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Spontaneous Cognitive Strategies for the Control of Clinical Pain and Stress

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The spontaneous cognitive strategies employed by 75 patients undergoing dental extractions or mandibular block injections were elicited using a structured interview. Interest focused on the relationship between these strategies and several personality variables, including state and trait anxiety, locus of control, and absorption. In addition, the effect of strategy utilization on perceived pain and stress was assessed. Fourty-four percent of the patients employed cognitive strategies designed to minimize pain and stress, while 37% catastrophized, engaging in cognitive activity which exaggerated the fearful aspects of their experience. Only 19% of the patients denied any cognitive activity during the clinical procedure, and many of these used noncognitive coping strategies. Discriminant analysis revealed that situational anxiety was associated with the use of cognitive coping strategies. Catastrophizing was associated with increasing age, past dental stress, and higher levels of stress vulnerability (high trait anxiety and external locus of control). Copers reported less stress than catastrophizers but not less pain.

KEY WORDS: cognition; pain; dental anxiety; stress management.

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INTRODUCTION

The cognitive events accompanying painful or stressful stimulation have been studied intensively during recent years. One reason for this interest is the assumption that the magnitude of pain and stress experienced may be attenuated or exacerbated as a consequence of the cognitive events which accompany them (Barber *et al.*, 1974; Tan, 1982; Turk *et al.*, 1983; Turner and Chapman, 1982).

One approach to this area has been to provide subjects with cognitive strategies to employ during painful stimulation (e.g., Beers and Karoly, 1979; Chaves and Barber, 1974; Chaves and Doney, 1976; Chaves and Scott, 1979; Grimm and Kanfer, 1976; Spanos *et al.*, 1981). These strategies typically require subjects to engage in a pattern of thinking and imagining designed to attenuate pain and stress. For example, subjects have been asked to imagine that they are engaged in a pleasant or affectively neutral situation or to imagine that the painful stimulus has been rendered innocuous. Research conducted along these lines had generally confirmed the notion that the utilization of such cognitive strategies by subjects exposed to experimentally produced pain increases the pain threshold, decreases the reported pain magnitude, and increases pain tolerance.

Recent reports suggest that cognitive strategies may also be effective in attenuating clinical pain. For example, Rybstein-Blinchek (1979) found that patients taught reinterpretative and attention diversion strategies showed greater attenuation of pain than control subjects. Brown (1984) found that migraineurs taught to use imaginal coping strategies reported decreased headache activity compared to placebo controls. These reports, together with studies of the role of cognitive strategies in reducing experimental pain, suggest the potential clinical value of training patients to employ these techniques. However, there are indications that administered cognitive strategies may interact in complex ways with spontaneous, self-generated strategies that are already within the patient's repertoire (Chaves and Barber, 1974; Turk *et al.*, 1983).

Postexperimental inquiries conducted with experimental pain subjects have revealed that some subjects asked to employ one type of cognitive strategy for reducing pain have sometimes indicated a preference for employing their own strategy (Chaves and Barber, 1974). Moreover, subjects who are offered a choice of strategies show greater attenuation of pain than those not provided with such choice (Worthington, 1978). The notion that active patient involvement in strategy selection could improve the initiation and persistence of cognitive coping behavior is consistent with Bandura's (1968) theory of self-efficacy.

The present study was designed to investigate the type and prevalence of spontaneous strategies used by patients undergoing dental procedures and to determine how the use of these strategies relates to potentially relevant personality variables such as state and trait anxiety and locus of control. Finally, the study examined the effect of strategy utilization on reported pain and stress.

