1972; 1973). Specifically, they indicated that persons exposed to unpredictable, uncontrollable noise perform more poorly on tasks administered after noise termination than either those exposed to predictable and/or controllable noise or than those not exposed to noise. Glass and Singer tentatively concluded that exposure to unpredictable and uncontrollable noise produced aftereffects "because unpredictability and uncontrollability lead to a sense of helplessness which manifests itself as lowered motivation in subsequent task performance" (Glass & Singer, 1973, p. 414).

Seven years later, Cohen (1980) reviewed over 30 studies replicating and extending the Glass and Singer aftereffect work. The review indicated that the aftereffects of stress on performance occur as a consequence of a wide range of unpredictable, uncontrollable stressors including noise, electric shock, bureaucratic stress, arbitrary discrimination, density, and cold pressor. Hence, post-stimulation effects are attributable to the

unpredictability and uncontrollability of stressful events and not to some unique feature of noise or of any other stressor. Moreover, the two dozen noise studies clearly indicated that the physical parameters of the sound are relatively unimportant in producing aftereffects. That is, post-stimulation effects were found over a wide range of sound levels and types of noise. Cohen also concludes that aftereffects are not necessarily attributable to helplessness. Instead they may be wholly or partly due to psychic costs, shifts in arousal, overgeneralization of strategies evolved to cope with the stressors, and mood shifts associated with stressor exposure.

The present work is an attempt to gain further understanding of why exposure to unpredictable, uncontrollable stressors results in post-stimulation deficits in performance. Specifically, we are interested in determining the role stressor exposure plays in determining the effect. Glass and Singer's helplessness interpretation was based on the assumption that exposure to uncontrollable noise resulted in feelings of helplessness that interfered with performance on subsequent tasks. Other explanations offered for stressor aftereffects similarly assume a key role for exposure. For example, one approach argues that the effect is due to a fatigue that results from coping with the noise. Another that is a result of persisting in a strategy used during the noise period. In order to address this issue, we started with the most fundamental question about the relationship between exposure and post-stimulation effects. Is exposure necessary to produce an aftereffect? Hence we designed a number of studies in which we attempt to produce aftereffects without exposing subjects to the stressor. Our approach was influenced by recent work indicating that persons anticipating exposure to a stressor often behave as if they were actually exposed (e.g., Baum & Greenberg, 1975; Baum & Koman, 1976). The

premise was that the mere anticipation of exposure to aversive noise or other stressful stimuli would be sufficient to produce an effect. In short, if stressor anticipation is equivalent to stressor exposure, one would expect that same effects found after exposure to noise to occur after the mere anticipation of exposure.

The typical design of aftereffects research, as conducted by Glass and Singer (1972) and others, involves three conditions: a condition in which subjects are exposed to a stressor, a nonstressful comparison condition, and a third condition in which subjects are exposed to the stressor but told that they can, if they so desire, terminate the stressor (see Cohen, 1980, for a full review). Such perceived control has been found to ameliorate or lessen the negative aftereffects of stressor exposure. In the present study, this perceived control condition was added by telling one-third of the subjects that while they were going to be exposed to noise, they could decide to terminate it if necessary. Our hypothesis, in this regard, was that expectations of perceived control would alleviate the negative effects associated with expecting to be exposed to the noise.

METHODS

Subjects

Fifty-five female subjects were randomly assigned to one of three experimental conditions. All subjects were recruited to participate in "two separate, short experiments" that together would take half an hour. The experiments were to be conducted by different experimenters in different laboratory rooms in the same building. This instruction allowed us to separate the experimental manipulation (administered as part of the "first experiment") and the post-noise anticipation measure of performance (part of the "second experiment"). This prevented the possibility that a subject would expend less effort on the performance task because of her dislike for an experimenter who was going to expose her to an aversive sound or her dislike for the experimental situation in which this exposure would occur. Moreover, by keeping the second experimenter blind to the experimental condition, we were able to avoid the possibility of experimenter bias. Approximately half the subjects in each condition received one unit of extra credit for their participation; the remaining subjects were recruited through a local newspaper ad and were paid $3.00 for participation.

Procedure

Subjects were run individually. Upon arrival at the laboratory, initial measures of the subject's blood pressure and mood (on the Multiple Affect Adjective Checklist; Zuckerman, Lubin & Robins, 1965) were obtained. The experimenter then explained the subject's task (crossing out the letter "a" in columns of words). Approximately one-third of the subjects were also informed that they would be listening to bursts of noise played through headphones, while they worked on the task. The noise was described as the sound of a dentist drilling out a cavity, played at a sound level "about as loud as the level of a jackhammer if you walked past it while it was operating on the street" (NOISE condition). The subject was then presented with a pair of headphones and a consent form describing the experiment. Subjects were given several minutes to practice the task. During the practice session, they were given a sample burst of the noise (approx. 2 seconds at 100 dB(A)).

