Journal of Experimental Psychology
1968, Vol. 77, No. 3, 474–482

GENERALIZATION EFFECTS IN HUMAN DISCRIMINATION LEARNING WITH OVERT CUE IDENTIFICATION[1]

DOMINIC W. MASSARO, JOSEPH HALPERN,[2] AND JOHN W. MOORE

University of Massachusetts

Cue similarity and reinforcement schedule were covaried in 2 experiments (total N = 408) utilizing a 2 choice discriminative event prediction task with and without overt cue identification. $P(A_1|S_1)$ was a linear function of $\pi_2 = P(E_1|S_2)$ when the cues (pure tones) were highly confusable and a U-function when S_1 and S_2 were highly discriminable. $P(A_1|S_1)$ was independent of π_2 and did not differ from $\pi_1 = P(E_1|S_1)$ at the intermediate level of cue similarity, suggesting that, in order to predict probability matching, models of discrimination learning require some degree of confusability between S_1 and S_2. Ss tended to shift their event prediction response whenever they shifted their identification response from that of the previous trial and to shift their cue identification following an incorrect event prediction. The conditional probabilities found when $\pi_1 = 1 - \pi_2$ could be predicted by redefining the task as a stimulus learning rather than a response learning problem.

A previous study in two-choice auditory discrimination learning found that the proportion of correct responses, $P(A_1|S_1)$ and $P(A_2|S_2)$, increased as the intensity differential ΔI between the two stimuli, S_1 and S_2, increased (Moore & Halpern, 1965). Popper and Atkinson (1958) have shown that $P(A_1|S_1)$ is also dependent on $\pi_2 = P(E_1|S_2)$ in two-choice probability learning using nonsense syllables as cues. These two results indicate that the probability of an appropriate response to S_1 under a noncontingent reinforcement schedule is dependent upon both the cue similarity of S_1 to S_2 and the reinforcement schedule of S_2. However, no experimental results have described how these two sources of generalization interact. The present studies attempted to assess the relative contribution of generalization due to cue similarity and generalization due to π_2 at different levels of psychophysical similarity and different schedules of π_2 in a probability learning discrimination task.

Models of discrimination learning, e.g., Bush and Mosteller (1951) and Burke and Estes (1957), that can account for the generalization effects due to cue similarity would predict that generalization due to π_2 should be positively related to the cue similarity of S_1 and S_2. That is, when S_1 is identical to S_2, $P(A_1|S_1)$ should equal $P(A_1|S_2)$ at asymptote and depend only on $P(E_1)$, whereas with sufficient cue distinctiveness between S_1 and S_2 and therefore no stimulus overlap or confusability, $P(A_1|S_1)$ should be independent of π_2 and depend only on π_1. Studies in two-stimulus probability learning usually assume that the cues are psychophysically discriminable or that the distinctiveness of the cues is positively related to discrimination performance, the separation of $P(A_1|S_1)$ and $P(A_1|S_2)$. However, in the present study, an identification response preceding the event prediction

[1] This investigation was carried out during the first author's tenure as a National Aeronautics and Space Administration predoctoral fellow under Grant NSG(T)-137.

[2] Now with the Department of Psychology, University of Denver.

response was required of half of the *S*s as an independent observation of the amount of confusability of the two stimuli at different levels of cue similarity.

