Letters

Stimulus Generalization of a Positive Conditioned Reinforcer

The question raised by Thomas and Williams [*Science* **141**, 172 (12 July 1963)] as to whether stimuli generalize in a similar manner for different behavioral effects—in this case reinforcement and discriminative control—is important to our understanding of the bases of these effects. Unfortunately, however, the method leaves some room for doubt whether the two behavioral effects were measured independently.

Thomas and Williams trained pigeons to peck a key on a variable-interval schedule of food reinforcement preceded by a brief key-color stimulus and then measured effects of variations in the stimulus during extinction under the same schedule without the food. They took response rate during the stimulus presentations as a measure of "discriminative function" and amount of responding between stimulus presentations as measure of "reinforcement." For these to be considered measures of completely different functions of the stimulus requires the assumptions that discriminative effects do not outlast the physical presence of the stimulus and that reinforcement-produced increments in response rates do not generalize from a situation with an unlighted response key to one with an illuminated key. Neither assumption seems justified.

As Bugelski [*The Psychology of Learning* (Holt, New York, 1956)] has long argued, extinction resistance, as used by Thomas and Williams, does not provide a valid measure of conditioned reinforcement, since the "reinforcing" stimulus has had ample opportunity during training to become part of a response "chain" in which the "reinforced" response is maintained by a purely discriminative function. That the key-color stimulus always followed a response in Thomas and Williams's experiment means it could have had its effect through reinforcement, but does not rule out the possibility that its effect was a forward-acting cue function. It is particularly important to avoid any possible contamination of the measure of one function with effects of another if one wishes to demonstrate that both functions obey the same law. Since Thomas and Williams have failed to do so, their otherwise interesting data do not support their titular conclusion that they have demonstrated "stimulus generalization of a positive conditioned reinforcer." They may have only demonstrated stimulus generalization of a discriminative stimulus in two different ways.

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In our paper, responses to a blank key which produced aperiodic 2-second exposures of a green light were considered evidence for the reinforcing function of that light, whereas responses during the presentation of light were viewed as evidence of discriminative function.

Pigeons trained to peck at a blank, unilluminated key show virtually no tendency to respond to the same key when it is illuminated with the green stimulus (R. E. Miller, "The development of stimulus control in operant conditioning," thesis, Kent State Univ., 1962). Laudauer's first point is more difficult to handle. We agree that a discriminative effect (Bugelski would prefer to call it an "eliciting effect") may outlast the physical presence of the stimulus and must therefore agree that our results are theoretically interpretable in terms of Bugelski's "elicitation hypothesis." We feel, however, that such an interpretation, though logically possible, lacks sufficient empirical support to warrant a rejection of the interpretation that we have offered.

In an important review of positive conditioned reinforcement, Kelleher and Gollub pointed out that the "elicitation hypothesis," the "facilitation hypothesis," and the "discrimination hypothesis" have been offered as alternatives to the concept of conditioned reinforcement but concluded that none of these interpretations has the explanatory power of the concept they would replace [*J. Exptl. Analysis Behavior* **5**, 543 (1962)]. With regard to the "elicitation hypothesis" they argue: "When animals have been trained on FI or DRL schedules of reinforcement, for example, the magazine click is characteristically followed by a zero response rate. . . . Obviously, the click does not elicit responding on these schedules. . . . Nevertheless, responding occurred more frequently in the extinction records when responses produced the click. . . . The empirical data contradict the 'elicitation' hypothesis."

It would be impracticable if not impossible to build into each experiment on conditioned reinforcement controls sufficient to preclude all alternative interpretations of data. We feel that the interpretation of our data in terms of conditioned reinforcement is the most parsimonious. If comparable results are obtained with current experiments, our past findings will be supported. If not, a reinterpretation of our findings will indeed be indicated at that time. More definite conclusions must await the accumulation of additional evidence.

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Librarians and Technical Literature

The recent Special Libraries Association meeting in Denver focused attention within the professional library fraternity on the need for closer collaboration between scientists and engineers and professional librarians. It was encouraging to note the constructive response of those present to the challenges offered by the report of the President's Science Advisory Committee, "Science, Information, and Government."

More evidence of the need for greater rapport between some college and university librarians and scientists and engineers is found in the relegation of scientific and engineering periodicals to separate reading rooms, apart from the bulk of the library accessions. The ready explanation for this can perhaps be found in the liberal arts training of most university librarians. However, when such broadly based journals as *Scientific Ameri-*

can and *Science* are located in secondary reading rooms or only in science departmental libraries, it makes it difficult for the average undergraduate to satisfy even a momentary curiosity about scientific progress.

