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Error Trends in Paired-associates Learning After Response Familiarization

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Abstract. A study was run to reveal the course of overt errors over paired-associate trials when response learning was eliminated, and to determine a method of satisfying Ss on such a task for use in treating data from a subsequent motor task learned to the same stimuli.

Sixty-eight Ss were given thorough response familiarization, followed by 17 anticipation trials of a paired-associate task using verbal responses to non-verbal stimuli. Subsequently they received 30 trials on the Star Discrimeter.

Mean % correct responses and errors were plotted across pretraining trials. Ss were divided into two strata on the basis of pretraining scores and the strata were plotted separately across pretraining and motor trials. A Pearson product-moment between %CR on pretraining and criterion task was .47, a conservative estimate of the curvilinear relationship.

Overt errors in pretraining were found to decrease monotonically from the first anticipation trial. Pretraining stratification was found to differentiate Ss by performance on the motor task, showing its effects in the error function.

When verbal responses are learned to nonverbal stimuli, the subsequent acquisition of motor responses to the same stimuli may exhibit facilitation or interference. Such transfer effects have been found to be dependent upon the complexity and similarity of the stimuli and upon various verbal response parameters such as meaningfulness and similarity.

Just how these parameters interact with pretraining acquisition to produce transfer is not known. But whatever the process, the factor or factors responsible for transfer must appear incrementally during pretraining, regardless of any particular theoretical stand taken, and within wide ranges of stimulus and response parameters, a positive relationship between amount of pretraining and amount and direction of transfer should be demonstrable.

The notion that some critical amount of pretraining will produce negative transfer stems primarily from the work of Gibson (1942). She was able to show that in the course of verbal paired-associates learning, overt errors increased to some maximum early in practice, then decreased monotonically with further practice. On the assumption that overt errors bear a positive relation to stimulus generalization, Ss who have pretraining inter-

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rupted at the point of maximum error-making (maximum inferred generalization) should exhibit the greatest possible negative transfer for the particular stimuli and responses utilized.

A close examination of Gibson's data, and the data from a similar study by McCormack using colors as stimuli, shows that initial increases in error-making are generally concommitant with a decreasing number of response omissions. The apparent increase in errors per trial could therefore be an artifact of response learning, the adding of to-be-associated verbal responses to S's repertoire. If stimulus generalization is functionally related to paired-associate learning, the events underlying the relationship must inhere to the associative, or hook-up- phase sincec presumably, stimulus units (at least those imposed by E) are only peripherally involved in the response learning process.

The primary purpose of this study was to reveal the course of the overt error function over paired-associate trials when response learning *per se* is effectively eliminated from the paired-associate task. The expectation was that errors would decrease monotonically over trials subsequent to a high level of response familiarization.

Another aim was to show correct response and error trends on a motor task subsequent to paired-associate pretraining on motor task stimuli.

The motor task was provided by the Star Discrimeter. Individual learning curves for performance on this task are extremely variable. Group curves, however, may obscure brief but potentially important changes in accelleration. One alternative to using either individual or group curves is to treat learning data for like-performing, homogeneous, subjects.

A secondary purpose of the investigation was to determine a way of stratifying Ss, selecting like-performing Ss, on the basis of pretraining, which would yield a) motor performance curves widely different enough to warrant subsequent consideration of transfer effects for each stratum separately, and b) a high positive relationship, on the stratification measure, between pretraining and criterion performances for all Ss.

Method

Subjects. Sixty-eight students in the elementary psychology course volunteered to serve as Ss. Each received the equivalent of two examination points for participating.

Experimental Design. The experimental design conforms to an AB-AC transfer paradigm where, initially, verbal responses (B) are learned to nonverbal stimuli (A). The same stimuli (A) are subsequently associated with motor responses (C).

Specifically, all Ss were given 18 trials of verbal paired-associates training. Six 24-point random shapes, selected from those tionship must inhere to the associative, or hook-up, phase since sense syllables, "mep," "yab," "ruz," "von," "cuz," and "fiji," were verbal responses.

Prior to verbal paired-associates training, all Ss were given a high level of response familiarization; and subsequent to verbal pretraining, all were given 30 trials on the Star Discrimeter with the six random shapes as stimuli.