In recent experiments (e.g., Halpern & Moore, 1967), *conditional* statistics of the form $P(A_{1,n}|S_{i,n}S_{j,n-1}A_{k,n-1}E_{m,n-1})$, $i, j, k, m = 1, 2$, are not always rank-ordered as they should be if the reinforcement assumptions of these models are correct and sufficient. Omitting the trials subscripts, $P(A_1|A_2E_2)$ often exceeds $P(A_1|A_2E_1)$, $P(A_1|A_1E_2)$, or even $P(A_1|A_1E_1)$, whereas most learning models require that $P(A_1|A_1E_1) > P(A_1|A_iE_j) > P(A_1|A_2E_2)$, $i \neq j$. These "inversions," which rarely occur in simple probability learning, seemed to be most prevalent whenever different cues are presented on successive trials. It also seemed that the likelihood of an inversion was directly related to the distinctiveness between the cues S_1 and S_2. These observations suggested that inversions might somehow be related to covert cue identification activity by *S*s. As one possible example, if *S* decides that a given trial is of a different type from the previous one, the outcome of the latter may be completely ignored as having no bearing on the choice at hand; hence, no reinforcement effects would appear in the data. Unfortunately, this account is too simple. Observed inversions are often too pronounced to be discounted as random fluctuation resulting from stochastic independence between successive trials (Halpern & Moore, 1967). Therefore, a purpose of these studies was to determine the sequential effects of cue identification by requiring *S* to identify the cue he thought was being presented before making his event prediction on each trial.

METHOD

General

Subjects.—The *S*s were 408 University of Massachusetts undergraduates assigned unsystematically to the various experimental treatments.

Apparatus.—Up to three *S*s were run at a time, each seated at a table top enclosure containing a conditioning board (Estes-Straughan) consisting of a white center warning light and two red event lights positioned above each of two spring-loaded lever switches. Tones were generated by an audio oscillator (Hewlett-Packard Model 200) and were presented over matched headphones with a continuous white masking noise. Experimental events were controlled by programming equipment consisting of a paper tape reader, interval timers (Hunter), and relays. This equipment was housed in a cubicle adjacent to *S*s' room. Events and responses were recorded on an event recorder (Esterline-Angus).

Procedure.—The onset of a tone started a trial. The tone lasted 2.83 sec. during which *S*s in the identification task were required to make a loud or soft identification response by pressing the respective button. At the offset of the tone the warning light was illuminated for 1.5 sec. and *S*s made their prediction responses. The event light was illuminated for .67 sec. at the offset of the warning light. Hence each trial lasted 5 sec. and the intertrial interval was also 5 sec.

The *S*s required to identify the tones were given the following instructions:

> You will be receiving two tones differing slightly in loudness over the headphones. Your *first* task will be to indicate which of the tones you are listening to. You will do this by pressing one of the buttons. You will push the top button for the louder (softer) tone and the lower button for the softer (louder) tone. You are expected to guess if you are not sure which tone is on. You will have 2½ sec. to make your choice. After 2½ sec. the tone will go off and the white light on top of your panel will go on. Your *second* task will be to predict which of the two red lights at the bottom of your panel will go on. As soon as possible after the white light goes on, you are to press one of the two switches. After you have pressed a switch, one of the two red lights will go on. If the red light above the switch you pressed

goes on, you were correct. If the other one goes on, you were incorrect on that trial. Remember, you will be told whether or not you have been correct on the second task only. You will be given no information regarding your response on the first task, that is indicating which tone is on.

The *S*s not required to identify the tones were instructed as follows:

You will receive two tones differing slightly in loudness. When the tone goes off, the white light on top of your panel will go on. Your task is to predict which of the two red lights at the bottom of your panel will go on. As soon as possible after the white light goes on you are to press the switch under the red light you think will go on. Be sure to press the switch only once and *before* a red light goes on. If the red light above the switch you have pressed goes on, you were correct. If the other one goes on, you were incorrect on that trial.

Experiment I

The *S*s required to identify cues did so by pushing one of two button switches on a smaller removable panel located in front of the conditioning board. Four levels of cue similarity were obtained by varying the intensity differential (ΔI) between two 800 Hz. tones in steps of 1 db., from 0 through 3, starting at 70 db. (SPL). Hence, the intensity pairings in db. were 70–70, 70–71, 70–72, and 70–73. In the latter three groups the more intense tone was S_1 for half of the *S*s and S_2 for the other half.

