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Multiple Subjective Representations of Experimental Pain

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One of the great problems of pain research has been the identification of adequate measures of the pain experience. In recent years, two general lines of research have attempted to bring to the measurement of pain some of the advances of contemporary psychophysics. The first of these, sensory decision theory (SDT), has claimed the ability to distinguish between alterations in sensory capacity and changes in response criteria following an analgesic procedure (1,2). Although this assertion has been challenged on both theoretical (8,10) and empirical grounds (9), it suffers as well from the fact that almost all published studies have asked observers to provide ratings that are oversimplified or confounded.

The second approach (4) combines the direct scaling procedures of Stevens (11) and the emphasis on multiple dimensions of pain advanced by Melzack (6,7). This latter component, that of multiple representations of the pain experience such as sensory intensity and unpleasantness, stands in marked contrast to the unitary concept that is implicit in the existing SDT research.

The present study brings the multidimensional view to the SDT experiment. It examines whether it matters how we ask the observer to describe his pain experience—in terms of its painfulness, intensity, unpleasantness, or discriminative capacity—and also looks at the importance of the SDT parameters that are utilized to make these comparisons.

METHODS

Twelve practiced university students received two levels of noxious constant-current electrocutaneous stimulation (40 1-msec monophasic square wave pulses at 100 Hz) across a pair of silver cup electrodes on the volar surface of their forearms. The stronger pulse train was set at a value of 75% of the range between the subject's pain threshold and pain tolerance; the weaker stimulus was at a current level 6% lower. Each experimental session was divided into four blocks of 80 trials during which 40 higher-intensity and 40 lower-intensity trials were presented in random order. During each block, the order of which was also randomized across subjects, category scales were used to describe the experienced sensation along one of four dimensions, as described in Table 1. The first three tasks involved judgments of the painfulness, intensity, or unpleasantness associated with the stimulus, utilizing eight possible responses; the fourth task required the observer to indicate his confidence in being able to discriminate the two levels of shock by means of a five-point response scale.

RESULTS

The data obtained in this study can be analyzed in a number of ways. The mean ratings assigned for pain, intensity, and unpleasantness were not significantly different at either shock level, although they were significantly greater ($p < 0.001$) for the stronger stimulus than for the weaker one.

Such an analysis averages the data across observers and consequently ignores the individual results. The SDT approach, whatever its interpretative pitfalls, emphasizes individual discriminative capacity. Accordingly, the data were analyzed by a procedure (3) that takes the rating data obtained from each subject and provides a maximum-likelihood fit of a receiver operating characteristic (ROC curve) from which one can estimate the slope of the normalized curve as well as a number of discrimination parameters: (a) d' (the y-intercept of the ROC curve); (b) Δ_m (d'/slope); (c) d_e' (an analog of d' that takes the slope of the ROC curve into consideration); (d) $P(A)$ (the area under the ROC curve); and (e) $D(A)$ (a parameter similar to d_e').

TABLE 1. *Category scales utilized for reports on four subjective dimensions*

	Dimension			
Rating	Pain	Intensity	Unpleasantness	Discrimination
1	Nothing	Nothing	Nothing	Certain it was the weaker
2	Touch	Possible sensation	Not unpleasant	Fairly sure it was the weaker
3	Very faint pain	Very faint intensity	Very faint unpleasantness	Unsure
4	Faint pain	Faint intensity	Faint unpleasantness	Fairly sure it was the stronger
5	Mild pain	Mild intensity	Mild unpleasantness	Certain it was the stronger
6	Moderate pain	Moderate intensity	Moderate unpleasantness	
7	Strong pain	Strong intensity	Strong unpleasantness	
8	Very strong pain	Very strong intensity	Very strong unpleasantness	

Consequently, there were four tasks and six dependent measures. An analysis of variance revealed that both task and measure yielded significant effects ($p < 0.001$), although the interaction did not reach statistical significance ($p < 0.13$). The pattern of results is described in Fig. 1.

Discriminative capacity is not identical across tasks—the question one poses for the observer does matter. Of particular importance is the direct discrimination task; a Newman–Keuls test indicated that its values are significantly greater than those for each of the other three tasks ($p < 0.05$), suggesting that observers can discriminate stimuli, even with a five-point scale, that they judge to be equally painful, intense, or unpleasant. Differences among these latter three are considerably smaller, although they point to the capacity to judge stimuli as comparably equal in intensity and yet unequal in