METHOD

Subjects

The subjects for this investigation were 75 adult patients being seen by second-year dental students at the Southern Illinois University Dental School or by private dental practitioners associated with the dental school. A total of 58 patients (77%) came from the dental school clinic, while 17 (23%) came from private dental practices. The private practitioners and second-year dental students notified the experimenter (JMB) when patients were identified who required one of two dental procedures: a mandibular block injection prior to a restorative dental procedure or a simple extraction of one or two teeth. A mandibular block injection refers to the induction of anesthesia in the trunk of the inferior alveolar nerve by injecting a local anesthesia close to the nerve before it enters the body of the mandible (Boucher, 1963). A simple extraction refers to a method of removing a tooth intraalveolary (from within the bony socket) by means of elevators and/or forceps (Boucher, 1963). Prior to the injection of local anesthesia, topical anesthesia (Hurricane Jell) composed of ethylaminobenzoate in water-soluble polyethylene glycol base was applied in the area to be injected. Only patients receiving local anesthesia and no additional medication were included in the study. The local anesthesia employed was a 2% solution of lidocaine hydochloride (Xylocaine) with epinephrine (1:100,000).

Four patients declined to participate in the investigation. Of the patients who volunteered for the study, four were eliminated. Three subjects were eliminated because they were unable to complete the questionnaires, and one because the surgeon judged participation to involve unnecessary stress for the patient.

Instruments

Demographic Data. Information regarding age, sex, and race was obtained for each subject. Social class was determined by Hollingshead's (1957)

Two-Factor Index of Social Position. Social-class ratings were based on both spouses' educational and occupational status rather than just the husband's in order to provide a more balanced measure (Haug, 1973).

Anxiety Measures. We hypothesized that the cognitive events which accompany the pain and the stress of the dental procedures might vary as a function of anxiety. Accordingly, all subjects completed both forms of the State-Trait Anxiety Inventory (STAI; Spielberger *et al.,* 1970). In addition, the dental setting frequently elicits specific anxieties which are unique to that setting. The Dental Anxiety Scale (DAS; Corah, 1969) was administered to assess the presence and magnitude of these concerns.

Locus of Control. The extent to which patients employed strategies to control their responses to pain and stress may be determined by the extent to which they viewed the reinforcements they received as determined by their own behavior and skills (internal) or by luck, fate, or chance (external). Rotter's (1966) Internal-External Locus of Control Scale was administered to assess this attitudinal dimension.

Tellegen's Absorption Scale. Tellegen's Absorption Scale (Tellegen and Atkinson, 1974) was administered to measure the subject's "disposition for having episodes of *total* attention that fully engages one's representational (i.e., perceptual, enactive, imaginative, and ideational) resources" (Tellegen and Atkinson, 1974, p. 268). We hypothesized that high scorers on the absorption scale might be better able to employ imaginative strategies to reduce pain and stress.

Self-Report Measures of Pain and Stress. Subjects were asked to rate on 10-point Likert-type scales (1) the degree of stress of the same dental procedure in the past, (2) the degree of nervousness while waiting for the appointment, (3) the degree of stress of the current procedure, and (4) the degree of pain of the current procedure.

Structured Interview. In order to assess the patient's cognitive activity during the dental procedure each patient was engaged in a structured, tape-recorded interview in which he/she was asked to tell the experimenter as completely as possible what was going through his/her mind during the procedure. All subjects were asked if they were aware of saying anything to themselves and if they had mental pictures or images during the procedure. Finally, patients were asked whether they did anything they felt would help them cope with the situation.

Transcripts of the interviews were reviewed independently by two judges, using a specially prepared guide. This guide incorporated some of the pain-control strategies described by Meichenbaum and Turk (1976). The judges were psychology graduate students who were aware of the general purpose of the study but who had no knowledge of the patients' test scores of their pain and stress ratings. Each transcript was evaluated for the presence of

cognitive coping strategies and catastrophizing ideation. If patients reported both coping and catastrophizing ideation, judges were asked to determine which type of cognition predominated. Patients who reported neither coping nor catastrophizing were identified as "deniers."