Two noncontingent random reinforcement schedules were crossed with ΔI: (*a*) $\pi_1 = P(E_1|S_1) = 1$ and $\pi_2 = P(E_1|S_2) = .5$ (Group 1–.5), and (*b*) $\pi_1 = .9$ and $\pi_2 = .6$ (Group .9–.6). Two independent random sequences of 200 trials were selected for each schedule. The only restrictions on these program tapes were that no more than four S_1 or S_2 trials occurred in succession and that each cue was presented 100 times. Position of A_1 response (right or left) and loud identification response (top or bottom) were purposely confounded with program tape to make the design more efficient. Thus, counting the contrast between the two types of tasks, i.e., with and without identification responses (henceforth designated Groups IR and NIR, respectively), there were 6 *S*s in each cell of a $4 \times 2 \times 2 \times 2$ between-groups factorial design for a total of 192 *S*s. For analysis of variance of $P(A_1)$s, the data were further partitioned by two within-*S*s factors: cue (S_1 *vs.* S_2) and trial block (1–100 *vs.* 101–200).

Experiment II

Added to the center of the conditioning board was a 2×4.5-in. panel recessed 1.5 in. with two spring-loaded buttons mounted vertically and labeled loud and soft. This panel was covered for *S*s not required to make indentification responses.

Three levels of cue similarity (ΔI) were crossed with three stimulus contingent reinforcement schedules for both types of tasks. The two types of task, with identification response (IR) and without identification (NIR), provided the third principle factor. In all groups the louder tone was S_1 for half of the *S*s and S_2 for the other half. Thus, there were 6 *S*s in each cell of a $3 \times 3 \times 2 \times 2$ between-groups factorial design for a total of 216 *S*s. The intensity pairings of the two 800 Hz. tones were 73–74.5, 73–76, and 73–79 db. giving a 1.5-, 3-, and 6-db. differential, respectively, for three decreasing levels of cue similarity. The three reinforcement schedules (π) were $\pi_1 = P(E_1|S_1) = .8$ for all groups, $\pi_2 = P(E_1|S_2) = .8$, .5, and .2, respectively, for Group .8–.8, Group .8–.5, and Group .8–.2.

A sequence of 300 trials was determined for each schedule of π with the restrictions that not more than 4 S_1 or S_2 trials occur in succession and that each cue be presented 25 times in each 50 trial block. The events were randomized such that the appropriate percentage of E_1s were presented in each 50 trial block. Both position of A_1 response (right or left) and loud identification response (top or bottom) were counterbalanced between *S*s. The analysis of variance of $P(A_1)$ included the four between variables of Task, ΔI, π, and Tone (loud or soft as S_1) and the two within variables of Cue (S_1 vs. S_2) and Trial Blocks. The analysis of identification response, $P(I)$, included only data from Group IR.

Results

Experiment I

Marginal statistics.—Figure 1 shows $P(A_1)$ plotted at asymptote (defined as the last block of 100 trials). The figure indicates that $P(A_1|S_1)$ exceeded $P(A_1|S_2)$, $F\ (1,\ 160) = 75.84$, $p < .001$, and this difference was inversely related to cue similarity, $F\,(3, 160) = 23.79, p < .001$. Figure

