A QUANTITATIVE STUDY OF PAIN AND ITS REDUCTION THROUGH HYPNOTIC SUGGESTION*

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Pain is such a familiar phenomenon that it is surprising that we know so little about it. It is our aches and pains that lead us to consult a physician, and the alleviation of pain is one of his major tasks; the surgeon of course calls upon the anesthetist to control the pain of his patient during and after his operation. Hence there is widespread interest in pain; our lack of knowledge is not based upon neglect, but upon the elusiveness of pain and its physiological correlates. Consider, for example, the effects of morphine, the most widely used painkiller. Careful studies, particularly by Beecher and his associates,[1] show in the relief of surgical pain that for roughly one third of the patients suffering postoperative pain, a placebo is as effective as morphine, for another third morphine is more effective than placebo, while for the final third neither placebo nor morphine (in safe doses) can relieve the pain. We are thus dealing with something that has components beyond the simple chemical effect upon a local pain center. The importance of subjective and idiosyncratic factors in the control of pain, evidenced by the effectiveness of placebos in some cases, is shown dramatically by the relief of pain under hypnosis, as in dentistry, childbirth, serious burns, and terminal cancer. Reviewing this background set us upon the laboratory task of finding out more about individual differences in suprathreshold pain responsiveness, and about the control of pain by way of hypnosis.

Normal Responsiveness to Pain.—It is difficult in the laboratory to produce, under controlled conditions, intense pains which have anything of the endurance and anguish of the postoperative pains found in hospitals. One method, with a long history, is known as the cold pressor method,[2] and consists in immersing a limb, either a hand or a foot, in ice water. This is the method we adopted, placing both the hand and forearm in ice water, although we modified the usual practice by circulating the water rapidly, producing greater cooling and greater pain than is found when the water is quiet and a layer of warmer water forms between the skin and the ice water. We have also arranged a refrigeration unit with precise thermostatic controls so that we are not dependent upon melting ice, and can use various water temperatures.

A simple method of reporting pain (used by Smith and others[3] and earlier by Dallenbach[4]) is to ask the subject to count as the pain increases. Because we wished to have some uniformity in the actual reports, we called the normal nonpain state zero and defined 10 as representing a pain so great that the subject feels he can no longer keep his hand in the water. While free to remove his hand if he reaches 10, we persuade him to keep it in the water and to continue to count, which indeed he is able to do. It comes as something of a surprise to find how orderly the reports of pain are by an inexperienced college student who is given these counting instructions. We at first permitted him to count freely as the pain mounted, but

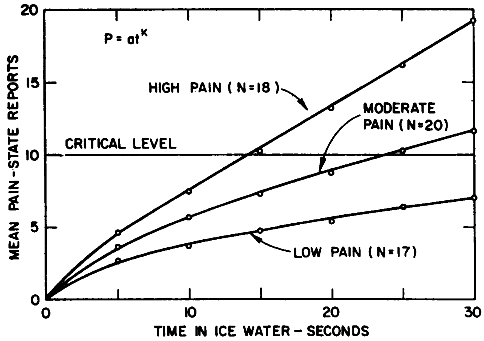

FIG. 1.—Pain-state reports upon a repetition of ice-water stimulation on a second day. Subjects classified according to their responsiveness on the first day.

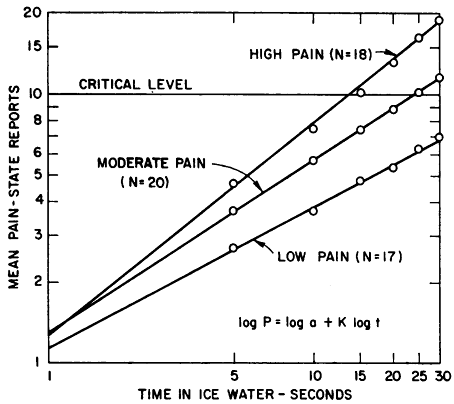

FIG. 2.—Data of Fig. 1 plotted on log-log scale.