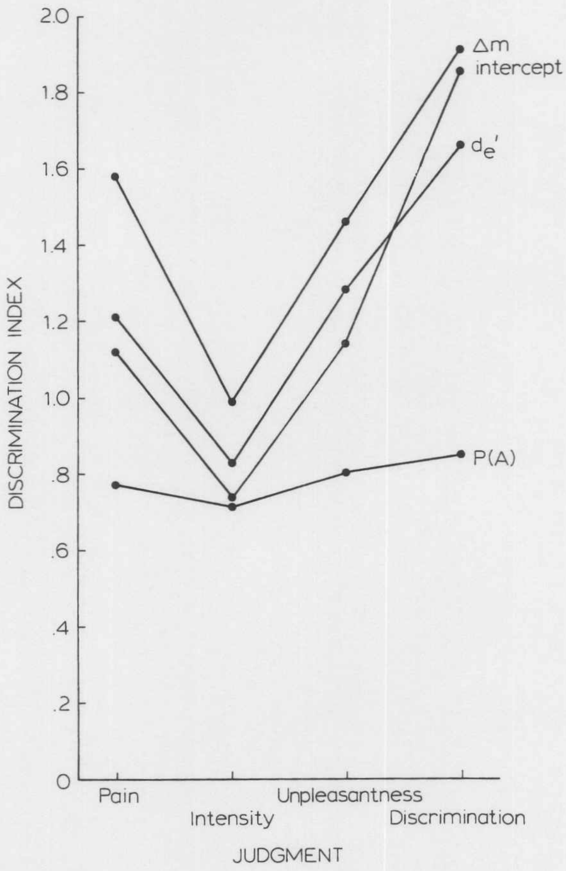

FIG. 1. Values of the discrimination indices as a function of judgment task conditions, with dependent measure as a parameter.

unpleasantness [significant Pillais ($p < 0.04$) and Wilks ($p < 0.05$) tests in a MANOVA analysis].

Do all SDT parameters indicate the same thing? Figure 2 reveals large differences in the absolute values of these indices [*D(A)* has been excluded since its values are essentially equal to d_e'], but these are relatively unimportant because of differences in the definitions of the measures and the constraints on values consequently introduced [e.g., *P(A)* cannot be greater than 1.0]. However, further analyses show that the slope-dependent parameters d_e', *P(A)*, and *D(A)* correlate almost perfectly with each other, whereas d' and Δ_m show the lowest correlation, only 0.42.

The "sensitivity" or "discrimination" parameters of SDT are not equivalent, nor are they uninfluenced by task demands. A wide-ranging measure such as d_e', which accounts for both the height of the ROC curve and its slope, appears to provide the most useful compromise. With regard to task, the

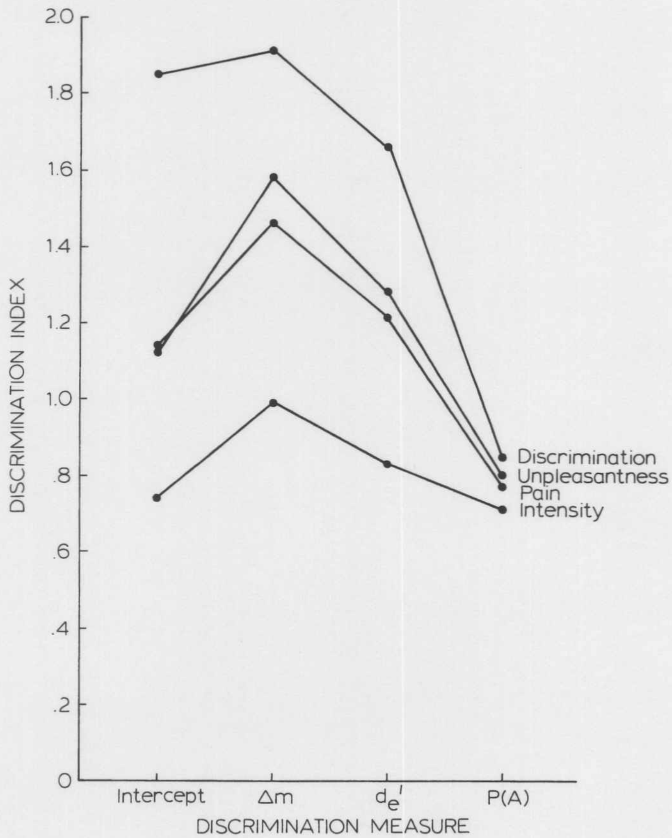

FIG. 2. Values of the discrimination indices as a function of dependent measure, with judgment task as a parameter.

values obtained when observers must judge which of two noxious stimuli has been presented (for which there are correct and incorrect answers) show greater discriminative capacity than when the subjects rate the painfulness, intensity, or unpleasantness of their experiences. Jones (5) has criticized this second approach, since no objective measure of performance is available. In theory, one can obtain ROC curves from a suitable partitioning of subjective ratings for the stimulus pair; in practice, the discrimination indices differ.

This matter is of greatest importance in the evaluation of potential analgesic procedures. Under base-line conditions, as in this experiment, subjects tend to indicate that stimuli are about equal in painfulness, intensity, and unpleasantness with regard to both absolute ratings and discriminative capacity. It remains to be seen, however, whether analgesics preserve this equivalence. Proponents of SDT must test their subjects with the intensity, unpleasantness, and discrimination tasks. If the changes they obtain are not parallel, they will need to reevaluate the interpretations they provide for the "sensory discriminability" and "response bias" measures they advocate.

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