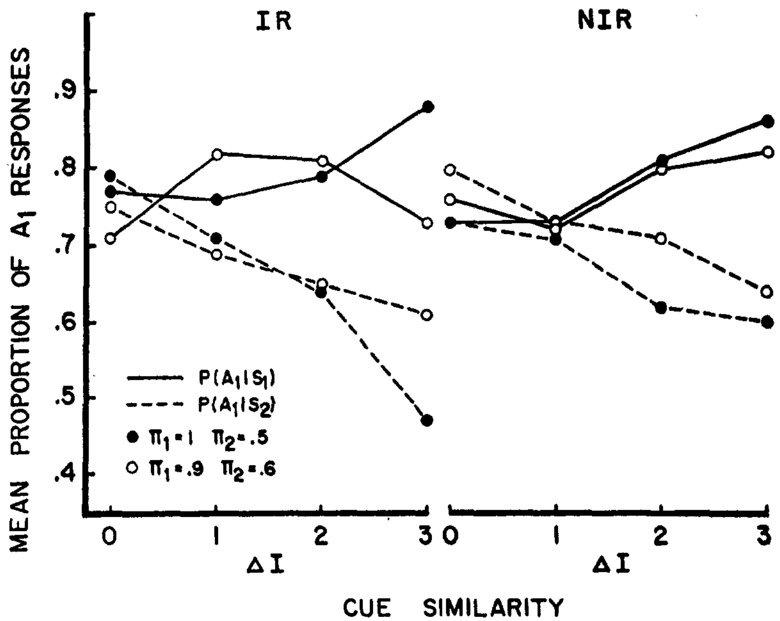

FIG. 1. Asymptotic proportion of A_1 responses to S_1 and S_2 as a function of Task, ΔI, and reinforcement schedule.

1 also illustrates an increased separation between $P(A_1|S_1)$ and $P(A_1|S_2)$ as ΔI increased, with greater separation in Group 1-.5 than Group.9-.6, F (3, 160) = 3.77, $p < .025$.

The identification performance of Group IR in terms of proportion of correct identification of the two tones was .51, .59, .69, and .78 at $\Delta I = 0$, 1, 2, and 3 db., respectively. The mean proportion of correct identifications under the two reinforcement schedules for $\Delta I > 0$ were .68 and .69 for Group 1-.5 and Group .9-.6, respectively.

Sequential statistics.—Asymptotic and preasymptotic first order conditional probabilities of an A_1 response were compiled separately for each reinforcement schedule and task. Data were pooled over levels of ΔI and other factors in order to increase reliability, and the transition point from preasymptotic to asymptotic data was estimated from inspection of learning curves (not shown) to have been Trial 80.

An analysis of the sequential data from Group IR in which *S*s indicated that the cues presented on successive trials were the same ($I_{i,n} = I_{j,n-1}$), whether they actually were or not, revealed that inversions were rare and based on very few observations. By contrast, when *S*s identified cues as different ($I_{i,n} \neq I_{j,n-1}$), 15 out of 16 sets of four conditionals were inverted, either asymptotically or preasymptotically. These inversions were striking enough to confirm our earlier impression that inversions are most likely to occur in those situations in which *S*s can identify at least two types of trials and specifically on those trials which are identified as being of a different type from the preceding one.

But what process or mechanism underlies the occurrence of inversions? The data suggest one answer: Out of a total of 64 inversions, all but 8 involve $P(A_1|A_2E_1)$ or $P(A_1|A_2E_2)$. It would therefore appear that *S*s tend to *shift* their event prediction response (from A_2 to A_1 in these cases) whenever they shift their identification response from that of the preceding trial. This shift bias can evidently override the immediate effects of reinforcement. The usual name given to this phenomenon is response generalization or induction. The fact that this bias was as strong, if not stronger, in preasymptotic as in the asymptotic data suggests that it might either be brought into the situation by *S* or else instilled by way of instructions. It remains to be determined whether the shift bias can be reduced or eliminated with different instructions, feedback for overt identifications, or more extended training.

Like any other response, cue identification should be influenced to some extent by reinforcement contingencies in the situation. Therefore, an analysis was made on the observed first order conditional probabilities of correct identification for that portion of the data of Group IR where $I_{i,n} = I_{j,n-1}$. In 13 out of 16 cases, the probability of correct identification was on the average higher following correct (A_1E_1 and A_2E_2) than incorrect (A_1E_2 and A_2E_1) event predictions. Thus, positive reinforcement, being correct, tended to increase the probability of retaining the identification response of the preceding trial; and negative reinforcement, being wrong, tended to increase the probability of a shift of identification response. An analysis was made also on that portion of the data from Group IR in which $I_{i,n} \neq I_{j,n-1}$. Once again, negative reinforcement tended to increase the probability of a shift in identification response, and thus 13 out of 16 cases showed a higher average probability of a correct identification following incorrect event predictions.

Atkinson's theoretical writings have anticipated many of the kinds of findings reported here (Atkinson, 1958; 1960). One direction for further development of an adequate model for discrimination learning within the framework of stimulus sampling theory could take the multiprocess observing response model as its starting point (cf. Atkinson & Estes, 1963). Such a model would have greatest success in predicting inverted conditionals if it could incorporate a shift bias or response generalization process acting between identification or observing responses on the one hand and event prediction on the other.

