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9

Self-Efficacy Mechanism in Physiological Activation and Health-Promoting Behavior

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It is now widely acknowledged that people's health rests partly in their own hands. To prevent the ravages of disease, they must exercise control over their health habits and the environmental conditions that impair physical well-being. How well they cope with the demands of everyday life can have significant impact on biological systems that affect the quality of health at any given time and the development of chronic dysfunctions. Psychosocial determinants of biological functioning and health status thus operate, in part, through the exercise of personal agency.

Among the different mechanisms of personal agency, none is more central or pervasive than people's beliefs in their capability to exercise control over their own motivation and behavior, and over environmental demands. Converging evidence from diverse lines of research shows that perceived self-efficacy operates as one cognitive mechanism linking psychosocial influences to health functioning (5). Perceived self-efficacy refers to beliefs in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands.

One can distinguish two levels of research on the psychosocial determinants of health functioning in which efficacy plays an influential role. The more basic level examines the biochemical mediators of efficacy effects on health. The second level is concerned with reducing habits that impair health and promote those that enhance it. Before addressing these two lines of research, I would like to comment briefly on the diverse sources and effects of self-efficacy beliefs.

FUNCTION AND DIVERSE EFFECTS OF SELF-EFFICACY BELIEFS

In their daily lives, people continuously have to make decisions about whether or not to attempt certain courses of action and how long to pursue

those they have undertaken. Such decisions are partly determined by judgments of personal efficacy. Appropriate self-appraisal of capabilities plays an important role in successful functioning. Serious misjudgments of personal efficacy in either direction can produce adverse consequences. People who grossly overestimate their capabilities undertake activities that are well beyond their reach. This begets high disappointments, failures, and many other troublesome consequences. People who underestimate their capabilities also bear costs, although these are more likely to take self-limiting forms. Such individuals shun activities that cultivate competencies and offer potential rewards. When they approach task demands with a sense of inefficacy, they generate debilitating thought patterns and stress reactions that take a toll on the body and create internal obstacles to effective functioning.

Self-percepts of efficacy regulate psychosocial functioning in diverse ways. They affect what people choose to do, how much effort they will mobilize in a given endeavor, how long they will persevere in the face of difficulties and setbacks, whether their thought patterns are self-hindering or self-aiding, and the amount of stress and despondency they experience in coping with environmental demands.

SOURCES OF PERCEIVED SELF-EFFICACY

People's beliefs about their efficacy can be altered in four principal ways (5). The most effective way of instilling a strong sense of efficacy is through *mastery experiences*. Successes build a robust sense of efficacy. Self-efficacy is best developed through a series of subgoals that serve to expand competencies. Subgoal attainments provide indicants of mastery for enhancing a sense of personal efficacy along the way. Failures undermine it, especially if failures occur early in the course of events. Performance accomplishments provide the most influential source of efficacy information because it is based on authentic mastery experiences.

The second method is through *modeling*. People partly judge their capabilities in comparison with others. Seeing people similar to oneself succeed by perseverant effort raises observers' beliefs about their own capabilities. The failures of others coping with similar problems instill self-doubts about one's own ability to manage similar tasks. Vicariously derived information can alter perceived self-efficacy through ways other than social comparison. Competent models can teach observers competencies and effective strategies for dealing with taxing situations. In addition, modeling influences convey information about the nature of environmental tasks and the difficulties they present. Adoption of serviceable strategies and altered perceptions of task demands will change perceived self-efficacy.

For many activities people have difficulty appraising their capability because they are unsure about its indicants, the social criteria by which it is judged, and the nature of task demands. Self-appraisals are, therefore, partly based on the opinions of others who presumably possess evaluative competence. *Social persuasion* is a third mode of influence that is widely used to try to talk people into believing they possess the capabilities to achieve what they seek. Realistic boosts in efficacy that lead people to exert greater effort increase their chances of success. However, to raise unrealistic beliefs of personal efficacy runs the risk of inviting failures that discredit persuaders and undermine perceptions of personal efficacy.

People also rely partly on inferences from their *physiological state* in judging their capabilities. They read their autonomic arousal and tension as signs of vulnerability to dysfunction. In activities involving strength and stamina, people interpret their fatigue, windedness, aches, and pains as indicants of physical inefficacy. The fourth way of modifying self-efficacy beliefs is to equip people with skills to reduce aversive physiological reactions and to alter how they interpret somatic information.

Information that is relevant for judging personal efficacy—whether conveyed actively, vicariously, persuasively, or physiologically—is not inherently instructive. Rather, it gains significance through cognitive processing. The cognitive processing of efficacy information involves two main functions (5). The first concerns the types of information people attend to and use as indicators of personal efficacy. Each of the four modes of conveying information has its distinctive set of efficacy indicators. The second concerns the combination rules or heuristics people use for weighing and integrating efficacy information from different sources in forming their self-efficacy judgments. The weight given to new experiences depends on the nature and strength of preexisting self-conceptions into which the new information must be integrated. Self-conceptions of efficacy exert selective influence on attention to efficacy-relevant information, and how it is interpreted, integrated, and coded for memory representation.

ENHANCING PERCEIVED CARDIAC EFFICACY AND POSTCORONARY RECOVERY

Research designed to facilitate recovery of functional capability after a myocardial infarction illustrates how different modes of influence can be enlisted to build perceived self-efficacy for health-promoting behavior. About half the patients who experience myocardial infarctions have uncomplicated ones (36). Their heart heals rapidly, and they are physically capable of resuming an active life. However, the psychological and physical recovery is slow for patients who believe they have an impaired heart. They avoid

physical exertion. They fear that they cannot handle the strains in their vocational, and social life. They give up recreational activities. They fear that sexual activities will do them in.

The recovery problems stem more from patients' beliefs that their cardiac system has been impaired than from physical debility. The rehabilitative task is to convince patients that they have a sufficiently robust cardiovascular system to lead full, productive lives. Each of the four sources of efficacy influence can be used to enhance patients' perceptions of their cardiac capabilities. Physical accomplishments on the treadmill provide telling demonstrations of cardiac capabilities. Modeling influences, in which ex-patients exemplify the active lives they are leading, can strengthen belief in the restorability of cardiac function. Physicians use their expertise to persuade patients of their physical capabilities. They also correct patients' tendency to misread their physiology if they misattribute fluctuations in physical functioning arising from other causes to an impaired heart.

The initial study in this program of research demonstrated that having patients master increasing workloads on the treadmill, and persuasive medical counseling both strengthen patients' beliefs in their physical capabilities (44). The stronger their perceived self-efficacy, the more active they become in their everyday life. Maximal treadmill attainment, itself, is a weak predictor of patients' level and duration of activity. Treadmill experiences, thus, exert their influence indirectly, facilitating recovery by raising patients' beliefs about their physical and cardiac capabilities. Enhanced perceived efficacy, in turn, fosters more active pursuit of everyday activities.

Ewart et al. (43) have further shown that patients' perceived physical efficacy predicts compliance with prescribed exercise programs, whereas actual physical capability does not. This further corroborates the earlier findings that the effect of treadmill experiences on activity level is largely mediated by changes in perceived self-efficacy. Patients who have a high sense of efficacy tend to overexercise; those who doubt their physical efficacy underexercise at levels that provide little cardiovascular benefits.

