Brief Cognitive and Relaxation Training Increases Tolerance for a Painful Clinical Electromyographic Examination

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We examined the effect of cognitive and/or relaxation training on the tolerance for a painful one and one-half hour clinical electromyographic (EMG) examination, which includes multiple electric shocks to nerves and multiple insertions of needle electrodes into muscles. Four groups of 10 males each received training as follows: (i) cognitive only, (ii) relaxation only, (iii) cognitive plus relaxation, and (iv) neither cognitive nor relaxation (control). The three trained groups tolerated the EMG study better than the control group as judged by assessments by "blind" observers, self-ratings, and measurements of heart rate. However, none of the training sessions was clearly superior to the other two types of training. We recommend cognitive relaxation training be used in the clinical setting to increase tolerance for painful medical procedures.

A growing number of papers have demonstrated that cognitive and behavioral interventions can increase pain tolerance and the perception of laboratory induced pain (1, 2). These experiments typically induce pain by having subjects immerse one hand in cold water (cold pressor task) or by restricting the blood flow in an arm (ischemic pain). Although the results of these studies are thought to be applicable to control of pain in the clinical situation, only a few experiments have attempted to assess directly the effect of behavioral interventions on tolerance for pain in clinical practice. As Ledwidge (3) emphasizes, research on the effectiveness of cognitive-behavior modification is more convincing if the data are collected in a clinical setting with the same patient population to whom the results are to be generalized. Many factors operate in a clinical setting which do not affect reactions in the laboratory. For example, clinically induced pain may be compounded by anxiety. In comparison to the laboratory analog, clinical patients are less likely to be reassured about potential damage, cause of pathology, or the nature of the procedure (4). In the present study, cognitive and behavioral interventions were used to help patients cope with the clinical pain associated with a stressful medical procedure known as electromyography.
THE ELECTROMYOGRAPH

Electromyograph (EMG) is a common neurological procedure that is performed to diagnose neuromuscular disorders and to gain information about the site and nature of the pathology. There are two parts to the examination: (i) the electrical stimulation of nerves and muscles by means of applied electrical currents, and (ii) the recording of action potentials during spontaneous or voluntary activity. During the first portion of the exam, a series of electric shocks with durations of 0.01 to 1 millisecond (MS) and output from 50 to 250 V is applied by means of surface electrodes. The second portion involves the insertion of needle electrodes into the muscles. Most patients experience some discomfort during the procedure, and the anticipation of forthcoming shocks and needle insertions tends to arouse anxiety and produce considerable discomfort. This is done in adults without routine use of tranquilizers or anesthetics.

COGNITIVE BEHAVIOR MODIFICATION

Cognitive behavior modification involves two distinct components. One component is cognitive and includes strategies which attempt to directly alter the internal dialogues in which people engage. It is this internal dialog, or talking to oneself, that determines expectations, evaluations, and focus of attention. Meichenbaum (5) has developed a strategy for increasing coping abilities by altering what people say to themselves in stressful situations. This procedure has been labeled stress-inoculation training. Meichenbaum’s procedure applies the technology of behavior therapy to the modification of cognitions. The other component is behavioral and involves relaxation training or a modified desensitization procedure. The Meichenbaum procedure has been shown to be remarkably effective for reducing stress in a wide variety of situations (5).

Turk (6) successfully applied Meichenbaum’s procedure to experimentally induced pain. Trainers described a variety of coping strategies from which subjects could choose to deal with the sensory-discriminative, motivation-affective, and cognitive-evaluative components of pain. Subjects were given relaxation training, suggestions for attention diversion and imagery manipulation, and instructions in generating positive self-statements to enhance coping with each phase of the pain experience. Measures obtained before and after the procedure included time that the ischemic pain was tolerated as well as verbal report of pain intensity. Results suggested a 15-min increase in tolerance for subjects in the training condition in comparison to a 1-min increase for an attention-placebo control group. This 15-min improvement in tolerance is particularly impressive since Smith, Chaing, and Regina (7) found that subjects’ tolerance for ischemic pain was prolonged by only 5 to 10 min following the administration of 10 mg of morphine. Since noxious medical exams are of brief duration, cognitive-behavioral interventions may provide an alternative to the use of drugs with toxic side effects.

