COGNITIVE AND PHYSIOLOGICAL FEEDBACK ON COLD PAIN TOLERANCE

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Psychological or mental-emotional states have long been recognized as important factors capable of influencing physiological states in the cold (1). Mental distraction for example, has been shown to decrease reported discomfort from cold pain in laboratory experiments (2). Physiological studies have indicated thermal biofeedback techniques may enable hand warming skills for some cold environment applications (3-5). Yet current evidence on subsequent generalization and transfer to extended long term field settings are minimal at best, i.e., a six-hour hike in cold rain (6). Interestingly, subjects trained in voluntary hand-warming in a natural cold outdoor environment were successful outdoors by outperforming indoor trainees as well as those with no training (7). Consistent with state dependent learning theory, subjects were more effective at hand warming while outdoors when trained outdoors and did not perform as well when trained indoors. Remarkably, all groups regardless of training overestimated their actual skin temperature values by 7°F higher. It is important to note the task of distinguishing between actual hand temperature and the task of hand warming in the cold are two different skills and require different training methods. Hand warming typically involves mental and physical relaxation training of the blood vessels of the extremities through vasodilatation with thermal skin temperature biofeedback whereas, recognition of current skin temperature requires specific response discrimination training also via biofeedback (7).

Moreover, when subjects were informed and aware of the natural physiological responses of hand immersion in cold water, subjects showed significantly greater tolerance when informed of the expected result than when simply told to expect a "novel stimulus" (8). This is consistent with social psychological studies indicating informed subjects experience less fear and perform better. Research (9) on physiological feedback has also consistently shown knowledge of physiological states with thermal biofeedback techniques facilitates learning of hand temperature self-regulation in laboratory cold pressor tests. Physiological training of thermal responses are contingent on recognizing both physical and cognitive parameters.

It is well known through Bandura's (10) extensive work that self-efficacy effects performance and is directly influenced through subjects' perceived abilities. For instance, subjects with noxalene injections aimed at breaking normal production of pain inhibitors, made it possible to study the independent effects of cognitive versus physiological responses (11). Results imply both responses are directly mediated by self-efficacy. Using false feedback, Litt (12), provided clear evidence of a causal relationship between self-efficacy and pain tolerance. Subjects' perceived ability and specific knowledge of their skin temperature may aid in the self-regulation of physiological responses and potentially increase pain tolerance.

The purpose of the following laboratory experiment was to determine the influence of cognitive (written) information and physiological feedback on cold pain tolerance. The cognitive manipulation was designed to test relevancy and usefulness of accurate and meaningful information on performance. The physiological feedback component was designed to examine the relevancy of accurate and continuous temperature feedback (physiological information) on pain tolerance during cold water immersion.

METHOD

Subjects

There were 44 female undergraduates from introductory psychology classes who volunteered to participate in this experiment. Women were specifically selected to control for known sex variance that has been observed in previous studies (13). Before each session, subjects read and signed a statement of informed consent, and completed a counterbalanced series of tests with specific questions concerning pain and personal preferences for cold experiences.

Procedure

Subjects received a practice test consisting of a 30 second hand immersion in ice water to examine their anticipated self-efficacy on their subsequent ability to perform the desired task. Following this brief test, subjects were requested to estimate and predict their actual time of immersion during the main cold immersion test. They were also asked to give their motivation level to succeed with their prediction on a scale of 1-20. The effect of cognitive information relevancy and physiological feedback was tested in a 2x3 (cognitive information vs physiological feedback) design. Subjects were randomly assigned to one of two cognitive information conditions: relevant or irrelevant information, and to one of three physiological feedback conditions: skin temperature (thermal) feedback, galvanic skin response (GSR) feedback, and no feedback. GSR was provided as an alternative test condition because of a potential distraction factor. Notably, higher pain threshold feedback and not the specific value of the feedback per se. The "irrelevant information-no feedback" group served as a no treatment control. Those who received relevant information were asked to read a paragraph which described the specific physiological processes normally expected and associated with immersion of hands in ice water. This paragraph included assurance of "rapid return to normal temperatures with no subsequent physiological damage." The irrelevant information groups read an unrelated paragraph which contained information about normal mean annual temperatures found common to Alaska.

Depending on random assignment, subjects were presented task related or unrelated information to read and were asked to focus on a specific biofeedback monitor during the test. All subjects were instructed to leave their hand immersed in the cold water for as long as possible. A series of readings were taken during the practice test and also during the administration of the main cold immersion test. Readings were taken at 30 second intervals while the hand was immersed. Upon completion of the main immersion test, subjects were given a final questionnaire on which they were asked to indicate their responses on a scale of 1-20 on the following variables: value of monitor feedback on immersion time, and value of information on time of immersion. They were also asked to estimate their hand temperature upon removal from water. Estimates of actual hand temperature ranged from 0 F to 89 F, which indicates extreme variation in thermal awareness and therefore were not included in further analyses.