Psychological recovery from a heart attack is a social, rather than an individual matter. The patients are almost always males. The wives' judgments of their husbands' physical and cardiac capabilities may aid or retard the recovery process. The direction that social support takes is partly determined by perceptions of efficacy. Spousal support is likely to be expressed in curtailment of activity if the husband's heart function is regarded as impaired, but as encouragement of activity if heart function is judged to be robust. A study by Taylor et al. (102) addressed itself to ways in which the treadmill might also be used to raise and strengthen spousal perceptions of the patients' capabilities.

Several weeks after male patients have had a heart attack, they performed a symptom-limited treadmill, mastering increasing workloads with three

levels of spouse involvement in the treadmill activity. The wife was either uninvolved in the treadmill activity; she was present to observe her husband's stamina as he performed the treadmill under increasing workloads; or she observed her husband's performance, whereupon she performed the treadmill exercises herself to gain firsthand information of the physical stamina it requires. We reasoned that having the wives personally experience the strenuousness of the task, and seeing their husbands match or surpass them, should convince them that their husband has a tough heart.

After the treadmill activities, couples were fully informed by the cardiologist about the patient's cardiac functioning and their capacity to resume activities in their daily life. If the treadmill is interpreted as an isolated task, its impact on perceived cardiac and physical capability may be limited. In order to achieve a generalized impact of enhanced self-efficacy on diverse domains of functioning, the stamina on the treadmill was presented as a generic indicant of their cardiovascular capability—that the patients' level of exertion exceeded whatever strain everyday activities might place on their cardiac system. This would encourage them to resume activities in their everyday life that place weaker demands on their cardiovascular system than did the heavy workloads on the treadmill. The patient's and spouse's perceptions of his physical and cardiac capabilities, were measured before and after the treadmill activity, and again after the medical counseling.

Figure 1 shows the patterns of changes in perceptions of the patients' physical and cardiac capabilities at different phases of the experiment under varying degrees of spousal involvement in the treadmill activity.

Initially the perceptions of wives and their husbands concerning his physical and cardiac capabilities were highly discrepant—husbands judged themselves moderately hearty, whereas wives judged their husbands' cardiac capability as severely debilitated and incapable of withstanding physical and emotional strain. For spouses who were either uninvolved or merely observers, the treadmill activity did not significantly change their considerable doubts about their husbands' physical and cardiac capabilities. Even the detailed medical counseling by the cardiology staff did not reassure them in this regard. However, wives who had personally experienced the cardiac strain imposed by mounting workloads interpreted their husbands' treadmill attainments as reflecting notable cardiac capability. The participant experience produced a sharp rise in spousal judgments of patients' capacity to withstand physical and emotional strain and high level of heart activity. Patients' treadmill performances were comparable in conditions in which their wives simply observed or participated themselves. The participant experience apparently altered spousal cognitive processing of treadmill information, giving greater weight to indicants of cardiac robustness than to symptomatic signs of cardiac debility. The change in perceived efficacy made the wives more accepting of the medical counseling. Following the medical counseling,

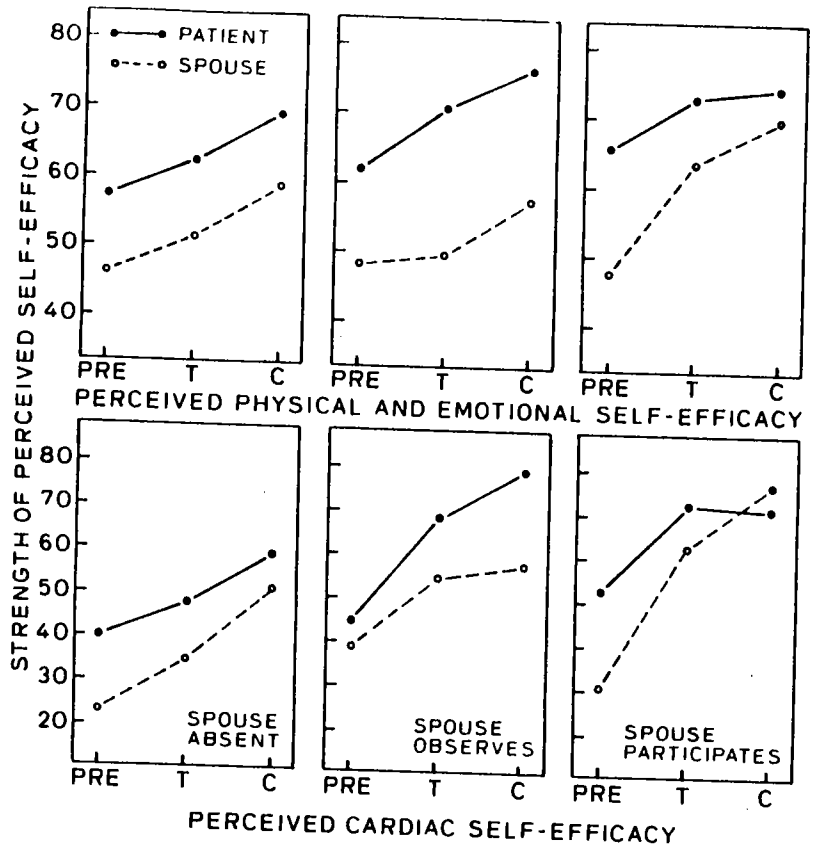

FIG. 1. Changes in perceived physical and cardiac efficacy as a function of level of spouse involvement, patients' treadmill exercises, and the combined influence of treadmill exercises and medical counseling. Perceived efficacy was measured before the treadmill (Pre), after the treadmill (T), and after the medical counseling (C). (From ref. 102, with permission.)

couples in the participant spouse condition had congruently high perceptions of the patients' cardiac capabilities.

The findings further show that beliefs of cardiac capabilities can affect the course of recovery from myocardial infarction. The higher the patients' and the wives' beliefs in the patients' cardiac capabilities, the greater was the patients' cardiovascular functioning as measured by peak heart rate and maximal workload achieved on the treadmill 6 months later. The joint belief in the patients' cardiac efficacy proved to be the best predictor of cardiac functional level. Initial treadmill performance does not predict level of cardiovascular functioning in follow-up assessments when perceived efficacy is partialled out. But perceived cardiac efficacy predicts level of cardiovascular functioning when initial treadmill performance is partialled out. It is noteworthy that the degree of recovery was associated more with beliefs about the strength of the heart, than with beliefs about general physical capabilities.

Wives who believe that their husbands have a robust heart are more likely to encourage them to resume an active life than those who believe their husband's heart is impaired and vulnerable to further damage. The positive relation between the wife's perceptions of her husband's cardiac capability and his treadmill accomplishments months later may be partly mediated by spousal encouragement of activities during the interim period. Pursuit of an active life improves the patient's physical capability to engage in activities without overtaxing their cardiovascular system.

COGNITIVE PROCESSING OF TREADMILL EFFICACY INFORMATION

Treadmill experiences affect efficacy judgment through cognitive processing of multiple sources of information indicating cardiovascular capabilities and limitations. Treadmill activity produces a lot of negative signs, such as fatigue, pain, and shortness of breath, and other exercise-induced symptoms which mount as the task continues. Patients who focus on their physical stamina as they master increasing workloads will judge their cardiac system as more robust than will patients who selectively attend to, and remember, the negative signs. Positive indicants of capability can be made more salient by providing patients with ongoing feedback of their performance as they master heavier workloads. Judgment of cardiac efficacy will vary depending on how this diverse symptom information and the indicants of cardiac robustness are weighted and integrated.