Meichenbaum’s useful procedure confounds cognitive and behavioral interventions, thus it is often difficult to assess the contribution of each component. Results from studies attempting to compare the relative effectiveness of the two components have been mixed (3). In the present study, independent variation of the cogni-
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tive and relaxation procedures yielded four conditions: (i) cognitive only, (ii) relaxation only, (iii) cognitive plus relaxation, and (iv) neither cognitive nor relaxation. Although the fourth group received neither the cognitive nor the relaxation manipulation, they did receive attention from the experimenter in order to control for contact time and for the effects of experimenter support.

Theoretical models of pain and emotion (8) suggest that the observable reactions to pain experiences include: pain reports, cries of distress, facial expressions, and autonomic responses such as heart rate changes. Each of these categories is represented among the outcome measures.

METHOD

Subjects. Forty adult male patients who were scheduled to undergo a clinical electromyographic study at the La Jolla Veterans Administration Hospital served as volunteer subjects. Potential subjects were randomly assigned to one of the three training conditions or to the attention control group. Written informed consent was obtained from all subjects. Two patients declined participation in the study.

Experimenters. Two female psychology graduate students served as experimenters. All training sessions were conducted by an advanced clinical psychology graduate student. The observer was a graduate student in experimental psychology.

Procedure. Subjects in each of the training conditions were given: (i) a rationale for the coping strategy, (ii) specific training instructions for the relaxation and/or cognitive modification, and (iii) an opportunity to practice the coping skills by means of imagery rehearsal.

Experimental Conditions

Relaxation training. One-half the subjects received relaxation training. They were told that many people react to potentially painful procedures by tensing their muscles, and that muscle tension can actually increase the experience of pain. The example of natural childbirth methods was given to emphasize that relaxation has been shown to reduce pain and minimize stress. Next, the subject was instructed through several steps of the tension-release technique of progressive relaxation training (9). A deep breathing technique was then described as a way to achieve the desired state of relaxation. Filling the lungs completely with several short, deep breaths followed by a slow, prolonged exhalation was demonstrated by the experimenter and practiced by the subject several times. Finally, the subject was instructed to close his eyes and imagine himself in the examination room. As he visualized the doctor beginning the examination, he was instructed to practice the breathing technique and to bring about a state of relaxation.

Cognitive reappraisal. Subjects in the cognitive reappraisal condition were told that thoughts about a potentially painful situation can greatly influence the amount of discomfort. The example of how negative or positive thinking can affect people's reactions to dental procedures was described to demonstrate that thoughts commonly influence experiences. The subjects were instructed to focus their attention on positive aspects of the situation and to think in a positive, calming manner. A tape recording of positive, coping self-statements was played to model for the subjects the type of thoughts they were to engage in while undergoing the medical procedure. The tape was in narrative style, for example: "When I started to feel some pain, I would say things like 'this does hurt, but I can handle it...one step at a time...don't think about the pain...relax.' " After listening to the tape, subjects were instructed to close their eyes and to imagine themselves in the examination room. The subject then described what he imagined and practiced the positive type of self-talk he was to use. The experimenter gave feedback and instructed the subject through a second rehearsal.

Cognitive Behavior Modification. Subjects in the cognitive-behavior modification condition were given the same rationale as that given to subjects in the cognitive reappraisal condition. It was suggested that negative thoughts and tension increase pain, so both intervention strategies, positive thinking, and relaxation training, were plausible ways to decrease pain. Subjects in this combined condition received the relaxation training with one rehearsal followed by the cognitive modification instructions with one
rehearsal. Finally, they were instructed to practice both strategies by covertly rehearsing the positive self-talk while breathing in the prescribed manner. Each treatment lasted about fifteen minutes.

Attention Control Group. Subjects in the control condition did not receive instructions to engage in any coping strategy. However, they were interviewed by the experimenter for 15 min to provide an approximate control for exposure time and for attention from the experimenter. Questions about demographic characteristics and general health were asked to convey interest and concern for the patient as an individual.