Experiment II

Marginal statistics.—Figure 2 indicates the significant main effects and interactions plotted at asymptote (defined as the last block of 100 trials). Discrimination performance $P(A_1|S_1) - P(A_1|S_2)$, F (1, 180) = 230.52, $p < .001$, increased as the difference between π_1 and π_2 increased, F (2, 180) = 73.79, $p < .001$. Discrimination performance also increased as the intensity differential ΔI between S_1 and S_2 increased, F (2, 180) = 14.28, $p < .001$; and this increase in discrimination was positively related to the difference between π_1 and π_2, F (4, 180) = 5.78, $p < .001$.

Figure 2 shows that at $\Delta I = 1.5$ db., $P(A_1|S_1)$ depended on π_2 such that $P(A_1|S_1)$ decreased with decreases in π_2. A trend analysis (orthogonal polynomials) of $P(A_1|S_1)$ at asymptote as a function of π_2 yielded a significant linear component at $\Delta I = 1.5$ db., F (1, 180) = 124.5, $p < .001$. In contrast, no components of the trend were significant at $\Delta I = 3$ db. It thus appears that $P(A_1|S_1)$ was

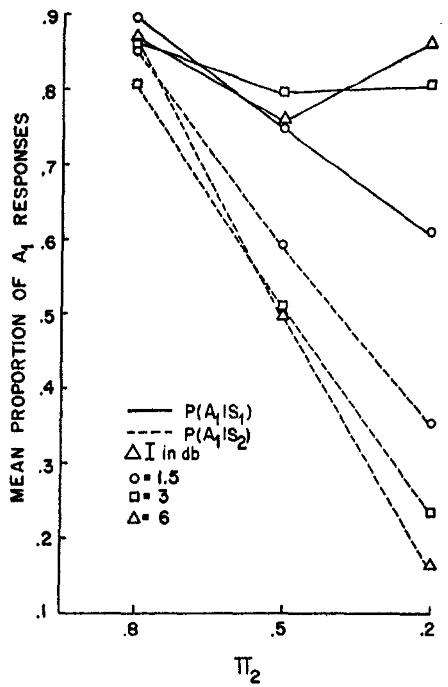

FIG. 2. Asymptotic proportion of A_1 responses to S_1 and S_2 as a function of ΔI and π_2.

independent of π_2 and, as seen in Fig. 2, did not deviate from probability matching. However, the significant quadratic component seen in Fig. 2 at $\Delta I = 6$ db., F (1, 180) = 12.32, $p < .001$, indicates that an even larger increase in ΔI reinstated the dependence of $P(A_1|S_1)$ on π_2.

The analysis of variance of identification responses in Group IR revealed that correctness of identification increased with increases in intensity differential ΔI, F (2, 90) = 50.10, $p < .001$, and that the number of correct identifications increased with practice, F (2, 180) = 15.39, $p < .001$. The mean percentage of correct identifications for ΔI = 1.5, 3, and 6 db. were 63%, 79%, and 93%, respectively. A significant π × Trail Blocks effect, F (4, 180) = 3.39, $p < .01$, revealed that *S*s improved in correct identification from the first trial block to the third in Group .8-.2 (77 to 80%) and Group .8-.5 (74 to 80%), but that no improvement was found in Group .8-.8 (77 to 77%). These results suggest that the discriminability of the π schedules in Group .8-.2 and Group .8-.5 enhanced the distinctiveness of S_1 and S_2 such that these *S*s were able to improve identification performance over training.