Sequence of Procedures

Prior to the patient's appointment, an informed consent form was completed, demographic information was obtained, and the patient completed the STAI and the DAS. The patient was then escorted to a dental operatory where the indicated dental procedures were performed. The patients undergoing extractions received topical anesthesia followed by an injection of local anesthesia appropriate to the extraction and then the actual extraction. Patients being prepared for restorative dental procedures first received topical anesthesia and then a mandibular block injection. Dentists did not talk to or otherwise distract the patient during these procedures. Immediately after the injection, patients completed self-report scales measuring the pain and stress associated with the dental procedure. A structured interview was then conducted while the patient remained in the dental operatory. Immediately following the dental appointment, patients completed Tellegan and Atkinson's Absorption Scale and Rotter's Locus of Control Scale.

RESULTS

The demographic characteristics of the patient population are shown in Table I. Most of the patients were Caucasian, although the sample was relatively diverse with respect to age and socioeconomic status. More patients (65%) received mandibular block injections than extractions.

An examination of the interview protocols revealed that 44% of the patients employed spontaneous coping strategies during these dental procedures. An additional 19% denied using any strategies while undergoing the dental procedures. Finally, 37% were found to have engaged in various kinds of catastrophizing ideation during the dental procedure. Our raters were able to assign patients to these three groups (copers, deniers, catastrophizers) with a high reliability; they agreed in 87% of the cases. The resulting contingency coefficient is 0.75 of a maximum possible contingency coefficient of 0.82 (Siegel, 1956).

The types of strategies employed by our subjects are presented in Table II. As can be seen, attention diversion and coping self-statements were the most commonly employed coping strategies. Catastrophizing throughts were the most common maladaptive ideation.

Table I. Cognitive Strategies and Dental Pain and Stress

Sex	
Male	32 (43%)
Female	43 (57%)
Race	
White	68 (91%)
Black	7 (9%)
Age	
15–25	22 (29%)
26–40	28 (37%)
41–65	21 (28%)
66–78	4 (5%)
Socioeconomic status[a]	
1	6 (8%)
2	13 (17%)
3	17 (23%)
4	23 (31%)
5	16 (21%)
Dental procedure	
Extractions	26 (35%)
Injections	49 (65%)
Place	
Clinic	58 (77%)
Private practice	17 (23%)

[a]Source: Hollingshead (1957).

Table II. Categories of Strategies[a]

Strategy	Frequency	Percentage
Coping		
Attention diversion—refocusing on something other than stressful situation	17	19
Somatization—attempt to control physiological result of stress (e.g., slow heart rate)	8	9
Imaginative inattention—daydreaming about some pleasant experience	4	5
Imaginative transformation of context—imaginatively transforming the meaning of stress by altering context	1	1
Imaginative transformation of stress—imaginatively transforming stress response into some other set of responses	2	2
Coping self-statements—positive self-verbalizations	15	17
Dissociation—imaginatively separating oneself from one's physical sensations of pain or stress	1	1
Catastrophizing		
Negative self-statements—internal verbalizations of a negative nature	11	12
Catastrophizing thoughts—nonimagery negative thoughts	25	28
Catastrophizing images—images of a negative nature	5	6
Total	89	100

[a]A more detailed discription of strategies can be obtained from the authors.

Table III. Pearson Product-Moment Correlations Among Anxiety, Stress, and Pain Measures

	State anxiety	Trait anxiety	Dental anxiety	Past dental stress	Nervousness	Stress	Pain
State anxiety	1.00						
Trait anxiety	0.51*	1.00					
Dental anxiety	0.72*	0.38*	1.00				
Past dental Stress	0.37*	0.25	0.46*	1.00			
Nervousness	0.57*	0.24	0.58*	0.48*	1.00		
Stress	0.43*	0.14	0.50*	0.75*	0.54*	1.00	
Pain	−0.03	−0.08	0.06	0.39*	0.18	0.53*	1.00

*$P < 0.001$.

As expected, a number of significant correlations were found among the measures employed in this study. These correlations are displayed in Table III. Significant correlations were found between state and trait anxiety and between state anxiety and dental anxiety.