Apparatus. The motor task was provided by the Star Discrimeter. The Star has a response unit with six slots spaced 60 degrees apart, radiating from a central opening in a horizontal steel plate. A wobble stick, protruding from this opening, can be moved freely into any one of the six slots. The stimulus panel contains a circular piece of opal glass, onto which six different stimuli can be projected. For a particular task, each stimulus is associated with one of the response slots. As S moves the wobble stick into the correct slot, a microswitch simultaneously activates the stepping switch (changing the stimulus) and the correct response counter. Entering any of the other five (incorrect) slots closes an error microswitch. A single stimulus remains on the panel until S goes all the way into the correct slot, bringing up a new stimulus.

Verbal pretraining was given in the same room as motor training. S sat on a chair facing a transluscent rectangular 8 x 10 in. screen approximately 4 feet distant.

An automatic (LaBelle 2 x 2) slide projector was located behind the screen. Stimulus and response materials (random shapes and nonsense syllables) were individually photographed on 35 mm. film and mounted in 2 x 2 binders. Photographic postives were used, so that shapes and syllables were seen as black on a white ground. Six slides of each stimulus, and six of each stimulus with its corresponding nonsense syllable, were made. For paired-associates pretraining, the slides were stacked, in six random orders of the six pairs, into a metal cartridge which fed the projector. Each time the projector was activated, one slide was projected onto the screen. The slides were received by a second cartridge. At the end of each block of six trials (six presentations of each stimulus), the receiving cartridge could be removed and immediately placed in the feeding position.

A series of timers provided automatic activation of the projector ever 2 sec. During the first 2 sec. of each sequence, one of the six stimuli appeared by itself. During the next 2 sec. the same stimulus appeared with its associated nonsense syllable directly below. Thus, paired-associates learning by the anticipation method was provided.

Procedure. Instructions for verbal paired-associates training stated that S was to learn the discriminate six different shapes by associating a particular syllable with each shape, and to pronounce the correct syllable out loud before it appeared on the screen. Throughout pretraining, all stimuli were visible to *E,* so that correct responses and errors could be recorded easily.

Response familiarization occurred prior to paired-associates training. Ss were brought to three familiarization criteria in the following order:

1. First, *E* showed S a card on which the six syllables were printed in one of three random orders. As *E* pronounced the responses in succession, S looked at them and listened. Then S was required to read the syllables to a criterion of two successive correct pronunciations in two orders.

2. Next, S was given a card on which the syllables appeared and was asked to memorize them, irrespective of order, pronouncing them to himself as he did so. One min. was allowed for study, then E was required pronounced reproductions of the syllables. Next, S was given a card with the syllables arranged in another order, and the same instructions to memorize. This procedure was repeated to a criterion of two successive correct reproductions in two different orders. A minimum of two 1-min. study periods was given to each S.

3. Finally, *E* pronounced one of the syllables and S was required to pronounce the other five. *E* repeated this procedure, selecting "cue" syllables in different orders, until S gave successive correct reproductions of five to each of the six syllables as cues.

The mean time for response familiarization was 10 min.

Instructions for paired-associates training were given immediately after response familiarization. Ss were told that they *must* attempt to anticipate the correct response upon every stimulus presentation after the inspection trial. Ss were told when to start guessing.

At the end of pretraining, the motor instructions were read to Ss. Thirty trials were given on the Star Discrimeter. Each trial was 20 sec. long, with 10 sec. inter-trial intervals. The number of correct responses and the number of errors were recorded for each trial.

Results

In Fig. 1, the means of number of correct responses and of errors are plotted against pretraining trials. As seen, correct responses increased monotonically, while errors decreased monotonically, with increasing trials. The mean number of omissions on Trial 1 was 0.57. Because of the small number of omitted responses, the correct response and error curves are reciprocally related.

The possibility of stratifying Ss on the basis of total errors or total correct responses was rejected. A stratification criterion measure was sought which could be applied to both pretraining and motor data, and which would reflect "goodness" of performance equally well for both tasks. Many Ss proved to be exceptionally high total responders on the motor task, though they appeared not to learn the task at all. By virtue of their high response frequency, their total number of correct responses was much higher than the total number for Ss who eventually reduced errors to zero, and who by all counts "learned" the task. Further, several Ss continued to make many errors throughout training, even though their correct response scores were on the upswing.