Sequential statistics.—The results of Exp. I showed that the reinforcement effects found when the same cue is presented on successive trials are either washed out or inverted when different cues are presented on successive trials. Therefore, a sequential statistic was desired which would permit comparison of the reinforcement effects on same and different stimulus trials. To accomplish this, the dependent measure chosen for the analysis of variance of first order conditional probabilities was

$$P(A_{1,n}|S_{i,n}S_{1,n-1}E_{1,n-1}) - P(A_{1,n}|S_{i,n})$$

where i = 1, 2. This statistic provided an index of the first order conditional effects of S_1E_1 on $P(A_1|S_1)$ and on $P(A_1|S_2)$ independent of the marginal probabilities. If S_1E_1 had no reinforcement effect on $P(A_1)$, the expected value of this index would be zero since the conditional probability would be equal to the marginal probability. A positive reinforcement effect would be reflected by a positive value and a negative reinforcement effect by a negative value. This statistic was computed for each *S* at each 100 trial block. Table 1 presents the mean values of this index for each ΔI group pooled over trial blocks.

Table 1 shows that the reinforcement effect increased for $P(A_1|S_1)$

TABLE 1

MEAN $[P(A_{1,n}|S_{i,n}S_{1,n-1}E_{1,n-1}) - P(A_{1,n}|S_{i,n})]$ POOLED OVER LEVELS OF π AND TRIAL BLOCKS AS A FUNCTION OF ΔI AND CUE

Cue	ΔI in db.		
	1.5	3	6
S_1	.04029	.04326	.05917
S_2	.02124	.00788	.00312

and decreased for $P(A_1|S_2)$ as the intensity differential ΔI between S_1 and S_2 increased, F (2, 180) = 6.0, $p < .01$. This result shows that the reinforcement effect of $S_{1,n-1}$ and $E_{1,n-1}$ on $P(A_{1,n})$ was dependent upon the similarity of S_1 and S_2 trials. A larger positive reinforcement effect on $P(A_1|S_1)$ than on $P(A_1|S_2)$ was found in all π groups, F (1, 180) = 55.22, $p < .001$. The significant interaction of $\pi \times$ Cue $\times$ Trial Blocks, F (4, 360) = 4.83, $p < .001$, indicated that the reinforcement effect on $P(A_1|S_1)$ decreased over training in all π groups, whereas the reinforcement effect on $P(A_1|S_2)$ increased in Group .8-.8 and Group .8-.5 but decreased to a negative reinforcement effect in Group .8-.2 This result suggests that inversions would probably be found in Group .8-.2 when $I_{i,n} \neq I_{j,n-1}$. It is clear from Table 2 that the rank-ordering of the first order conditional probabilities of $P(A_1|S_1I_1)$ was inverted when the previous trial was identified as different (I_2). However, when the previous trial was identified as the same, the rank-ordering of the conditionals was exactly opposite that found when the previous trial was identified as different.

TABLE 2

OBSERVED FIRST ORDER CONDITIONAL PROBABILITIES OF THE FORM $P(A_{1,n}|S_{1,n}I_{1,n}I_{i,n-1}A_{j,n-1}E_{k,n-1})$ FOR GROUP .8-.2 POOLED OVER LEVELS OF ΔI AND TRIAL BLOCKS

$I_{i,n-1}$	$A_{j,n-1}$	$E_{k,n-1}$		
1	1	1	.8687	(1417)
	1	2	.6832	(647)
	2	1	.6285	(393)
	2	2	.5348	(316)
2	1	1	.4938	(81)
	1	2	.6923	(221)
	2	1	.8302	(377)
	2	2	.9484	(1162)

Note.—Entries in parentheses are the number of cases contributing to the denominators of each conditional probability.

DISCUSSION

The findings that (*a*) $P(A_1|S_1)$ did not become independent of π_2 with increases in correct cue identification, (*b*) overshooting appeared in Group .8–.8 at 1.5 and 6 db. and in Group .8–.2 at 6 db., and (*c*) first order conditional probabilities were inverted in Group .8–.2 when $I_{i,n} \neq I_{j,n-1}$ appear to provide strong evidence against extant reinforcement models of discrimination learning.