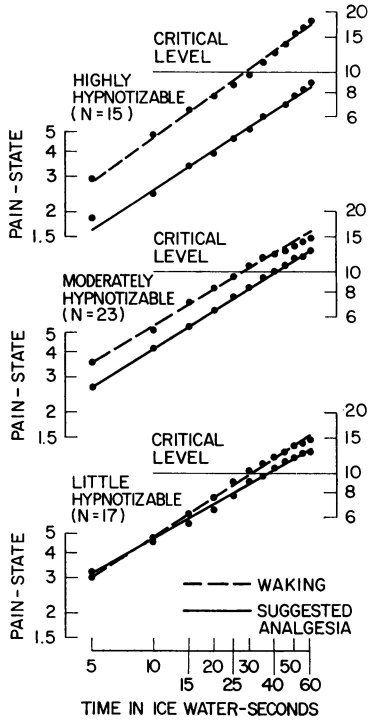

FIG. 3.—Pain-state reports after immersion of hand in ice water in normal waking state and following suggested hypnotic analgesia on another day. Subjects classified on the basis of prior tests of hypnotic susceptibility. Mean hypnotic scores (Forms A plus C, 24 possible): highly hypnotizable, 20.5; moderately hypnotizable, 13.7; little hypnotizable, 7.2.

found it preferable to ask for a report every five seconds, with results that were essentially alike (Fig. 1).

Figure 1 shows the course of the pain-state reports for subjects grouped by their responsiveness to the same ice water stimulus, those yielding high, moderate, and low pain-state reports on a previous day. The critical point of a report of 10 is reached by the high subjects ($N = 21$) in 14 seconds, by the moderates ($N = 20$) in 18 seconds, while the lows ($N = 17$) have not yet reached this level in 30 seconds. The data are sufficiently orderly that we have fitted power functions to them, of the form:

$$P = at^k$$

where P is the pain-state report, t the time in ice water, and a and k are constants. The appropriateness of these functions is better indicated by a logarithmic plot, in which, if the function holds, the three curves should become straight lines (Fig. 2).

While the data points of Figure 2 do not form perfect straight lines, the approximation to a straight line is close enough to justify the use of the power function in the analysis of the data.[5] Because the three lines of Figure 2 tend to converge to the same region at one second in the ice water, the main differences between the groups lie in the exponent k, which varies between 0.5 for the group least sensitive to pain and 0.7 for the group most sensitive to pain.

It would be desirable to have some independent criteria by which to judge the validity of the pain-state reports as reflecting felt pain, and further work in the laboratory is being directed to these ends. One method is to use simulators[6] who report that they do not feel pain when they actually do; another method is to reduce pain by aspirin in a double-blind aspirin-placebo experiment, in the hope that the pain-state reports will reflect the reduced pain felt under aspirin beyond any reduction by placebo; and a third method consists of an independent classification of those more sensitive and less sensitive to pain according to a nonverbal tactual perception method developed by Petrie.[7] These methods are all under way in our laboratory, but it is too early to report results, except to say that they thus far encourage us to believe that the pain-state reports are sound quantitative reflections of felt pain.

The Effect of Hypnotic Analgesia on Pain.—The subjects upon whom the pain measures were taken in the normal waking state, as reported in Figures 1 and 2, had all been tested for hypnotic susceptibility earlier, according to scales developed in our laboratory, known as the Stanford Hypnotic Susceptibility Scales, Forms A and C.[8] Neither of these scales has any item directly concerned with the reduction of pain. Because even highly hypnotizable subjects differ in their responsiveness to particular suggestions under hypnosis, we do not expect all hypnotizable subjects to be able to reduce pain as a result of suggested analgesia; at the same time, we would firmly expect those more highly hypnotizable to be able to reduce pain through suggestion more readily than those less hypnotizable. This turns out to be the case, as shown in Figure 3.