The perceived control manipulation involved treating another one-third of the subjects identically to the NOISE group. Additionally, these subjects were shown how a switch would turn on a light in the experimenter's control room. They were told that "although it is important for the sake of my research that you listen to all the noise...you may, if necessary, use this switch to alert me to stop the noise" (NOISE PC condition).

The remaining subjects were told only about the task of crossing out "As" (QUIET condition). Neither the consent form, nor the experimenter's instructions, mentioned the noise. They were told that they would wear a pair of headphones (unplugged) to block out any "extraneous distractions". They, too, practiced the task while wearing headphones.

The experimenter then gave the subject a questionnaire to answer which assessed their expectations about the noise and the degree to which they believed they would be able to terminate (control) it. While the subject was working on the questionnaire, there was a knock at the door. The experimenter answered the door and excused herself. A muffled conversation was held outside the door. This procedure was deemed necessary in order to lend credence to the procedures outlined below.

After approximately 1 minute, the experimenter rejoined the subject. The experimenter waited in the room until the subject had completed the experimental questionnaire, as necessary. The experimenter then announced that, due to scheduling problems and a backlog of subjects, there would not be enough time to do both experiments. Therefore, the subject would not have to be exposed to the dental noise after all. Even though they were relieved of having to listen to the noise, the experimenter explained that she wanted to go ahead and take their blood pressure and have them fill out some forms, as participants in the "second experiment" with the "other experimenter". The act of terminating the expectations in this manner provided the opportunity to measure the aftereffects of expecting exposure to aversive noise. Post-experimental interviews indicated that subjects believed the experimenter's excuse for not participating in the noise experiment. Support for the effectiveness of this instruction is also provided by previous studies in our laboratory that indicate decreased anxiety and depression among subjects relieved of the expectation that they will be exposed to a stressor (Spacapan & Cohen, in press).

All subjects agreed to this change in plans. The subject's blood pressure was taken and she again filled out the mood measure. The subject was then led to a separate room where the second experimenter (blind to the subject's experimental condition) administered a modified version of the Tolerance for Frustration task used by Glass and Singer.

In this version of the Tolerance for Frustration task, the subject is presented with two piles of line diagrams. Each pile is approximately 1 inch tall, and contains multiple copies of the same diagram. The diagrams are printed on 5 x 7 cards, and placed face down in front of the subject. The task is to trace over all the lines of the diagram without lifting pen from card and without tracing over any lines twice. The piles were placed in a specific order such that the subject would work first on an insolvable diagram and then on a solvable one. Subjects could take as many trials on a given diagram as they wished. The subject could choose to continue working on the same diagram, or move on the next pile (diagram) at any time, but could not return to a previous pile after proceeding to another. If the subject successfully completed the task for one diagram, she was to proceed to the next pile immediately. The total time allotted for the task was 10 minutes. The amount of time spent on each diagram was recorded . The more time spent on the insolvable diagram (Diagram 1), the greater was his/her tolerance for frustration (see Feather, 1961, for a full description of the task and its development). All subjects were then debriefed and had their height and weight measured (for use in the analysis of blood pressure data).

RESULTS

Manipulation Check

Data collected on the 7-point scales (were 1 = not at all, 7 = very) of the experimental questionnaire provided information on subjects' expectations of stressor exposure. Subjects expecting noise felt the experience would be more upsetting (NOISE $\underline{M}$ = 4.63, QUIET $\underline{M}$ = 1.47, NOISE PC $\underline{M}$ = 3.82; $\underline{F}(2, 50) = 33.41$, $\underline{p} < .001$) and more stressful (NOISE $\underline{M}$ = 4.53 QUIET $\underline{M}$ = 2.19, NOISE PC $\underline{M}$ = 3.59; $F(2, 49) = 10.50$, $\underline{p} < .001$) than subjects expecting the quiet condition. For both of these measures, post hoc comparisons by Scheffe"'s method reveal that QUIET is different from NOISE and from NOISE PC (all $\underline{p} < .05$), while the latter two conditions do not differ from one another. In addition, NOISE subjects felt more nervous (NOISE $\underline{M}$ = 3.05, QUIET $\underline{M}$ = 2.06, NOISE PC $\underline{M}$ = 2.47; $\underline{F}(2, 49) = 3.43$, $p < .04$) about the experiment than the other two groups. Post hoc comparisons by Scheffe"'s method revealed that in this case, QUIET differed from

NOISE ($p < .05$). While the mean for the NOISE PC group fell between the NOISE and QUIET means, it did not differ from either.

Subjects who expected exposure to noise also answered a scale assessing the degree to which they felt free to have the noise stopped. While subjects who expected to be able to control termination of the noise felt more free (NOISE PC $M = 4.23$) than subjects without control (NOISE $M = 3.79$), the difference was not significant.