The fact that probability matching did occur in all groups at 3-db. cue separation, where *S*s in Group IR identified the tones correctly 79% of the time, suggests that in order to predict probability matching, models of discrimination learning require some degree of confusability between the two stimuli. It may be that previous probability matching results (e.g., Estes, Burke, Atkinson, & Frankmann, 1957) found in two-stimulus probability learning were actually the result of generalization due to cue similarity. The fact that Group .8-.2 exceeded matching at the 6 db. separation suggests that maximizing may occur under certain reinforcement schedules when *S*s are correctly identifying the two cues most of the time. By contrast, increasing the intensity differential from 3 to 6 db., thereby increasing correct cue identification, lowered $P(A_1|S_1)$ in Group .8-.5. This difference might be explained by the fact that although increasing cue identification in Group .8-.5

increases the validity of S_1 as a cue for an appropriate response, it decreases the validity of S_2. Hence it appears that a discriminable stimulus with no cue value (i.e., one reinforced on a 50-50 basis) has a depression effect on $P(A_1|S_1)$ compared to a stimulus with cue value (S_2 in Group .8-.2).

The fact that the rank-ordering of the first order conditional probabilities of Group .8-.2, when a trial was identified as the same as the previous trial, was exactly the opposite of the rank-ordering, when the present trial was identified as different, suggests another reinforcement mechanism operating on trials identified as differing from the previous trial. The results of Exp. I have shown that inversions of the type $P(A_1|A_2E_1) > P(A_1|A_1E_1)$ and $P(A_1|A_2E_2) > P(A_1|A_1E_2)$ may be due to the fact that *S*s tend to shift their prediction responses when they shift their identification response from that of the previous trial because of response generalization. But this added process cannot account for the details of the rank-ordering of the conditionals found in Group .8-.2 in Exp. II (cf. Table 2). That is, even with an added response generalization process, reinforcement theories as presently defined would predict $P(A_1|A_1E_1) > P(A_1|A_1E_2)$ and $P(A_1|A_2E_1) > P(A_1|A_2E_2)$.

In probability learning research E_1 is usually identified arbitrarily as the left hand light and E_2 as the right hand light or vice versa. However, one can take the view of Spence (1960) that discrimination learning is a form of nonspatial selective learning in which *S* learns to behave in relation to some particular set of discriminanda (stimuli). That is, *S* is rewarded for behaving appropriately to a distinctive cue rather than for making a specific motor response. Therefore, in the two-stimulus situation E_1 can be redefined as the most frequent event following that stimulus.[3] An A_1 response now refers to the most *appropriate* response in the sense of having the highest likelihood of being correct on that particular stimulus trial. The reinforcement models now predict that if the appropriate response is reinforced on the previous trial, *S* will tend to make the appropriate prediction on the present trial even if he identifies the present trial as different. The results clearly show that if *S* identified the present trial as different from the previous one, the probability of making an appropriate response by predicting the most frequent event was highest when the appropriate response was reinforced and lowest when the inappropriate, or least frequent, event prediction was reinforced on the previous trial. When *S* identified the present trial as the same, either definition of E_1 predicts the results. For example, if the right hand light is the least frequent event and *S* is reinforced for making a right hand prediction, he is also reinforced for making an inappropriate response; and, therefore, he will be more likely to make the same response on the following trial if the two trials are identified as the same. But if the trial is identified as different, *S* will still be more likely to make the inappropriate response, which means a response that is physically opposite from the response on the previous trial. Therefore, conceiving *S* as being reinforced, not for a particular (right or left) event prediction, but for an appropriate (most frequently correct) or inappropriate response gives conditional probabilities predicted by reinforcement models.

[3] This redefinition of E_1 was suggested by Jerome L. Myers.

REFERENCES

Atkinson, R. C. A Markov Model for discrimination learning. *Psychometrika*, 1958, **23**, 309–322.

Atkinson, R. C. A theory of discrimination learning. In K. J. Arrow, S. Karlin, & P. Suppes (Eds), *Mathematical methods in the social sciences*. Stanford: Stanford University Press, 1960.

Atkinson, R. C., & Estes, W. K. Stimulus sampling theory. In R. D. Luce, R. R. Bush, & E. Galanter (Eds), *Handbook of mathematical psychology*, Vol. II. New York: Wiley, 1963.