The correlation between trait anxiety and dental anxiety ($r = 0.38$) is significantly lower [$t(72) = 5.05$, $P < 0.001$] than the correlation between state anxiety and dental anxiety ($r = 0.72$). Stress ratings were significantly correlated with state anxiety, denial anxiety, past dental stress, and nervousness but not with trait anxiety. Surprisingly, the magnitude of reported pain was not significantly correlated with state anxiety, trait anxiety, or dental anxiety, although it was correlated with past dental stress.

In order to determine whether the psychological variables measured in this study differentiated among the three groups (copers, deniers, and catastrophizers) and to determine the relative importance of each variable in discriminating among the groups, multivariate analysis of variance (MANOVA) and multiple discriminant analysis (MDA) were performed. Since multicollinearity can obscure the results of MDA (Borgen and Selling, 1978; Sanathanan, 1975) and several variables in the present study were found to be highly correlated, a principal-components factor analysis was employed to determine which, it any, of the variables could be combined for the MANOVA and MDA. Three factors were rotated orthogonally using the varimax method. The results are presented in Table IV.

State anxiety and dental anxiety both loaded highly on one factor. The standard scores of these two variables were combined to form a new variable which we called situational anxiety. Additionally, trait anxiety and external locus of control loaded highly on the second factor, and the standard scores of these two variables were combined to form a new variable called stress vulnerability.

A MANOVA was then performed to determine whether age, socioeconomic status, past dental stress, nervousness, absorption, situational anxiety, and stress vulnerability could differentiate significantly among the

Table IV. Cognitive Strategies and Dental Pain and Stress: Varimax-Rotated Factor Matrix

	Factor		
	1	2	3
State anxiety	0.809	0.338	−0.014
Trait anxiety	0.326	0.660	−0.001
Dental anxiety	0.786	0.218	0.134
Past dental stress	0.417	0.176	0.644
Nervousness	0.701	0.017	0.264
Absortion	0.010	0.033	0.329
Locus of control	0.045	0.545	0.158

three groups of subjects. The MANOVA revealed that these variables could differentiate among the groups [$U(7,2,72) = 0.6682$, $P < 0.015$]. Box's m statistic for homogenity of variance-covariance matrices was performed [$F(56,5646) = 1.033$] and was not significant ($P = < 0.411$).

A stepwise multiple discriminant analysis was performed to find the linear combination of variables that would maximally discriminate the copers, deniers, and catastrophizers. The stepwise procedure selects variables in order of their discriminatory power when combined with previously selected variables. The criterion for selection of variables was the minimization of Wilk's lambda with a partial multivariate F greater than unity. With three groups being discriminated, two discriminant functions were possible.

The first discriminant function was significant [$F(14,132) = 2.11$, $P < 0.015$], while the second was more dubious [$F(6,66) = 1.52$, $P < 0.185$]. Table V shows the resulting group centroids for the copers, catastrophizers, and deniers. The first discriminant function separated coping and catastrophizing, with the deniers falling in between. The second discriminant function separated the deniers from both the copers and the catastrophizers, who, in turn, appeared to fall close together. Eigenvalues revealed that the first discriminant function accounted for 69.7% of the discriminatory power of the variables, while the second discriminant function accounted for only 31.1% of the discriminatory power.

Table VI presents the canonical correlations for each discriminant function and the standardized discriminant function coefficient for each variable. The canonical correlation reflects the extent to which variations in group assignment (copers, catastrophizers, deniers) can be explained by the variables retained in the discriminant analysis. The standardized discriminant function coefficient, on the other hand, reflects the relative influence of each of the variables and permits us to see how each variable contributed to the separation of the three groups.