For each of three groups of subjects, high, medium, and low in hypnotic susceptibility, there are presented in Figure 3 both the pain-state responses to ice water in the waking state and under conditions of hypnotically suggested analgesia. There is possibly a slight reduction even for the least susceptible group, owing to the increased relaxation produced by hypnotic-like suggestions even upon the unhypnotizable, but there is obviously a greater effect on the moderates and most effect on the highest group. It should be noted that even the relatively hypnotizable subjects do not eliminate the pain entirely under these circumstances; were this merely a matter of being cooperative with the hypnotist, one would expect more extreme results. The relationship between the reduction of pain and degree of hypnotic susceptibility, as measured by our scales, can be expressed as a correlation, which is $r = +0.37$ for this group of 55 subjects, a value which, while not high, is statistically acceptable ($p = 0.01$).

These are relatively inexperienced subjects, not accustomed to hypnosis, who were given a short induction in this somewhat stressful situation. More highly susceptible subjects, selected for their susceptibility to analgesic suggestions, will of course feel no pain at all, and we have a number of records of this kind. Within this sample, if we divide the highly susceptible subjects further, according to their

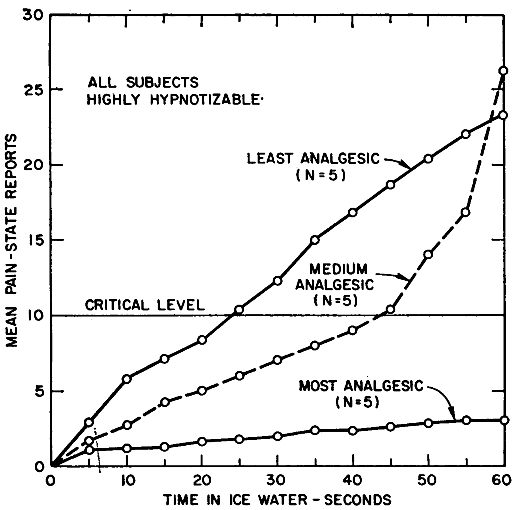

FIG. 4.—Highly hypnotizable subjects subdivided according to amount of analgesia reported to the pain of ice water following hypnotically suggested analgesia.

pain-state responses under hypnosis, we get the family of curves shown in Figure 4. The most highly pain-reducing subjects report little felt pain over the 30-second period, while we see that among highly susceptible subjects there are some who reduce the pain scarcely at all. Those most analgesic after 60 seconds in the ice water are reporting pain no higher than that felt after 5 seconds by waking subjects. The middle group are able to show considerable reduction in pain for the first 30 to 40 seconds; however, once the pain begins to mount, and reaches the critical point of 10, they apparently lose their pain control entirely, and the pain mounts rapidly until at the end of the minute it has reached the level of those who have not shown analgesia at all. Other complexities enter, in that a very few nonhypnotizable subjects are able to divert attention from the painful stimulus and thus report little pain in either the waking state or under analgesic suggestions. For them, their low pain sensitivity is not appreciably reduced by the suggestion of analgesia.

Lack of Precise Physiological Correlates of Felt Pain.—Thus far nothing has been indicated about the physiological correlates of the ice-water pain or of the reduced pain under hypnosis. A number of heart and breathing measures have been obtained, but none of these correlates with the amount of pain reported. The heart responses of Figure 5 are from the waking day and the hypnotic day for the five least analgesic subjects (among the 15 highly hypnotizable ones). The responses are essentially alike on the two days, hypnosis apparently having no effect. The heart rate is clearly elevated in the ice water on both days. The corresponding data for the five most analgesic subjects (among the 15 highly hypnotizable ones) are plotted in Figure 6. Now the somewhat surprising finding is that under hypnotic analgesia the heart rate with the hand and arm in ice water is actually higher than it was on the waking day when the water was reported as much more painful. The accelerated heart rate may be a function of the hypnosis and not of the pain. This is indicated by a correlation of +0.34 ($p = 0.01$) between the heart rate during ice water stimulation under hypnosis and susceptibility to hypnosis, while the correlation between heart rate and reported pain under the same conditions is a nonsignificant −0.05. These puzzling findings provide an occasion for further study and analysis.