Burke, C. J., & Estes, W. K. A component model for stimulus variables in discrimination learning. *Psychometrika*, 1957, **22**, 133–145.

Bush, R. R., & Mosteller, F. A model for stimulus generalization and discrimination. *Psychological Review*, 1951, **58**, 413–423.

Estes, W. K., Burke, C. J., Atkinson, R. C., & Frankmann, J. P. Probabilistic discrimination learning. *Journal of Experimental Psychology*, 1957, **54**, 233–239.

Halpern, J., & Moore, J. W. Two-choice discrimination learning as a function of cue similarity and probability of reinforcement. *Jornal of Experimental Psychology*, 1967, **74**, 182–186.

Moore, J. W., & Halpern, J. Two-choice discrimination learning as a function of stimulus similarity along an auditory intensity dimension. *Psychonomic Science*, 1965, **3**, 441–442.

Popper, J., & Atkinson, R. C. Discrimination learning in a verbal conditioning situation. *Journal of Experimental Psychology*, 1958, **56**, 21–25.

Spence, K. W. *Behavior theory and learning.* Englewood Cliffs, N. J.: Prentice Hall, 1960.

(Received July 6, 1967)

Manuscripts Accepted for Publication in the *Journal of Experimental Psychology*

Memory and Transformations in Concept Learning: Nathan R. Denny*: Department of Psychology, Texas Tech, Lubbock, Texas.

Reinforcement Difference Limen (RDL) for Delay in Shock Escape: Roger M. Tarpy*: Department of Psychology, Williams College, Williamstown, Massachusetts 01267.

Effect of List Organization on Short-Term Probe Recall: Robert C. Calfee* and Richard E. Peterson: Department of Psychology, Psychology Building, University of Wisconsin, Charter at Johnson, Madison, Wisconsin 53706.

Semantic Conditioning and Generalization of Autonomic Responses: David C. Raskin*: Department of Psychology, Olds Hall, Michigan State University, East Lansing, Michigan 48823.

Interaction of Aversive Stimuli: Summation or Inhibition?: Byron A Campbell*: Department of Psychology, Green Hall, Princeton University, Princeton, New Jersey 08540.

Monitoring Eye Movements during the Learning of Low-High and High-Low Meaningfulness Paired-Associate Lists: P. D. McCormack* and T. E. Moore: Department of Psychology, Carleton University, Ottawa 1, Canada.

Forgetting Curves with Semantic, Phonetic, Graphic, and Contiguity Cues: Albert S. Bregman*: Department of Psychology, McGill University, Montreal 2, Quebec, Canada.

Formal Intralist Stimulus Similarity in Paired Associate Learning: Willard N. Runquist*: Department of Psychology, University of Alberta, Edmonton, Alberta, Canada.

Intertrial Competition and the Prefix Effort: Robert G. Crowder* and Yvette J. Hoenig: Department of Psychology, Yale University, 333 Cedar Street, New Haven, Connecticut 06510.

Resistance to Extinction Following Partial Punishment of Reinforced and/or Nonreinforced Responses during Learning: Daniel Fallon*: Department of Psychology, State University of New York at Binghamton, Binghamton, New York 13901.

Movement Time as a Determiner of Timing Accuracy: Richard A. Schmidt*: Department of Physical Education, University of Maryland, College Park, Maryland 20740.

Children's Choice Behavior as a Function of Stimulus Change, Complexity, Relative Novelty, Surprise, and Uncertainty: F. Michael Rabinowitz* and Charlotte V. Robe: Developmental Psychology Laboratory, University of Washington, Seattle, Washington 98105.

Effects of Correction on Double Alternation Learning in Children: Morton Rieber* and David Lockwood: Department of Psychology, Middlesex College, University of Western Ontario, London, Ontario, Canada.

An Equal Discriminability Scale of Number: Stanely J. Rule*: Department of Psychology, University of Alberta, Edmonton, Canada.

---

* Asterisk indicates author for whom address is given.

(Continued on page 487)