Outcome Measures

The EMG procedure always began within 15 min after completion of the experimental training session. In order to monitor heart rate, the observer (who was "blinded" to the preceding training condition) attached the finger clip of the heart rate monitor (Lafayette Instruments Model 77065) to the hand opposite the side of the body being examined. During the procedure, heart rate was recorded prior to, during, and immediately after each electrical stimulation and needle electrode insertion. These multiple observations of heart rate were averaged to obtain a single score. Following each shock or needle insertion, the observer asked the subject to rate the degree of discomfort just experienced and recorded the numerical response. These ratings were obtained on an 11-point category scale with poles 0 for not painful at all to 10 for extremely painful. Subjects had received instructions on the use of the scale before the exam began. Several behavioral observations were recorded during the procedure. These included gross body movements, facial grimaces, and distress vocalizations. The observer had been assessed at an accuracy (agreement with criterion) rate of greater than 90%.

After the physician completed the EMG, the observer administered the post-examination questionnaire which asked for other self-ratings of anxiety and discomfort and about perceived benefit of the intervention. Upon completing the questionnaire, the subject’s participation in the study was completed. Finally, the physician rated the degree of distress displayed by the patient during the procedure on an 11-point category scale ranging from 0 for not distressed at all to 10 for extremely distressed.

RESULTS

The data were analyzed using the method of planned comparisons. Three orthogonal contrasts were specified in advance of the experiment. The first compared the average of the three experimental groups to the attention control group (coefficients = −3, 1, 1 for control, relaxation, cognitive—cognitive—relaxation, respectively). The second compared the combination cognitive—relaxation condition to the cognitive only and the relaxation only condition (0, −1, −1, 2). The third orthogonal contrast compared the cognitive only versus the relaxation only conditions (0, 1, −1, 0).

The results of the analyses were very consistent over a wide array of dependent variables. The means for all variables broken down by group are presented in Table 1. The repeated finding was that the three treated groups exhibited less distress than did the attention control group. Ratings by the physicians who performed the exams (and who were blind to treatment condition) suggested that the control patients were more distressed during the exam ($F_{1/36} = 5.11, p < 0.05$). Patients in the control group also reported experiencing more pain during the examination than those in the experimental groups ($F_{1/36} = 6.00, p < 0.05$). After the exam was over the experimental subjects reported that they had received more benefits than had the controls ($F_{1/32} = 7.46, p < 0.01$). Finally, heart rates remained lower for the experimental subjects than for the controls ($F_{1/32} = 5.52, p < 0.05$). The heart rate data were essentially the same at each evaluation period. Therefore this analysis represents the mean across three evaluation periods, averaged to obtain greater reliability. Technically it is
inappropriate to perform $2 \times 2$ analysis of variance after using the degrees of freedom for the planned comparisons. However, a post hoc review of the data suggested that the two relaxation groups had lower mean hearts rates than the two groups not given relaxation training. Indeed, this was confirmed in a $2 \times 2$ ANOVA ($F_{1,96} = 5.24$, $p < 0.05$). The other main effect and the interaction for this analysis of heart rate data were nonsignificant.

Although ratings by the blind observer showed that the experimental subjects appeared less distressed during the exam than the control subjects, these differences were only marginally significant ($F_{1,36} = 3.50$, $p < 0.07$).

The other two orthogonal contrasts compared the effectiveness of the cognitive—relaxation combination in comparison to the cognitive only and relaxation only approaches, and the differences between relaxation and cognitive. These contrasts were not statistically significant for any dependent variable.

The planned comparisons were also performed for the behavioral observation data. These data were frequencies for gross body movements, facial grimaces, and distress vocalizations during the examination. Although there were trends in the direction of the first contrast for all three of the analyses, the results were nonsignificant. Multivariate analysis of variance using all of the dependent variables was ruled out because the ratio of subjects to variable could not support reliable multivariate functions (10).

In summary, the data suggest the experimental groups consistently differ from the attention control group, with less convincing evidence that the experimental interventions differed from one another.