Conclusions.—The following conclusions are justified from this preliminary report:

(1) The measurement of suprathreshold pain by means of circulating ice water stimulation and verbal reports of felt pain yields orderly results, capable of quantitative analysis.

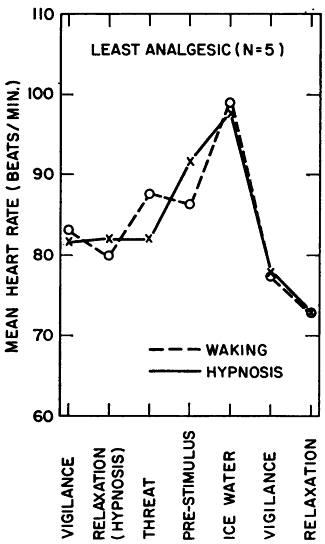

Fig. 5

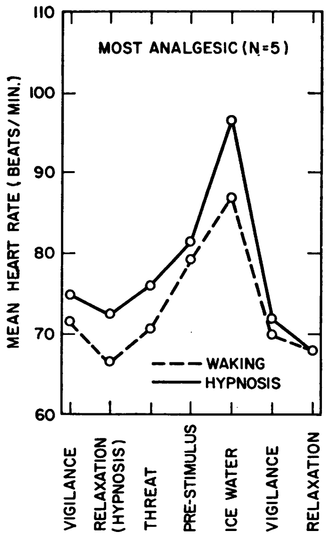

Fig. 6

Figs. 5 and 6.—Heart rate responses of the least analgesic among the highly hypnotizable subjects (Fig. 5) and the most analgesic among them (Fig. 6). Measures represent mean heart rate within successive periods as defined along baseline. The *vigilance* condition requires a repeated discriminatory response with the finger to two sounds differing in pitch; the first *relaxation* is a passive resting period on waking day, a hypnotic induction on hypnosis day; vigilance and relaxation (outside hypnosis) are repeated at the end of the session. The *threat* is the announcement that the hand and arm are about to be placed in ice water, followed by a quiet waiting period (*prestimulus*), with the hand then immersed in circulating *ice water* for 60 seconds.

(2) While hypnosis demonstrably can reduce laboratory pain as well as clinical pain, the physiological basis of this reduction is obscure. Because reflex measures, such as heart rate and breathing, are very insensitive relative to verbal reports, it is probable that the changes that occur are in the higher neural centers concerned with attention and alterations in consciousness.

The author wishes to acknowledge his gratitude to a number of colleagues and research assistants who have participated in these experiments. Their names will appear as collaborating authors of the detailed reports to which this is preliminary.

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[3] Smith, G. M., D. E. Lawrence, R. A. Markowitz, F. Mosteller, and H. K. Beecher, *J. Pharmacol. Exptl. Therap.*, **154**, 324 (1966).

[4] Dallenbach, K. M., *Am. J. Psychol.*, **76**, 152 (1963).

[5] The use of the power function as a first approximation is justified by its convenience and it conforms to the many psychophysical relationships found by Stevens to be fitted by this function (e.g., Stevens, S. S., *Perception and Psychophysics*, **1**, 5 (1966)). It has elsewhere been shown that a more complex function fits the data as well (Voevodsky, J., L. M. Cooper, A. H. Morgan, and E. R. Hilgard, *Am. J. Psychol.*, **80**, 124 (1967)). A complex function is required to fit the data if the hand is kept in ice water much longer than one minute, after which numbing may set in, with reduction in pain.

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[7] Petrie, A., *Individuality in Pain and Suffering* (Chicago: University of Chicago Press, 1967, in press); see also, Petrie, A., *Ann. N.Y. Acad. Sci.*, **89**, 13 (1960).

[8] Weitzenhoffer, A. M., and E. R. Hilgard, *Stanford Hypnotic Susceptibility Scale, Form A and B* (Palo Alto: Consulting Psychologists Press, 1959), *Form C* (1962).