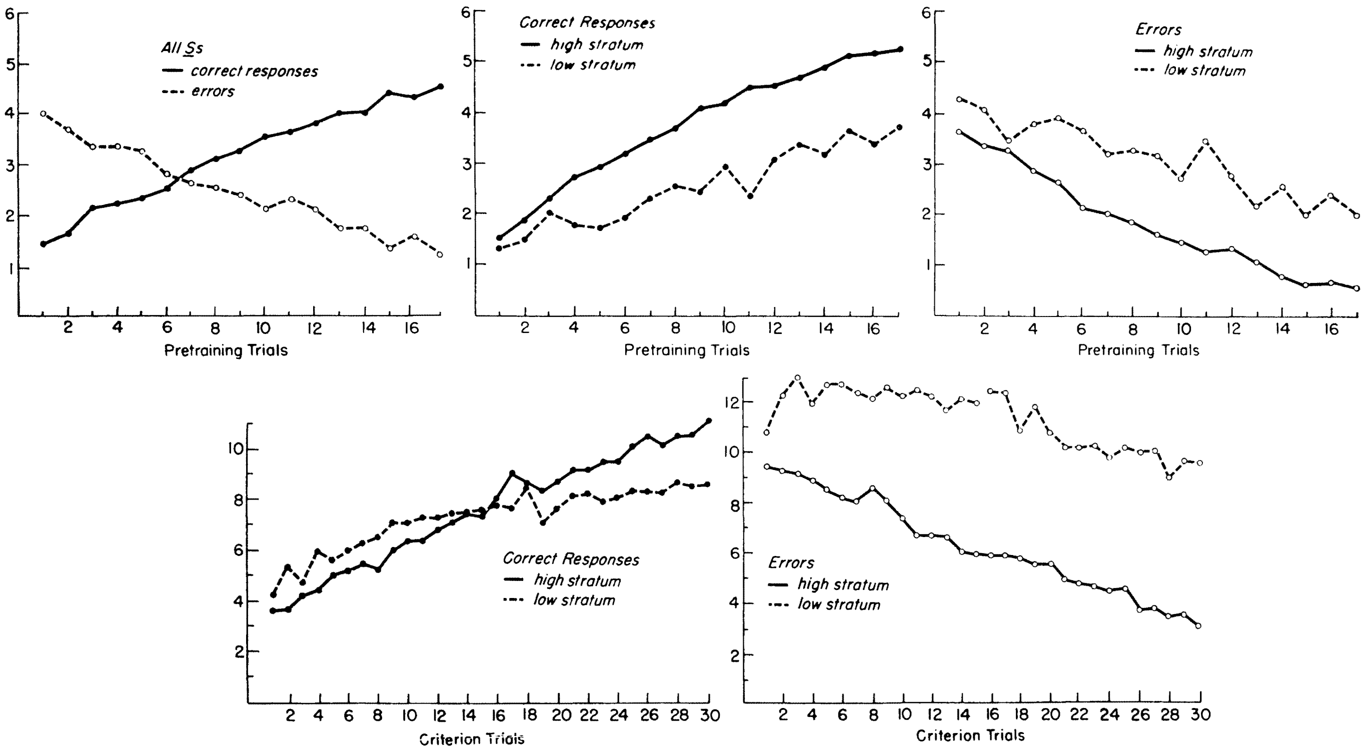
To account for these differences in overall quantity and quality of responding on the motor task, the percentage of total correct responses over trials (%CR = Number correct = Total) was computed for each S. The same measure was computed for pretraining responses.

Subjects were then divided into above- and below-median strata *on the basis of %CR over 18 pretraining trials*. Pretraining errors and correct responses for high stratum and low stratum Ss are compared in Fugures 2 and 3. Although the curves are markedly more stable for high stratum Ss than for low stratum Ss, monotonic error and correct response functions are indicated for both strata.

Figures 4 and 5 show the trends of correct responses and errors on the motor task, for the same strata. Stratification on %CR during pretraining does not appear to differentiate clearly between correct response trends for the two strata. As seen in Fig. 4, there is some indication of a difference between slopes of the two lines. There is a similar indication that had more motor training been given, the two curves might have reached different asymptotes.