This is shown in a study with a group of healthy men and women who completed a symptom-limited treadmill before entering an exercise program (58). Half the participants received concurrent feedback of the workloads they mastered on the treadmill task. The other half received the feedback about their attainments after they had completed the task. Their perceived cardiac efficacy was measured before and after the treadmill performance. They also recorded the physical signs they recall having experienced during the treadmill activity.

As can be seen from Fig. 2, negative signs are inescapable. But concurrent feedback of mastery of increasing workloads makes evidence of one's physical stamina highly salient as well. In the absence of feedback of positive indicants of capability exercise-induced symptoms completely dominate attention and memory representation of the treadmill experience.

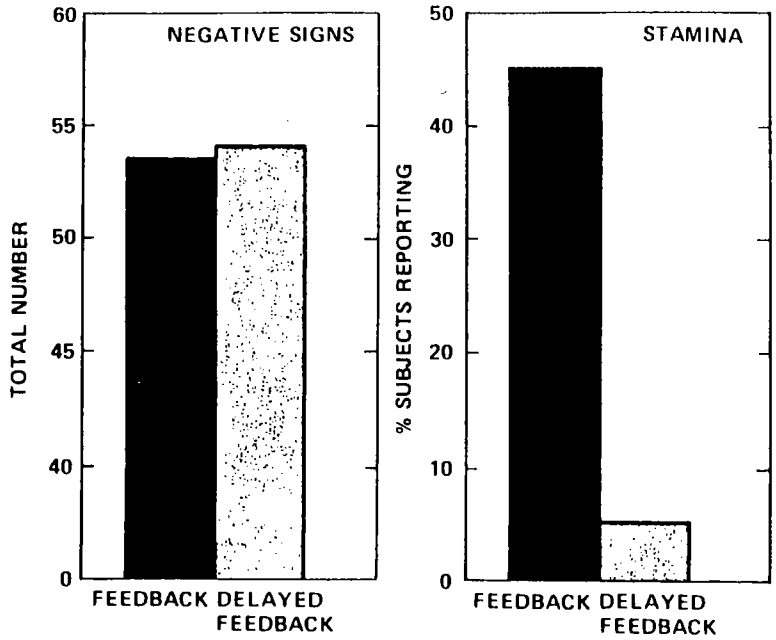

FIG. 2. Memory representation of the treadmill experience in terms of symptoms and indicants of capability as a function of timing of feedback (58).

Figure 3 shows how treadmill performances, with and without concurrent feedback, affect judgment of cardiac efficacy.

Healthy men have a more resilient conception of their cardiac capabilities than do healthy women, even though they do not differ all that much in their actual cardiac capabilities. A taxing treadmill test without feedback does not alter men's beliefs that they have a robust cardiac system. Feedback that makes physical attainments on the treadmill more noticeable raises women's judgments of their cardiac capabilities. However, in the absence of such feedback, women read the mounting negative physiological sensations accompanying increasing exertion on the treadmill as indicants of cardiac limitations and lower their judgments of their cardiac capabilities. Women do not report experiencing any more negative physiological sensations than do men. The adverse impact of treadmill experiences without positive feedback stems from negative cognitive processing of symptom information rather than from greater amounts or salience of such symptoms.

Preconceptions tend to bias how information is weighted and integrated (5,88). A similar process is indicated in women's reactions to delayed feedback regarding their treadmill performances. Upon being told of their notable physical attainments they raised their perceived cardiac efficacy to their pre-treadmill level, but they achieved no net gain from the treadmill experience. Apparently, positive signs of cardiac capability are difficult to assimilate after conceptions of one's efficacy have already been formed under conditions in which negative signs clearly predominate. A coronary can markedly undermine beliefs concerning one's cardiac efficacy. A strong preconception of cardiac impairment makes negative physiological reactions to exertion on the treadmill highly salient and recallable. Therefore, concurrent positive feedback of physical stamina would be especially important in overcoming beliefs of a frail cardiac capability in postcoronary patients who have not suffered clinical complications. Analysis of how efficacy preconceptions bias the interpretation and cognitive processing of physiological information is thus of considerable clinical import as well as of theoretical interest.

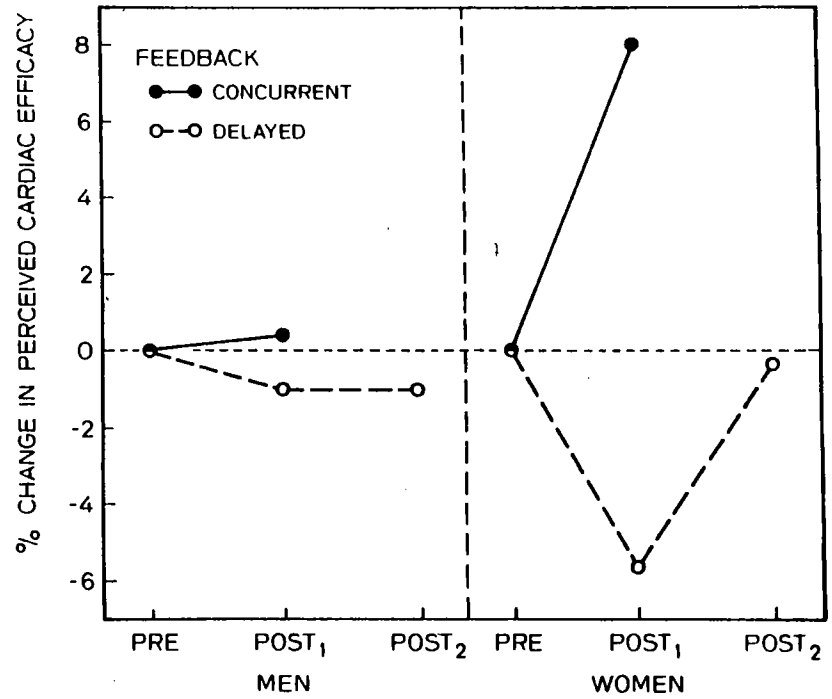

FIG. 3. Impact of treadmill performances on judgment of cardiac efficacy under conditions of concurrent and delayed feedback (58).

BIOCHEMICAL MEDIATORS OF SELF-EFFICACY EFFECTS

Anxiety and Stress Reactions

People's beliefs about their coping efficacy affect their emotional reactions in taxing situations as well as their motivation and behavioral functioning. Among the psychosocial factors that can modulate the operation of biological systems, psychological stressors have attracted the greatest attention. Stress arises from a relational condition in which perceived task demands strain or exceed coping capabilities in areas of personal import. Research from different perspectives has underscored the influential role of perceived control in stress reactions (3,65,86). A sense of controllability can be achieved either behaviorally or cognitively. In behavioral control, individuals take action that forestalls or attenuates aversive events. In cognitive control, people operate under the belief that they can manage environmental threats or stressors should they arise. These two forms of controllability are distinguished because actual and perceived control can differ substantially.

