Human Classical Conditioning

The Status of the CS

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Abstract—Recent reports of failure to obtain blocking in human galvanic skin response (GSR) conditioning, together with our own equivocal results with eyelid conditioning, have motivated us to re-examine the status of the conditioned stimulus (CS) in human conditioning studies. The issues raised by compound stimuli, by contextual cues and occasion setting stimuli, and by cross-modal transfer are considered in the light of data from our laboratories. These data include observations on the interchangeability of stimulus modalities during acquisition, the use of varying information loads embedded in occasion setting displays, the comparison of alternative blocking designs and the analysis of response topography in relation to stimulus variability. They suggested that an adequate account of the CS in human conditioning studies must recognize that it is dynamically processed and reprocessed both during and after acquisition.

In a symposium on Pavlovian approaches to human conditioning, it seems appropriate to recall some of Pavlov's central themes: the emphasis on the whole organism in its total environment; the concepts of adaptation and accommodation applied to a dynamic balance between individual organism and specific environment; the notion of remote signals which serve to anticipate environmental change thus ensuring the "adaptive correlation" which was the central theme of Pavlov's work. For Western investigators, this rich conceptual background gave rise to a narrowly parsimonious account of stimuli and responses in which the status of each was circumscribed by the polemical constraints of a body of theory seeking to describe behavior in the language of the physical sciences. No quarrel is taken with that aim. It is becoming apparent, however, that until fairly recently it has led to the neglect of dynamic aspects of the classical conditioning paradigm which were known to investigators in Pavlov's laboratory but unfamiliar in our own behavioral technologies. The effects of context, of stimulus configuration and compounding, of the selective interpretation of CS and UCS, and of overshadowing and saliency were late in coming to the serious attention of Western
investigators. In this paper, we examine some issues raised by our own work on human eyelid conditioning which seem to offer puzzling problems when viewed from the standpoint of a static concept of the CS.

Our early work on response topography of the conditioned eyelid response demonstrated (Martin & Levey, 1969) that in the course of acquisition the developing response becomes finely attuned to temporal aspects of the CS—UCS relation such that an optimally efficient endpoint is achieved; either avoidance of the airpuff under strong UCS intensity or blending of the CR with the UCR under moderate UCS intensity. We postulated the formation of an internal CS/US complex which integrates the stimulus properties of both CS and UCS to provide a template on which the developing response is modeled. One observation we found puzzling is the following. If the CS-UCS interval is randomly varied between, say, 400 and 1200 ms, the developing response is modified to form an anticipatory blink whose latency, amplitude and rise-time are optimally adjusted to encompass the full range of intervals. It is obvious that the range of stimuli, varying only in duration, cannot provide discriminable information and the compromise blink is therefore adaptive. The question of interest in these data however is: What is the nature of the CS? This question cannot readily be answered by reference to a static representation, whether a stimulus bond, an integrated complex, or the hidden units of an associative network.

A similar problem is raised by studies in which we wished to equate bisensory stimuli in terms of salience. The stimuli, pure tones and punctate lights, were first equated in subjective intensity and then used as CSs in a simple conditioning paradigm. The criterion of stimulus equivalence was the generation of comparable acquisition curves in subjects assigned at random to either tone or light. The puzzle, however, is presented by acquisition curves which could not be distinguished from either of the stimuli separately. Again, the question must be: What is the nature of the CS? Is it a tone, a light, or some distillation of the information they hold in common? Again, the answer cannot reside in a static CS representation; it must allow for some variation in degree of processing.

A further puzzle emerged in investigations of the effect of information on conditioning performance (Martin & Levey, 1987). If subjects are informed beforehand of the rule structure of a partial reinforcement schedule, the information is not used in the trial-by-trial control of responding. This is true of simple rules (e.g., every third trial is unreinforced) or complex rules and remains true even if subjects can state the rules perfectly before and after the series. Note that the physical CS remains the same; the differential information is contained only in the rules. It can be argued that a single eyeblink is not an ergonomically costly unit, and the effort of withholding on unreinforced trials is not justified. For these data, however, the status of the CS need not be queried.

If the paradigm is changed to provide a trial-by-trial indication of reinforcement, the result is quite different. Kayata (1987) arranged a panel of lights to precede each tone CS by six seconds. This display embodied a simple rule, e.g., that reinforcement would occur if lights at either end of the panel were of the same color but not otherwise. Subjects could now be informed of the rule, not for the reinforcement schedule itself, but for the occasion-setter. Those who were not so informed made no use of the information contained in the display. Fully informed subjects used the information to facilitate blinking on reinforced trials, thus producing reliable differential conditioning. Again, we must ask the question: What is the nature of the CS? Clearly it is a stimulus modulated by its context, but that context is internal and governed by the interpretation of the subject.

The blocking phenomenon has been of interest recently in human conditioning and has produced equivocal results in the published GSR literature (Davey & Singh, 1988;