Tolerance for Frustration

Time spent on the insolvable diagram (#1) was the measure of frustration tolerance; the less time spent, the less tolerance. An analysis of variance on this measure revealed an effect of the manipulation ($F(2, 52) = 6.13$, $p < .01$). Subjects who expected the noise without control spent a mean of 281 seconds on the task, while those expecting to be able to control the noise spent a mean of 437 seconds and those not expecting noise exposure spent a mean of 425 seconds. Post hoc comparisons by Scheffe's method support the fact that while the NOISE group was different from the QUIET group and the NOISE PC group (both $p < .05$), the latter two conditions did not differ from one another.

Blood Pressure and Mood

There were no effects of the experimental manipulations on these measures.

SUMMARY AND GENERAL DISCUSSION

When subjects' expectations of noise exposure were terminated, decreased frustration tolerance was observed in those subjects who had expected stressor exposure. Moreover, the expectation of control over stressor termination lessened the negative impact of stressor expectation after the anticipation period. In sum, it is apparent that there are

aftereffects of the anticipatory period that are similar to those produced by actual exposure to noise. It is noteworthy that we have found similar aftereffects of the anticipation of immersing one's hand in ice water (Spacapan & Cohen, in press).

It is not totally clear why there were no differences in blood pressure and mood by experimental conditions. It could be argued that these measures are only affected by actual exposure to noise, and not by the anticipation of such exposure. It should be noted, however, that studies of post-stimulation effects have not consistently found effects on these measures, while work with the tolerance for frustration task has been consistent.

The present research raises two important issues. First, it is unclear what mechanism is responsible for the observed decrease in tolerance for frustration. Second, given the demonstration of the powerful nature of stressor anticipation, one might question the actual contribution of stressor exposure in producing "poststimulation" effects.

Possible Mediators

Heightened arousal, negative mood, and attentional overload are a few of the explanations that have been offered for the poststimulation effects of stressor exposure (see Cohen, 1980). It is noteworthy that aftereffects of the anticipation period were obtained in the absence of evidence for these possible mediators. First, neither self-report nor physiological data support a heightened arousal hypothesis. Moreover, there was no evidence that either self-reported stress, or blood pressure were affected by the expectation of control. Second, the lack of differences between stressor conditions in self-reported mood suggest that mood is likewise unaffected by the anticipation of stress exposure, and hence plays a minor role (at best) in producing the frustration tolerance effects.

Finally, it is difficult to argue that attentional capacity was seriously depleted in the present research, given the brevity of the anticipation period and the absence of task demands during the anticipation period.

There are a number of explanations offered for the post exposure effect that are consistent with these results, although there is no direct evidence that they are applicable. For example, it is possible that those anticipating exposure to uncontrollable stressors use coping strategies during the anticipation period and maintain these strategies even after the expectation is terminated. Although a particular strategy may be adjustive during the anticipation period, it may interfere with task performance after expectancy termination (cf. Cohen, 1980). Similarly, a preoccupation with the threatening situation may persist to some degree after expectation termination resulting in distraction that affects performance on post-anticipation tasks.

It is worth noting that the fact that we find effects of anticipation that are analogous to the effects of exposure does not definitively indicate that these effects are mediated by the same mechanisms. However, the similarities are striking and such an assumption is not unfounded at this point.

Poststimulation vs. Postexpectation Effects

Is it possible that previously observed poststimulation effects are really "postexpectation" effects? We have demonstrated that stressor expectations are sufficient to produce aftereffects. Given this demonstration of the powerful nature of stressor anticipation, one might well question the actual contribution of stressor exposure in producing stressor effects. In other words, it is possible that both during-exposure and

after-exposure effects reported in the literature are wholly or partly attributable to residual effects of the anticipation period. While expectations of stressor exposure are sufficient to produce aftereffects, it remains for further research to demonstrate whether the manipulation of stressor expectation is necessary to produce similar effects during and after stressor exposure.

REFERENCES

Baum, A., & Greenberg, C. I., 1975. Waiting for a crowd: The behavioral and perceptual effects of anticipated crowding. Journal of Personality and Social Psychology. 32, 671-679.

Baum, A., & Koman, S., 1976. Differential response to anticipated crowding: Psychological effects of social and spatial density. Journal of Personality and Social Psychology. 34, 526-536.

Cohen, S., 1980. Aftereffects of stress on human performance and social behavior: A review of research and theory. Psychological Bulletin. 88, 82-108.

Feather, N. T., 1961. The relationship of persistence at a task to expectation of success and achievement related motives. Journal of Abnormal and Social Psychology. 63, 552-561.

Glass, D. C., & Singer, J. E., 1972. Urban Stress: Experiments on noise and social stressors. New York: Academic Press.

Glass, D. C., & Singer, J. E., 1973. Behavioral effects and aftereffects of noise. In W. D. Ward (Ed.), Proceedings of the International Congress on Noise as a Public Health Problem, Washington, D.C.: U. S. Environmental Protection Agency.

Spacapan, S., & Cohen, S., In press. The effects and aftereffects of anticipating stressor exposure. Journal of Personality and Social Psychology.

Zuckerman, M., Lubin, B., & Robins, S., 1965. Validation of the MAACL in clinical situations. Journal of Consulting Psychology. 29, 594.

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