Being able to exercise control over potential threats can diminish stress because the capability is used to reduce or to prevent painful experiences. But there is much more to the process of stress reduction by behavioral control than simply curtailing painful events. In some studies of controllability, ordinarily stressful events occur undiminished, but they are promptly transformed to pleasant ones when their occurrence is personally controlled (52). Here it is the exercise of personal control, not the curtailment of the events themselves, that reduces stress. That a sense of controllability diminishes stress, even across domains of functioning, is strikingly demonstrated by Mineka et al. (87) in a developmental study. Monkeys who had been reared under conditions in which they exercised control over food months later showed little fear of novel threats, whereas the same threats were highly stressful to monkeys who could not develop a sense of control because food was given to them independently of their actions. In situations in which the opportunity to wield control exists but is unexercised, it is the self-knowledge that one can exercise control should one choose to do so rather than its application that reduces stress reactions (47). These converging lines of evidence suggest that much of the stress reductive effects of behavioral control stem anticipatorily from perceived capability to wield control over troublesome events rather than simply from attenuating aversive events.

The impact of perceived control alone on stress reactions has been the subject of study. Perceived control without the actuality has been shown to reduce stress reactions. People who are led to believe they can exercise some control over painful stimuli display lower autonomic arousal and less

impairment in performance than do those who believe they lack personal control, even though they are equally subjected to the painful stimuli (46,48). Repeated failures create stress reactions when ascribed to personal incapability, but the same painful experiences leave people unperturbed if ascribed to situational factors (112).

In social cognitive theory, perceived self-efficacy operates as a cognitive mechanism by which controllability reduces stress reactions (5). This theory conceptualizes anxiety and stress reactions in terms of perceived inefficacy to exercise control over potentially aversive situations. If people believe they can deal effectively with potential threats, they are not perturbed by them. But if they believe they cannot control threatening situations, they have much cause for distress. They tend to dwell on their coping deficiencies, and see the environment as fraught with danger. In so doing, they distress themselves, and constrain and impair their level of functioning (17,65,84,96).

Aversive arousal in situations involving some risks is affected not only by perceived coping efficacy, but also by perceived efficacy to control distressing cognitions (91). Dysfunctional cognitions are not distressing if one can exercise cognitive control over them so that they do not become ruminative. Therefore, people are more perturbed by their perceived inefficacy to control aversive cognitions than by the cognitions themselves (61).

There is a growing body of evidence that exercise of control over stressors is a critical factor influencing biological functions that govern health and illness. Controllability appears to be a key organizing principle regarding the nature of these stress effects. Exposure to stressors without the ability to control them activates stress-related hormones, release of endogenous opioids, and impairs various components of the immune system (51,78). Exposure to the same stressors with a concomitant ability to control them has no adverse physiological effects. These findings are based mainly on experimentation with animals involving uncontrollable physical stressors. Efforts to verify these effects with humans have relied extensively on correlational or quasi-experimental studies in which occurrences of life stressors are related to indices of biological functioning or infectious illnesses. Such studies leave some ambiguity about the direction of causality.

We have devised a research paradigm combining strong phobic stressors with mastery modeling that enables us to examine causal relationships under laboratory conditions with a high degree of control over confounding sources of influence. Participants cope with a uniform stressor that can be varied in intensity. Because a high sense of controlling efficacy can be quickly instilled through mastery experiences, we can create conditions incorporating phobic stressors with, and without, perceived controlling self-efficacy. By the end of each study, the phobia is eradicated in all participants so they all gain lasting relief from chronic phobic stressors while contributing to knowledge.

Several lines of research provide corroborative evidence that perceived coping efficacy operates as a cognitive mediator of stress reactions during encounters with phobic stressors. In these studies, phobics' perceptions of their coping efficacy are raised to differential levels by modeling or mastery experiences, whereupon their level of subjective distress or autonomic activation is measured (13). Phobics display little stress on tasks for which they judge themselves fully efficacious. But as they cope with tasks for which they distrust their coping efficacy, their distress mounts, their heart rate accelerates, and their blood pressure rises. After their perceived coping efficacy is strengthened to the maximal level by mastery experiences, they manage the same stressors without experiencing any stress or autonomic arousal.

Understanding of the biological mechanisms by which self-efficacy beliefs result in stress reactions was carried one step further by linking strength of perceived self-efficacy to plasma catecholamine secretion (14). The range of perceived coping efficacy in severe phobics was broadened by modeling which conveyed predictive information about the phobic threat and demonstrated effective ways of exercising control over it. The phobics were then presented with coping tasks they had previously judged to be in their low, medium, and high self-efficacy range, during which continuous blood samples were obtained through a catheter.

Figure 4 presents graphically the microrelation between self-efficacy beliefs and plasma catecholamine secretion. Epinephrine, norepinephrine, and dopamine metabolite, 3,4-dihydroxyphenylacetic acid (DOPAC), levels were low when phobics coped with tasks in their high efficacy range. Self-doubts in coping efficacy produced substantial increases in these catecholamines. When presented with tasks that exceeded their perceived coping capabilities the phobics instantly rejected them. Catecholamines dropped sharply.

The DOPAC response differs markedly from the other catecholamines. Whereas epinephrine and norepinephrine dropped upon rejection of the threatening task, DOPAC rose to its highest level, even though the phobics had no intention of coping with the task. DOPAC seems to be triggered by the mere apperception of environmental demands overwhelming one's perceived coping capabilities. DOPAC has no known physiological function and arises entirely through the monoamine oxidase mediated degradation of dopamine. Peripheral dopamine is not traditionally thought to play a significant role as either a hormone or a neurotransmitter, although elevation by a variety of stressors has been observed (105).

Plasma concentrations of free dopamine are very low. Almost all of the dopamine in plasma exists as the sulfate conjugate (35). The physiological significance of plasma dopamine sulfate is unclear, but it has been proposed that intraneuronal desulfation may occur, allowing β-hydroxylation to form

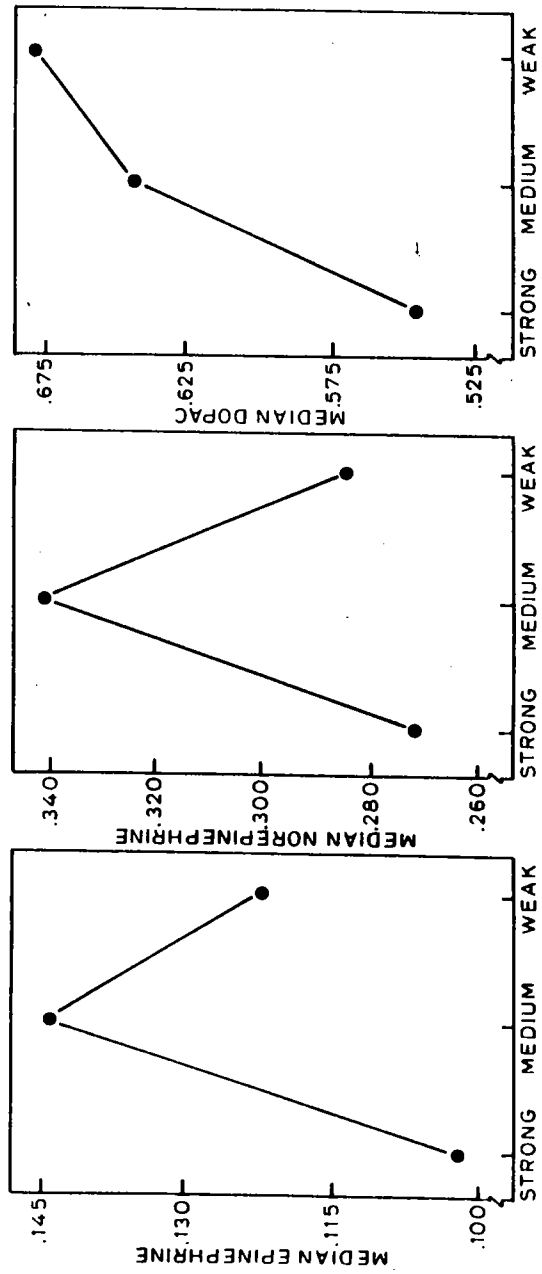

FIG. 4. Microrelation between weak, medium, and strong self-percepts of coping efficacy and level of plasma catecholamine secretion. (From ref. 14, with permission.)

norepinephrine (104). DOPAC might be formed by intraneuronal degradation of free dopamine (after desulfation); thus DOPAC concentrations would parallel those of norepinephrine, as shown in Fig. 5.