RESULTS

Pearson correlations were obtained between cold immersion time and various variables in the experiment (Table 1).

TABLE 1. INTERRELATIONSHIPS TO ACTUAL TIME IN WATER

Variable	r
Information	.22
Feedback	.17
Motivation	.59*
Self efficacy	.56*

* $p < .001$

An information manipulation check appears to demonstrate adequate control since subjects judged "Value of information" to be appropriate to the information conditions ($r = .44$, $p < .01$). In particular, the results show subjects perceived relevant information more valuable. "Value of monitor" was also related to information ($r = .31$, $p < .05$), rather than physiological feedback ($r = .15$ $p < .05$) as expected. Feedback condition was mostly associated with motivation ($r = -.39$, $p < .01$). Subjects who received thermal physiological feedback versus no feedback appeared more motivated but did not find the monitor valuable. Perhaps this suggests small initial pretest motivational differences and may account for some error variance.

An ANOVA was conducted on the main dependent variable, "cold water immersion time" by information and feedback conditions. Results showed a main effect for information ($F = 7.8$, $p < .05$) (see figure 1).

Figure 1. Physiological Feedback

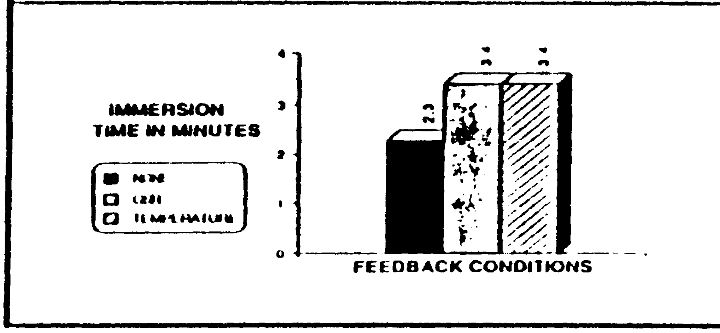
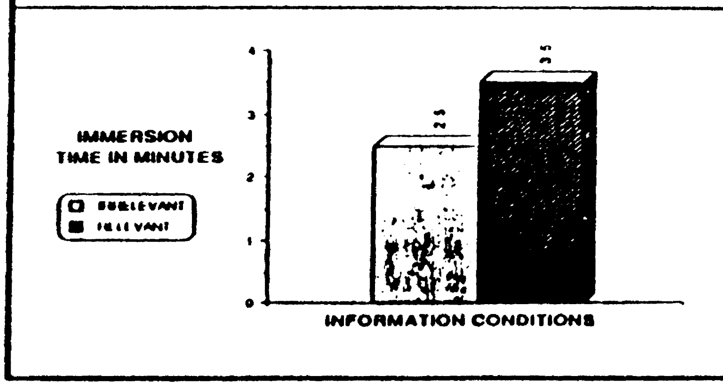


Figure 2. Irrelevant vs. Relevant Information



Surprisingly, this was not the case for feedback ($F = .07$, $p > .05$) (see figure 2). A comparison of group means for "immersion time" shows relevant information groups ($X = 3.5$ min.) with consistently longer immersion times when compared to irrelevant information groups ($X = 2.5$ min.). Relevant information by physiological feedback groups means in minutes were: No feedback ($X = 3.3$), GSR ($X = 3.6$), Temperature ($X = 3.6$), while irrelevant conditions were; No feedback ($X = 1.3$), GSR ($X = 3.2$), and Temperature ($X = 3.1$) respectively.

SUMMARY AND CONCLUSIONS

Results supported the relevancy of cognitive information effects on pain tolerance, in that subjects who were given a rational and accurate explanation of what to expect showed greater tolerance than those who received irrelevant information. Accurate monitoring of hand temperature did not seem necessarily advantagous as an influence on pain tolerance. It appears merely watching a monitor, regardless of the specific contents of the screen, resulted in longer hand immersion times when compared to no monitor. The monitors seem to serve as distractors and specificity of physiological information was not particularly useful.

However, neither information nor physiological monitoring emerged as the primary influence on pain tolerance in this study. Instead, the strongest predictors found were motivation and self-efficacy. The subject's own self prediction of anticipated performance with cold induced pain was closely consistent with actual performance. Although these results alone may not generalize to extended field situations, this study does reinforce the general findings of previous research: namely Bandura's (10) evidence on self-efficacy.

While it is obvious cold temperatures have measurable physiological consequences, the experience of pain is also psychologically mediated. Pain associated with cold injury and frostbite in hospital studies show personality correlates are significantly related to the frequency, severity and tragedy of subsequent results (15). A replication of this study will include male subjects even though it is anticipated that findings will be consistent, with perhaps longer immersion times. Future research may want to develop training strategies aimed at teaching self-efficacy and realistic expectations of potential consequences in cold environments rather than scare tactics regarding physiological and psychological cold pain tolerance.

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