The correlations between the dependent variables are presented in Table 2. Behavioral manifestations of distress,
such as body movements, facial grimaces, and vocalizations tended to be significantly correlated with ratings by the attending physician and the observer. These data suggest that the patients’ overt signs of distress were noted by the observers. It is interesting that overt behaviors had less impact on the patients’ own evaluations of distress. Heart rate tended to be uncorrelated with nearly all other measures. However, it had a weak negative correlation with doctor-rated distress \( p < 0.10 \). The only significant correlation involving heart rate was a positive relationship with patient-rated distress \( p < 0.03 \). This suggests that the patients attended to their own heart rate while heart rate was not associated with the behavioral cues noted by the observer.

**DISCUSSION**

The results of the experiment suggest that cognitive and behavioral training can be of benefit for patients during a painful medical procedure such as an EMG examination. Although earlier laboratory research had demonstrated that cognitive and behavioral interventions can increase pain tolerance \( p < 0.10 \) and anxiety in nonmedical situations \( p < 0.03 \), there have been few empirical demonstrations that these methods are successful for coping during real clinical procedures \( p < 0.03 \).

Advice on the “best” intervention does not clearly emerge from the present study. The results suggest that the treatments may have similar effects. There are several explanations for this finding. It might be argued that credibility of the treatment, rather than its specific content is responsible for the change. Yet, the data suggest that there were effects which were independent of perceived benefit. There were effects for ratings by the blind physician and observer, yet these outcomes were not significantly correlated with perceived benefit. Another explanation is that the three treatments used similar behavioral strategies. For example, the cognitive intervention taught subjects to identify pain producing cues and to tell themselves to “relax.” Despite its grounding in behavior theory, relaxation training may influence patients to use a cognitive strategy while in the exam room. Although we did not obtain formal data, some patients in the relaxation group reported that they talked to themselves in a positive manner during the examination (i.e., “I can handle this because I know how to relax my muscles”). Thus, the three interventions may have generated the same psychological effect \( p < 0.03 \). A third explanation for the small differences between the experimental groups is that there were too few subjects to detect differences. Future research with larger samples may be able to test for differences with greater statistical power.

Despite the marginal differences between the three experimental groups, the evidence suggests that the interventions were consistently more effective than only support and attention. If we were to recommend a single intervention for clinical use, the cognitive—behavioral approach seems to be the best candidate. Although our data do not show clear superiority for this method, they do not suggest any contraindications. Among the three approaches, the cognitive—behavioral approach has the widest spectrum and may appeal to the largest number of patients. Considering several outcome measures, the mean for the cognitive—relaxation combination was most consistently in the appropriate direction. In addition, a variety of related studies have obtained en-
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couraging results with a cognitive-behavioral approach (14, 15, 16).

Schwartz, Davidson, and colleagues (17, 18) have offered a psychobiological analysis of anxiety that divides responses into cognitive and somatic components. Some interventions, they argue, should affect somatic anxiety responses while others should affect cognitive aspects of anxiety. Schwartz et al. (18) have offered preliminary data supporting their position. Our data also support this analysis. Patients given skeletal muscle relaxation training show decreases in heart rate, while cognitive therapy groups did not. However, cognitive therapy groups did change on self-report measures. Similar analyses of test-taking anxiety have also suggested somatic and cognitive subcomponents of anxiety (19). We feel this is an important distinction which requires continued scrutiny in research and practice.

Personality characteristics were not considered because we had only limited time with each patient. Indeed personality assessment would have been more time consuming than the treatments themselves. A recent paper by Shipley, Butt, and Horwitz (20) suggests that patients classified as repressors and sensitizers respond differently to preparation for a stressful endoscopy examination. However, it is not clear that repression—sensitization coping style would have interacted with the cognitive and behavioral interventions in the present study. Beers and Karoly (14) found no relation between coping style and effect of cognitive and behavioral interventions in a study of cold-pressor tolerance. More research is needed to evaluate the importance of repression—sensitization for coping with stressful medical exams.

It is worth noting that the effects observed in the present study are not particularly strong. Longer and repeated interventions might have been more effective in producing more distinctive experimental effects. However, psychological preparations for the electromyogram would not be useful in practice if they were time consuming or required repeated visits. The brief interventions applied in this study could be utilized within the period patients typically spend in a waiting room and would not require serious constraints on scheduling. The modest experimental effects suggest that the interventions could be useful within the clinical practice of neurology.

REFERENCES