An alternative source of plasma DOPAC could be via central dopamine metabolism. Significant correlations have been described between central dopaminergic activity and plasma DOPAC and homovanillic acid concentrations (4). These data suggest that under some conditions plasms DOPAC

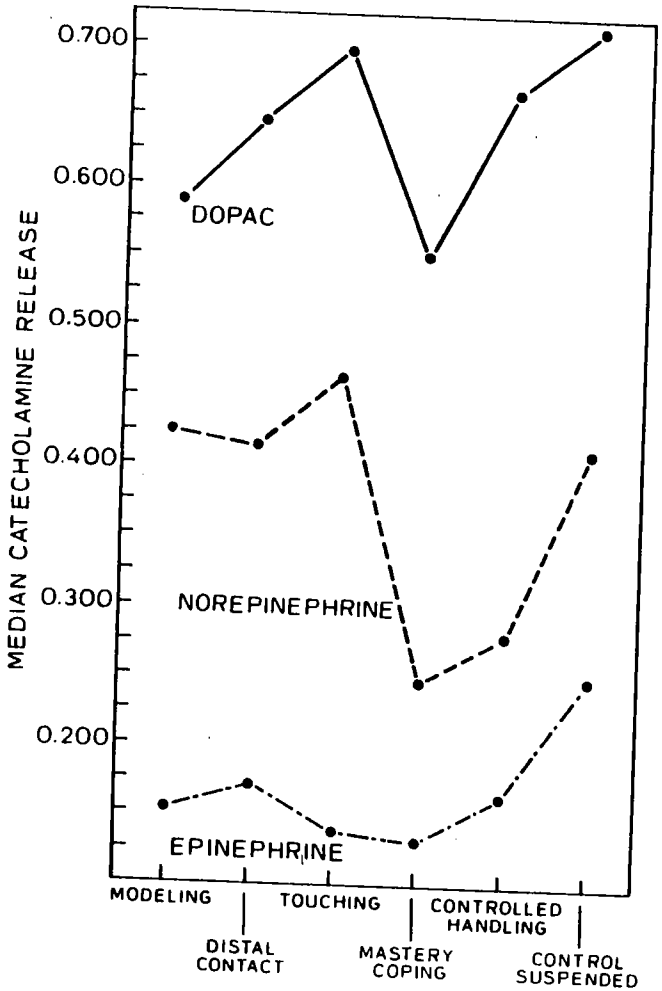

FIG. 5. Changes in level of catecholamine secretion as people master effective coping techniques through mastery modeling treatment. (From ref. 14, with permission.)

could reflect activity of brain dopamine neurons. Such a central contribution would be consistent with the enhanced DOPAC concentrations observed with perceived inefficacy to cope with a task, as shown in Fig. 4.

After perceived coping efficacy was strengthened to the maximal level by guided mastery, performance of the previously intimidating tasks no longer elicited differential catecholamine reactivity. Thus, the elevated catecholamine secretions observed in the initial test resulted from a perceived mismatch between coping capabilities and task demands, rather than from properties inherent in the tasks themselves. That the coping tasks, per se, are not the source of variance in stress reactions is further corroborated in the studies reviewed earlier showing that fear and autonomic reactions to coping tasks differ when perceived self-efficacy differs, but reactions to the identical tasks are the same when perceived self-efficacy is raised to the same maximal level (13). Thus, perceived coping efficacy determines the perceived dangerousness of interactions with phobic objects. People regard contact with phobic objects as potentially dangerous when they believe they cannot control them, but regard such contact as nondangerous when they believe they can exercise control over them.

Mastery and Catecholamine Reactivity

Guided mastery is a powerful vehicle for instilling a robust sense of coping efficacy in people whose functioning is seriously impaired by phobic encumbrances. It provides persuasive confirmatory tests that one can exercise control over potential threats. However, intractable phobics are not about to do what they dread. One must, therefore, create an environment so that incapacitated phobics can perform successfully despite themselves. This is achieved by enlisting a variety of performance mastery aids. Modeling of coping strategies, graduated subtasks, graduated temporal enactment, joint performance with the therapist, protective aids, and modulation of the severity of the threat are used to restore and develop a sense of coping efficacy (8,11). As treatment progresses, the mastery aids are withdrawn to verify that the coping attainments stem from the exercise of enhanced personal efficacy rather than from mastery aids. Self-directed mastery experiences, designed to provide varied confirmatory tests of coping capabilities, are then arranged to strengthen and generalize the sense of coping efficacy (10).

Guided mastery treatment achieves widespread psychological changes in a relatively short time. It eliminates phobic behavior and stress reactions, creates positive attitudes, and eradicates phobic ruminations and nightmares (7,10). Evidence that achievement of coping efficacy profoundly affects dream activity is a particularly striking generalized impact.

The crucial role of controllability in physiological activation is further shown in microanalysis of changes in catecholamine secretion as phobics gain mastery over phobic threats through guided mastery treatment (14). Figure 5 presents the plasma catecholamine levels at five demarcated stages in treatment.

During the initial phases of treatment, when phobics lacked a sense of coping efficacy, even the mere sight or minimal contact with phobic objects activated catecholamine responses. After participants gained controlling efficacy, their catecholamine level dropped and remained relatively low during the most intimidating interactions with phobic objects. When they were asked to relinquish all control, which left them completely vulnerable, catecholamine reactivity promptly rose. This pattern of results is in accord with a mechanism involving controllability rather than simple extinction or adaptation over time.

We saw earlier that autonomic arousal to stressors is reduced by self-knowledge that one can wield control over them at any time even though that controlling capability is unexercised. Choosing not to exercise control at a particular time, but being able to do so whenever one wants to, should be distinguished from relinquished control in which one is deprived of all means of control while subjected to stressors. Relinquished control leaves one completely vulnerable, whereas freely usable control, though unexercised at a particular occasion, leaves one in full command.

Degree of Personal Controllability and Stress Reactions

Perceived controlling efficacy is a major contributor, although not the sole one, to anticipatory anxiety and stress reactions. This is because many deleterious events are not completely under personal control. For example, the more efficacious people judge themselves as drivers the less stress they will experience on busy thoroughfares. However, even highly self-efficacious drivers will experience some apprehension because they cannot always spot and forestall reckless drivers from ramming them, sideswiping them, or broadswiping them through disregard of traffic signals. In situations where margins for error are narrow, mistakes produce serious consequences and some limits exist on how much personal control can be wielded over potential threats, the exercise of high perceived self-efficacy will be accompanied by some stress activation. People who judge themselves to be highly efficacious take on riskier activities that may engender some hazardous elements that are not entirely personally manageable, than do those who distrust their efficacy. The more that potentially deleterious events are predictable and personally controllable, the smaller will be the contribution of extraneous factors to stress reactions.