Standardized coefficients for the first discriminant function indicate that nervousness and, to a lesser extent, increasing age, lower socioeconomic status, past dental stress, and stress vulnerability are associated with catastrophizing. Situational anxiety is associated with coping. The second discriminant function is characterized by high loadings for absorption, which

Table V. Cognitive Strategies and Dental Pain and Stress: Group Centroids in Reduced Space

	Discriminant function	
Group	I	II
Copers	0.565	0.170
Catastrophizers	−0.660	0.179
Deniers	−0.013	−0.758

Table VI. Standardized Discriminant Function Coefficients and Canonical Correlations for Copers vs. Catastrophizers vs. Deniers

	Discriminant function	
	I	II
	Canonical correlation	
Variable	0.49	0.38
Age	−0.572	0.108
Socioeconomic status	−0.409	−0.645
Situational anxiety	0.659	0.013
Stress vulnerability	−0.415	0.338
Nervousness	−0.912	0.241
Absorption	−0.009	0.774
Past denial stress	0.449	0.078

is associated with the presence of either coping or catastrophizing ideations, and socioeconomic status, which reflects an association between a lower socioeconomic status and the denial of cognitive activity.

One measure of the value of MDA is the extent to which derived functions result in a correct reclassification of the subjects. A total of 56% of all subjects could be correctly classified a copers, catastrophizers, or deniers using the discriminant function ($\chi^2 = 17.34$, $P < 0.001$). Univariate F tests revealed significant differences among the three groups on ratings of past denial stress [$F(2,72) = 3.62$, $P < 0.05$], nervousness [$F(2, 72) = 4.30$, $P < 0.05$], and socioeconomic status [$F(2,72) = 3.47$, $P < 0.05$]. Differences on Tellegen's Absorption Scale were marginal ($0.05 < P < 0.10$). Chi-square analyses revealed no significant differences among the three groups on sex, race, dental procedure, or location of the dental procedure (clinic or private practice). As expected, patients who reported using coping strategies during dental treatment rated their experience as significantly less stressful than the catastrophizers ($t = 1.79$, $P < 0.05$). However, there was no significant difference in pain ratings between the patients using coping strategies and those who denied cognitive activity or between the deniers and the catastrophizers. This finding, which is in marked contrast with the usual findings with experimentally produced pain, may be due to the fact that the dental procedures employed in the present study were not very painful.

DISCUSSION

The results of the present study reveal that a substantial number of dental patients, exposed to clinical pain and stress, employ self-generated cognitive strategies to help them control their response to this stress. The types of

strategies employed by these patients were diverse, with an insufficient number employing any one type of strategy to make any confident assertions regarding the prevalence or efficacy of any particular type of strategy. Future research will need to explore the relative efficacy of such strategies as coping self-statements and attention diversion.

Just as coping strategies took various forms, catastrophizing also was displayed in various forms, including negative self-statements, catastrophizing thoughts, and catastrophizing imagery. Additional research will be needed to determine which forms of catastrophizing amplify stress the most as well as to identify alternative techniques for disrupting these different forms of catastrophizing.

The present study revealed that copers and catastrophizers differ in some important and interesting ways. The association between situational anxiety and coping reinforces the notion that anxiety can often serve as a cue in eliciting adaptive behavior. It may be, as Janis (1965) has suggested, that people who cope adequately with stress mentally rehearse the forthcoming stressful event, which he regards as essential for generating self-delivered assurances. Alternatively, failure to cope with stress is thought by Janis (1965) to involve the absence of anticipatory apprehension and mental rehearsal, leading to feelings of helplessness when the threat materializes, as well as increased expectation of vulnerability. Janis' view that the "work of worry" is associated with anticipatory anxiety, but diminished stress during and after the threatening event, has received empirical support in the clinical setting, especially from studies of hospitalized patients (e.g., Andrews, 1970; Burstein and Meichenbaum, 1974; Egbert *et al.*, 1964). It should be noted that the expected relationship between anticipatory anxiety and coping is sometimes not detected (e.g., Johnson *et al.*, 1971). As applied to the present findings, the "work of worrying" conceptualization suggests that the copers experienced sufficient anxiety regarding their dental treatment that they identified and executed specific strategies to help attenuate their response to their situation. The catastrophizers, on the other hand, denied their anxiety or failed to recognize their situational anxiety and were unprepared to cope with the impending stress and thus engaged in catastrophizing ideation. In light of the high ambient levels of anxiety these patients experience in general, perhaps they have difficulty recognizing and preparing for situations associated with moderate levels of anxiety for most people.