College and university librarians might indicate their awareness of the importance of scientific and engineering literature, not only to the specialist but to all men, by making available in the main reading rooms the major scientific and engineering periodicals. Perhaps *Science* could aid in accomplishing this task.

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Language of Scientific Reports

It has struck me forcibly of late years that many of your technical articles are getting so highly specialized that it is difficult even for one who, like myself, has studied quite a bit in experimental pathology to understand some of the newest papers and to make out what the authors are really driving at. Some of this, undoubtedly, is due to advancing science, but some of it, I think, is rather in the nature of showing forth what one might call the "cacophony of erudition." Quite a bit of it, I think, could be modified so that most scientists could get at least a vague idea of what is being done.

This is especially true of the recent papers dealing with viruses in their relation to oncology, the science of the study of tumor formation. With the present "Tower of Scientific Babel" getting ever more complicated, authors should be more explicit when addressing common ordinary medical men and should get down to earth, as it were; instead of presenting long columns of figures, which are all right in their place, they should give more time to relating the subject to everyday practice. For example: Does such and such a virus cause tumor formation? What is the exact relationship between the viruses inside the affected cell and the cell-free fluid? Is the fluid infectious?

Though it is, after all, highly specialized, *Science* could be made more understandable to the average reader if more common terms could be used where possible. For example, psychologists, instead of saying, "the candidate indulges in escapism," could say, "the candidate likes diversionary entertainment." The phrase, "the siblings in this case," could well be changed to, "the brothers and sisters in this case."

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Scientific Nomenclature

Boulding's system of "Scientific nomenclature" [*Science* **131**, 875 (18 May 1960)] is suitable only for use by astronomers. There are many other areas where more efficient systems are needed. The following system is highly adaptable and especially suitable for use on automobile license tags or other cases where the ability to read the nomenclature at a glance, remember it easily, and communicate it quickly and accurately by voice are important.

Each of 20 consonant symbols are rotated through five positions, each position associated with one of the five basic vowels. This gives the equivalent of 100 symbols, and can be translated easily into the decimal system for machine records.

Each symbol has a distinct single-syllable counterpart. The symbol "B" would be read as "Bay" when lying down to the left, as "Bee" when inclined to the left, as "Buy" when standing erect, as "Bow" when inclined to the right, and as "Bue" when lying down to the right.

To minimize errors in either reading or hearing, I found it advisable to use several digraphs. Chosen for maximum accuracy in both visual and aural perception, the 20 symbols are:

B	J	R
C(ch)	K	S
D	L	A(sh)
F	M	T
E(fl)	n	₸(th)
G	P	V
h	℮(pl)	

The upper case forms of H and N look the same when lying on either side, therefore the lower case forms were used. The S must be printed with a very small top curve and a large base curve in order to avoid the same type of ambiguity.

Selection of symbols for the digraphs was not entirely arbitrary. Those for "fl" and "pl" are the equivalent of upper case strikeovers. By crossing the capital T twice, "th" is appropriately represented. To represent "sh", the capital A was chosen because it is a known symbol that is distinctive in all positions.

Combinations of four symbols or less can identify 101,010,100 vehicles. That is enough to identify every vehicle in the nation regardless of state. Using state identification, a large percentage of tags would need no more than three symbols. This would greatly facilitate the reading, memorizing and reporting of wanted vehicles. (Many combinations are identical with common words or phrases. A license tag might read something like "dynamo" or "Bye Baby.")

In combinations of no more than five syllables (or symbols), over ten billion persons could be identified—ideal for a worldwide ID card system.

I believe that it will be difficult to devise a system that is easier to learn, read, remember, or communicate by voice without error.

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If Robert Koch Had Applied for a Research Grant

Suppose Robert Koch had needed a research grant to study the cause of anthrax. An obscure district physician, without university or research institute affiliation, he wished to develop original techniques to explore a new field. He worked, not in a laboratory, but in his own house. It seems obvious that he would have been brushed off quickly by almost any foundation or fund-granting agency operating according to current practices.

Suppose Edward Jenner had applied for a grant. He was a country practitioner, without university or research institute affiliation. He proposed to investigate an old wives' tale, that cowpox would prevent smallpox. He planned to test his postulation on human beings, without prior trial on animals. He had no statistically sound plan. Would any respectable voluntary foundation or government agency give such a crackpot funds?

Koch and Jenner were fortunate that their studies did not depend on successful research grant application under 1963 conditions.

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