Perceived Self-Efficacy and Control of Pain

Another line of research relating perceived self-efficacy to the operation of biological systems examines how people's belief in their coping capabilities facilitates exercise of control over pain. Pain is a complex psychobiologic phenomenon, influenced by psychosocial factors, rather than simply a sensory experience arising directly from stimulation of pain receptors. The same intensity of pain stimulation can give rise to different levels of conscious pain depending on how attention is deployed, how the experience is cognitively appraised, the coping strategies used to modulate pain, and on modeled reactions to nociceptive stimulation (33,103).

There are several ways by which perceived coping efficacy can bring relief from pain. People who believe they can alleviate pain will likely enlist whatever ameliorative skills they have learned and will persevere in their efforts. Those who judge themselves as inefficacious give up readily in the absence of quick results. A sense of coping efficacy also reduces distressing anticipations that create aversive reactions and bodily tension, which only exacerbate pain sensations and discomfort. Consciousness has a very limited capacity (59). It is hard to keep more than one thing in mind at the same time. If pain sensations are supplanted in consciousness, they are felt less. Dwelling on pain sensations only makes them more noticeable and, thus, more difficult to bear. Perceived self-efficacy can lessen the extent to which painful stimulation is experienced as conscious pain by diverting attention from pain sensations to competing engrossments. Thus, for example, attentional diversion enables long-distance runners to press on even though their body is wracked in pain. Were they to focus on their mounting pain sensations they could not continue for long. Finally, people who believe they can exercise some pain control are likely to interpret unpleasant bodily sensations and states more benignly than those who believe there is nothing they can do to alleviate pain (25). Construals that highlight the sensory rather than the affective aspects of pain reduce distress and raise pain tolerance (1).

Results of several lines of research indicate that perceived self-efficacy can mediate the analgesic potency of different psychological procedures. Reese (92) found that cognitive techniques, self-relaxation, and placebos all increase perceived self-efficacy to cope with and ameliorate pain. The more self-efficacious the people judged themselves to be, the less pain they experienced in later cold pressor tests, and the higher was their pain threshold and pain tolerance. Arbitrary persuasary influences, in the form of bogus feedback that one's pain tolerance is high or low compared to that of others, similarly alters people's beliefs in their efficacy to manage pain which, in turn, affects their actual pain tolerance (71). Arbitrarily instilled perceived inefficacy restricts pain coping behavior even when the opportunity to exercise personal control exists, whereas instilled perceived efficacy largely

overrides ostensible external constraints on personal control. Holroyd et al. (55) demonstrated with sufferers of tension headaches that the benefits of biofeedback training stem more from boosts in perceived coping efficacy than from the muscular exercises themselves. Perceived self-efficacy, created by false feedback that one is a skilled relaxer for controlling pain, predicted reduction in tension headaches, whereas the actual amount of change in muscle activity achieved in treatment was unrelated to the incidence of subsequent headaches.

The preceding findings indicate that changes accompanying psychological ministrations may result as much, if not more, from instilling beliefs of coping efficacy as from the particular skills imparted. To the extent that people's beliefs in their coping efficacy are strengthened, they approach situations more assuredly and make better use of the coping skills they have.

Cognitive Control of Acute and Chronic Clinical Pain

That perceived self-efficacy makes pain easier to manage is further corroborated by studies of acute and chronic clinical pain. Manning and Wright (79) studied women who had been taught relaxation and breathing exercises to reduce pain during their first childbirth. Although they all received the same training, they differed in how much control they believed they could exercise over pain while giving birth. Their beliefs in their coping efficacy predicted how well they managed pain during labor and delivery. The stronger their self-belief in their coping capabilities, the longer they tolerated labor pain before requesting medication, and the less pain medication they used. Shoor and Holman (99) document the influential role of perceived self-efficacy in managing the chronic pain of arthritis. When patients are equated for degree of physical debility, those who believe they can exercise some influence over how much their arthritic condition affects them, lead more active lives and experience less pain.

A study by O'Leary et al. (90) shows that arthritic patients can substantially improve their psychophysical functioning by enhancing their efficacy to exercise some control over their condition. Patients suffering from rheumatoid arthritis were taught how to use self-relaxation, attention refocusing, vivid imagery, and dissociation to lessen pain as they pursued their daily activities. They also used proximal goal-setting to increase their level of activity and self-incentives to motivate their efforts. A matched control group of arthritic patients received an arthritis helpbook describing self-management techniques for coping with different aspects of arthritis and were encouraged to be more active.

Treatment increased patients perceived self-efficacy to reduce pain and other debilitating aspects of arthritis, and to pursue potentially painful activities (Fig. 6). The treated patients reduced their pain and inflammation

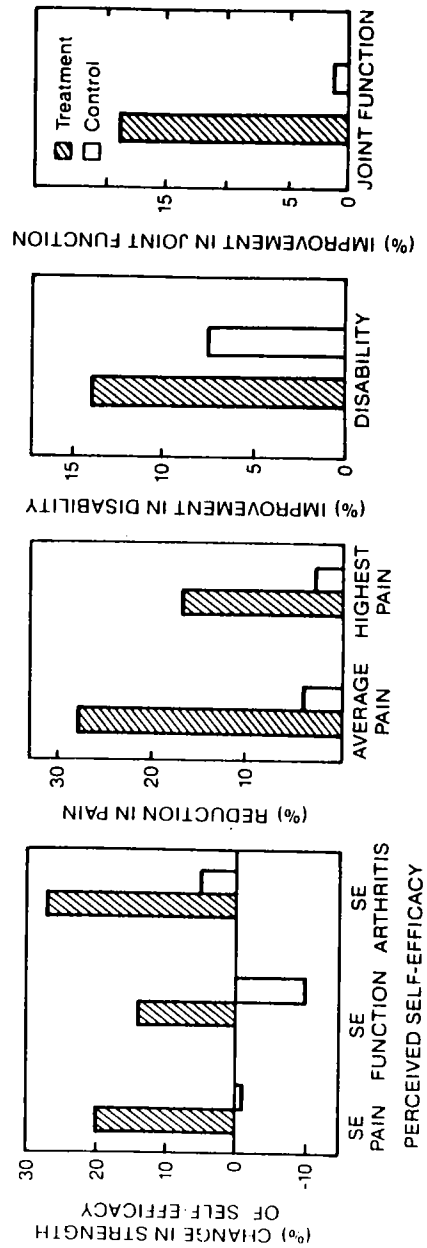

FIG. 6. Changes exhibited by arthritic patients in perceived self-efficacy and reduction in pain and impairment of joints as a function of training in self-regulatory techniques. (Adapted from ref. 90.)

in their joints, and were less debilitated by their arthritic condition. The higher their perceived coping efficacy, the less pain they experienced, the less they were disabled by their arthritis, and the greater the reduction they achieved in joint impairment. The more efficacious were also less depressed, less stressed, and they slept better.