Trait anxiety, together with a high external locus of control (stress vulnerability), was associated with catastrophizing in the present study. Perhaps a perceived lack of control over one's life results in a generalized apprehensiveness which is reflected in chronic catastrophizing ideation. Conversely, the tendency to catastrophize may result in generalized apprehensiveness and feelings of helplessness. In any case, the observation of a

relationship between high trait anxiety and catastrophizing ideation has been reported by others (e.g., Fox *et al.*,1983; Houston, 1977).

The relationship between the demographic variables and the presence of coping or catastrophizing ideation also merits further investigation. The reasons for the association between increasing age and catastrophizing is unclear. One possibility is that older patients typically require more extensive dental work or are faced with the possibility of becoming edentulous. Alternatively, they may have suffered more dental trauma during early life because of the more primative dental treatment techniques used at that time. Thus, this association between age and catastrophizing may reflect the development of dental technology over time. Further research is needed to select between these alternative explanations and to help decide whether the prevalence of coping and catastrophizing changes with age.

The increased prevalence of coping ideation among patients from higher socioeconomic levels also can be explained in several ways. One possibility is that better-educated patients are more likely to be aware of and to rely on the use of cognitive skills than patients from lower socioeconomic levels. It would be interesting to see whether patients from lower socioeconomic levels were more prone to rely on motoric coping strategies, such as clutching the arms of the dental chair ("white knuckling"). Our "deniers" employed such noncognitive strategies. Unfortunately, we did not collect sufficient systematic data that could provide answers to these interesting questions.

An interesting finding from a clinical viewpoint is that it was more important for patients to avoid catastrophizing than to engage in coping. The deniers behaved quite similarly to the copers. The only characteristic which seemed to be able to separate these two groups of patients was absorption, as measured by Tellegan and Atkinson's scale. It is probably not surprising that patients who display the kind of total cognitive involvement indexed by high scores on this scale would be more likely to rely on cognitive mechanisms for coping with stress than would patients not having that ability.

Probably the most important finding of the present study is that most individuals exposed to clinical stress and pain engage in cognitive activity relevant to that experience. Those patients who catastrophize appear to amplify their stress, while those who engage in coping ideation attenuate their stress. Strategy utilization did not have a significant effect on pain ratings in the present study, although many other studies have documented the influence of cognitive activity on pain (e.g., Chaves and Barber, 1974). The failure to find an effect on pain in the present study may be due to the fact that the dental procedures employed are not particularly painful for most patients, although they are experienced as stressful. Thus, mean pain ratings were less than two points on a ten point scale. The Chaves and Barber (1974) study which employed the same scale found average pain ratings above 6.0, more

than three times higher than those measured in the present study. Similar data need to be collected with other, more painful medical and dental procedures.

Another interesting set of questions arises regarding the interaction between spontaneous cognitive activity during pain and stress and suggested coping strategies which might be incorporated within, for example, a hypnotic treatment or cognitive interventions such as stress inoculation (Barber *et al.*, 1974; Turk *et al.*, 1983). Are strategies for pain and stress management most effective when they articulate with the preexisting cognitions with which the patient copes or catastrophizes? Thus, patients prone to use distraction might have that ability enhanced with alternative means being suggested. Or is it more effective to broaden the spectrum of coping skills by introducing new and, perhaps, unfamiliar strategies or even multiple strategies? Clearly, much remains to be done to explore fully the potential of cognitive strategies as self-management tools.

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