Figure 5 shows that error trends for high and low strata differ importantly over motor trials. Since correct response trends are effectively coincident, the higher error rate for low stratum Ss means that %CR during pretraining is predictive of absolute response level (number of responses made per trial) on the motor task.

The Pearson product-moment r between %CR on pretraining and %CR on the motor task was .47. This may be a con-


All Ss
correct responses
errors
Pretraining Trials
Correct Responses
high stratum
low stratum
Pretraining Trials
Errors
high stratum
low stratum
Pretraining Trials
Correct Responses
high stratum
low stratum
Criterion Trials
Errors
high stratum
low stratum
Criterion Trials

servative measure of the strength of relationship between pretraining and motor performances, since that relationship displayed some evidence of curvilinearity over low values of both variables.

Discussion

Figure 1, showing correct response and error trend lines over pretraining trials, supports the expectation that, with response familiarization, errors decrease monotonically from the first anticipation trial. By inference, a monotonic decrease in stimulus generalization is also indicated.

The implication of the pretraining error data for the Gibson hypothesis may be stated alternatively: either stimulus generalization is a monotonic decreasing function of trials, or overt errors do not represent the course of generalization with accuracy. If the first and simplest of these alternatives is assumed, the point of maximum generalization is on Trial 1 of pretraining; hence, transfer should increase monotonically toward the positive end of the transfer continuum as amount of pretraining increases. Thus, the maximum amount of negative transfer for any given set of stimuli and responses must be expected following the smallest possible amount of pretraining, if, in fact, any negative transfer appears at all.

Subjects divided into high and low strata on the basis of %CR during pretraining do perform differently on the motor task. That there are individual differences in performance which hold over both pretraining and criterion tasks is confirmed by the positive correlation between %CR on pretraining and %CR on the motor task.

Figures 4 and 5 show these differences to be marked for the error measure. Correct response trends do not appear to differ importantly, at least over 30 motor trials. This means that pretraining performance (in terms of %CR) is predictive of overall level of responding on the motor task. Low stratum Ss make more responses per 20 sec. trial than do high stratum Ss, and the additional responses are errors.

Thus, the criterion of stratification (%CR) seems *not* to tap factors contributing to ease or rate of associating motor responses with appropriate stimuli. That is, the factor reflected in %CR on pretraining is apparently not a habit factor as such. The wide divergence of error trends for the two strata suggests, instead, the operation of some kind of interference factor reflected in competition of available responses.

If errors during pretraining can be assumed to reflect stimulus generalization, then Fig. 3 shows that low stratum Ss go into motor training with considerably more generalization than do high stratum Ss. The higher amount of generalization for the low stratum group could well account for the higher level of error making on motor trials. If this is so, *transfer* for high stratum Ss should be greater in a positive direction than for low stratum Ss. If transfer effects can be shown to be comparable for high and low strata, no harm should be done in treating averaged data. If transfer effects are importantly different from one stratum to another, however, the treatment of transfer effects for each stratum separately will not only be a statistical necessity, but also a potential advantage in a theoretical sense.

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Figure 1. Mean performance by trials on verbal pretraining and criterion tasks, employing strata based on pretraining scores.

An Investigation of the Judged Complexity of Stimuli With High Information Content

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Abstract. The complexity of stimuli with high "constructed complexity" was judged by 40 subjects on an equal-appearing intervals scale. Earlier studies had employed stimuli of lower constructed complexity, and it was felt that the judgment task would prove more difficult when the constructed complexity was increased. Results showed that subjects experienced no difficulty in making the judgments—as constructed complexity increased, so did judged complexity. It was suggested that magnitude estimation might be a more appropriate means of assessing judged complexity than equal-appearing intervals for future studies.

Attneave (1954) first postulated the application of an information theory model to form perception. The model represented a realistic attempt to quantify and operationalize form and the generation of stimuli. Later, Attneave (1955) found that information is concentrated at changes in contour. In a subsequent paper, Attneave & Arnoult (1956) presented a series of methods for constructing randomly derived stimulus shapes, which may contain as many changes of contour, or sides, as one chooses. This

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