The cognitive coping treatment did not alter immunologic function, but relationships were found between perceived coping efficacy and immunologic indices. There is some evidence that in the arthritic disorder the suppressor T-cell function of the immune system is depressed. This results in proliferation of antibodies, which is aided by helper T-cells. Arthritis is an autoimmune disorder in which the immune system produces antibodies that destroy normal tissues of the body. Increases in suppressor T-cells, which tend to inhibit production of antibodies, suggest improvement in the immune system for this disorder. Perceived coping efficacy was associated with increases in the number of suppressor T-cells and with a decrease in the ratio of helper to suppressor T-cells.

Childhood Pain

The Rosses (94) have recently called attention to the serious neglect of childhood pain. Pediatric pain clinics are virtually nonexistent. Little effort is made to teach children how to cope with pain. The Ross' have interviewed hundreds of children on how they deal with pain. About a third of them make effective use of cognitive coping techniques. Most of these rely on attentional strategies. Here is an 11-year old boy describing how he reduces the experience of pain by thoughts that command attention: "When the dentist says, 'Open,' I have to say the Pledge of Allegiance to the Flag backwards three times before I even am allowed to think about the drill. Once he got all finished before I did." Whatever children discover works in coping with stress,they use it to manage pain as well. Here's an 8-year old boy describing the multi-purpose value of the cognitive distraction technique: "I can get through most anything as long as there's something to count—like those little holes in the squares on the ceiling at the dentist. When I got sent to the school office for getting into trouble, I saw all the principal's freckles. The whole time he was giving it to me, I started at the top of his face and counted his freckles all the way down."

When pain sensations are hard to displace from consciousness, they are easier to bear if their meaning is transformed. Here is an example of an 8-year old girl coping with a painful ear procedure: "I pretended I was in a space ship and the pressure was making my ears hurt and I was the only one who could get it back to earth." The transformation of the pain situation can take quite an elaborate form, as this next child reveals: "As soon as I get in the dentist chair, I pretend he's the enemy and I'm a secret agent and he's

torturing me to get secrets and if I make one sound, I'm telling him secret information, so I never do. I'm going to be a secret agent when I grow up so this is good practice." Occasionally he got carried away with his fantasy role-playing. One time the dentist asked him to rinse his mouth. Much to the child's own surprise, he snarled, "I won't tell you a damn thing," which momentarily stunned the dentist.

Children can be helped to develop methods for coping with pain and perceived self-efficacy in their capabilities to do so. Such training can make it easier for them to bear pain.

Opioid and Nonopioid Mechanisms of Action

Although pain control by psychological means is well established, the mechanisms by which they reduce pain are less well understood. Research has clarified some aspects of the physiological mechanisms mediating pain reduction. Studies by Levine et al. (68,69) with postoperative dental pain indicate that endogenous opioids can be activated by placebo medication. A socially administered placebo produces analgesia, whereas unsignaled mechanical infusion of the placebo has no analgesic effect (67). There is some evidence to suggest that placebo-induced analgesia may involve both a nonopioid component and a stress analgetic component that is antagonizable by naloxone (50).

Studies with animals subjected to painful stimulation show that stress can activate endogenous opioids that block pain transmission (45). Opioid involvement is indicated by evidence that stress-induced analgesia is reduced by opiate antagonists, is blocked by adrenalectomy, and is reinstated by administering corticosterone to adrenalectomized animals (51,74). It is not the physically painful stimulation, per se, but the psychological stress over its uncontrollability that seems to be a key factor in opioid activation (77). Animals who can turn off shock stimulation show no opioid activation, whereas yoked animals who experience the same shock stimulation without being able to control its offset give evidence of stress-activated opioids.

At first sight, helplessness theory and self-efficacy theory appear to be at odds on how controlling efficacy relates to pain tolerance and the mechanisms mediating it. Endurance of pain is associated with deficient control over stressors in helplessness theory, but with controlling efficacy in self-efficacy theory. There are several possible explanations for this seeming contradiction.

Pain endurance can be achieved through different mechanisms. Pain sensations can be contravened at the locus of opioid blockage, or central processes involving attentional and cognitive activities that reduce consciousness of pain sensations. It might be reasoned, from research with

animals on stress-induced analgesia, that coping efficacy may enhance pain control mainly through nonopioid mechanisms. Because a high sense of coping efficacy renders aversive situations less stressful, it might reduce stress activation of opioids. Although there may be less opioid blockage of pain, exercise of personal efficacy that occupies consciousness with engrossing matters can block awareness of pain sensations by a nonopioid cognitive mechanism.

A second plausible explanation for the paradoxical findings is in terms of the markedly different consequences of control in the types of coping situations used. The exercise of control produces fundamentally different conditions of pain stimulation in the common animal and human coping situations that would argue for some opioid involvement with self-efficacy. In the usual animal experimentation, control promptly terminates pain stimulation. By contrast, in the human situation, active exercise of personal efficacy can attenuate conscious pain, but, in so doing, it promotes even more taxing pursuits that heighten the level and duration of pain stimulation. A strong sense of coping efficacy often increases engagement in pain-generating activities to the point where it can create stressful predicaments. Thus, for example, self-efficacious people suffering from arthritis generate pain and discomfort when they first take on vigorous activities, or people experience mounting pain the longer they endure the cold pressor task. Indeed, in the latter situation, continued exercise of controlling efficacy through cognitive means eventually heightens pain to the point where it begins to overwhelm one's coping capabilities. The stress of failing control with mounting pain in later stages of coping would activate opioid systems. In this conception of the human coping process, both opioid and nonopioid mechanisms operate in the regulation of pain, but their relative contribution varies with degree of controlling efficacy and stages of coping. A nonopioid mechanism would subserve pain tolerance while cognitive control is effectively exercised, but an opioid mechanism would come into play in later stages of coping when control techniques become insufficient to attenuate mounting pain or to block it from consciousness.

To test some of these notions concerning operative mechanisms, individuals were either taught cognitive methods of pain control, administered a placebo presented as a medicinal analgesic, or they received no intervention (12). Following the treatment phase, their perceived efficacy to control, and to reduce, pain and their tolerance of cold pressor pain were measured. Participants in all conditions were then administered either naloxone or a saline solution, and thereafter their pain tolerance was measured at periodic intervals.

Training in cognitive control heightened perceived self-efficacy to endure and reduce pain (Fig. 7). The enhanced efficacy was accompanied by a substantial increase in pain tolerance. Placebo medication had a differential

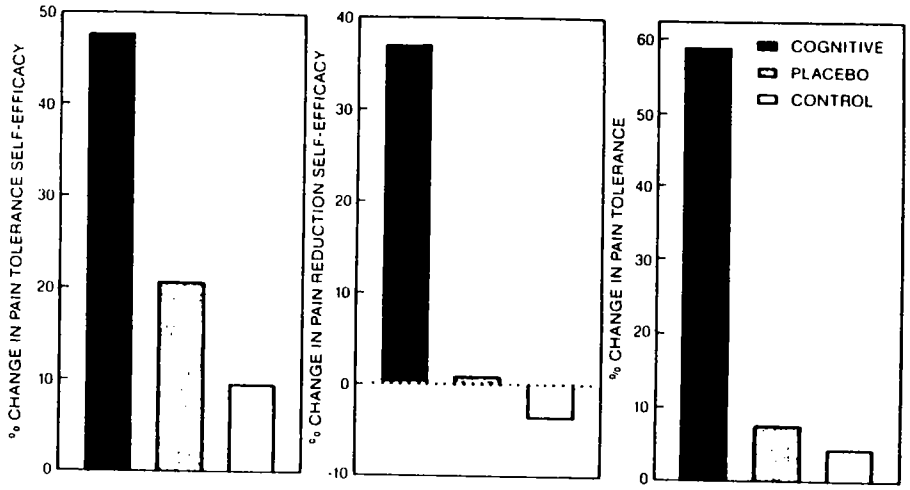

FIG. 7. Percent change from pretest level in perceived self-efficacy and pain tolerance achieved by people who were taught cognitive pain control techniques, administered a placebo, or received no intervention. (From ref. 12, with permission.)

impact on perceived endurance efficacy and reductive efficacy. People believed they were better able to withstand pain with the aid of a supposedly pain-relieving medication. However, success in reducing experienced pain depends on effective exercise of pain ameliorating skills, which mediation alone does not provide. Placebo medication did not persuade people that they became more capable of exercising reductive control over pain. These findings underscore the value of measuring different aspects of perceived self-efficacy in research designed to elucidate the exercise of control over pain.

Perceived self-efficacy predicted how well people managed pain. The stronger their beliefs in their ability to withstand pain, the longer they endured mounting pain, regardless of whether their perceived self-efficacy was enhanced by cognitive means or by placebo medication or varied preexistantly without any intervention. Endurance self-efficacy predicts tolerance of mounting pain when initial differences in pain tolerance are controlled. The strength of the placebo response is predictable from how the placebo affected perceived self-efficacy to endure pain. People who judged themselves efficacious to withstand pain given the supposed medicinal aid were good pain endurers, whereas those who continued to distrust their efficacy to manage pain despite receiving the placebo medication were less tolerant of pain. For people who lack assurance in their efficacy, the evident failure to achieve relief from pain, even with the help of a medicinal analgesic, is only further testimony for their coping inefficacy.

The variable effects of placebos on perceived self-efficacy to manage pain most likely reflect past correlated experiences with medication. If acting on self-beliefs of efficacy in conjunction with medication had usually brought them substantial pain relief, then people would come to judge themselves more efficacious to ameliorate pain with a medicinal aid. The regulatory function of perceived self-efficacy would be enlisted as well by placebo medication presented subsequently as pain killer. The enhanced perceived self-efficacy occasioned by placebo medication would activate pain-relieving processes. In contrast, people who had often experienced no relief or heightened pain despite medication, would not be at all persuaded by placebo medication that it has enhanced their capability to relieve pain. Indeed, a low sense of efficacy to exercise control over pain may even diminish the potency of genuine analgesics. That past correlated experiences affect how people respond to placebo medication is demonstrated by Voudouris et al. (106). They produced both positive and reverse placebo effects by accompanying placebo medication with decreases or increases in pain stimulation, respectively. Whether the effects of such correlated experiences are mediated by changes in perceived coping efficacy remains to be determined.

The effects of pharmaceuticals on perceived self-efficacy have received scant attention but raise issues with important implications for treatments that rely solely or partly on medication. A perceived self-efficacy that rests entirely on medicinal aid will not survive withdrawal of medication (23,24). Programs that combine medication with development of coping skills can have diverse effects on perceived self-efficacy depending on how the relative contribution of these two factors is cognitively appraised and weighted. If medication helps to create conditions that enable people to acquire generalizable coping skills they might otherwise fail to develop, then medication can enhance perceived self-efficacy. If medication facilitates skill development and the contribution of the skill component is emphasized whereas medication is given little weight, it will have no additive effect. And finally, medication can undermine the efficacy-enhancing value of skill development if coping successes are ascribed to medicinal aids rather than to improved capability (34).

Efficacious exercise of cognitive control over pain sensations enables people to tolerate high levels of painful stimulation. However, as previously noted, the more protracted their efficacy-sustained endurance, the more pain and stress they eventually create for themselves. Indeed, in coping with cold pressor pain, people who had prolonged their endurance substantially by cognitive means struggled with increasing stress as they approached the limit of their capabilities and began to experience the pain as unbearable. Thus, for cognitive copers, a nonopioid mechanism would contribute to pain tolerance during the coping phase when the exercise of cognitive control contravenes pain sensations, but an opioid mechanism would be

enlisted in later stages of coping as people experience the stressful predicament of mounting pain with failing cognitive control. This formulation posits differential levels of opioid activation during successful and failing phases of cognitive control.

The findings of the study under discussion (12) indeed provide evidence for both an opioid-mediated component and a nonopioid component for attenuating the impact of pain stimulation by cognitive means. As can be seen in Fig. 8, cognitive copers who were administered saline displayed a sizable increase in pain tolerance. In contrast, cognitive copers who were administered naloxone, an opiate antagonist, found it more difficult to manage pain. However, cognitive copers were able to increase their pain tolerance even under opioid blockage, which lends support for a nonopioid component as well in the exercise of cognitive control. For cognitive copers administered saline the combined action of both mechanisms contributed to their ability to achieve a sizable increase in pain tolerance.

The correlational findings shed some light on how different forms of self-efficacy relate to opioid activation under different modes of coping. Coping with heightened pain accompanying naloxone requires active exercise of strategies for alleviating pain rather than mere forbearance. People who judge themselves to be good pain copers would be especially distressed by their eventual ineffectiveness to manage their pain. It is perhaps for these

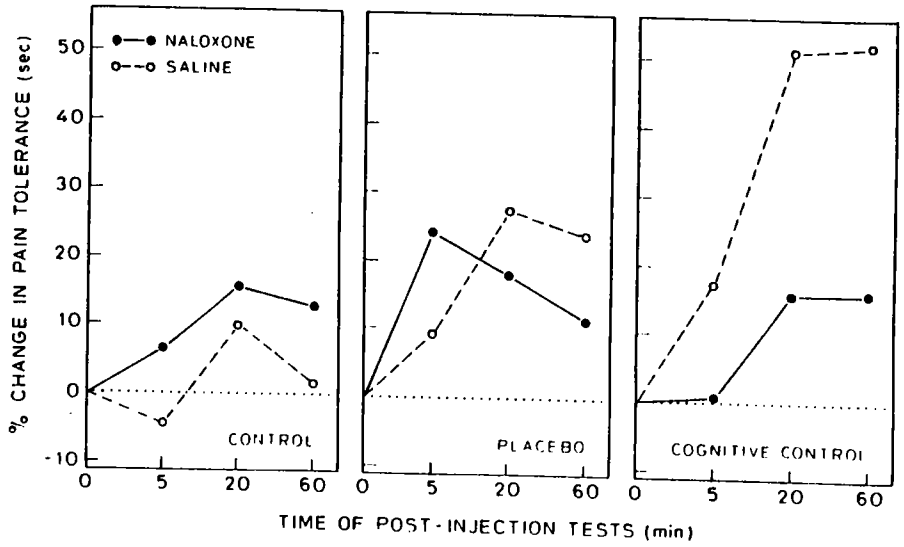

FIG. 8. Percent change in pain tolerance from the posttreatment level at each of three postinjection periods as a function of whether people received saline or the opiate antagonist, naloxone. (From ref. 12, with permission.)