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Motor Performance After Four Kinds of Verbal Pretraining[1]

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Abstract. Four groups of 20 Ss each were given 36 paired-associates trials on each of six random shapes. The four groups learned verbal responses which were, respectively, high in association value and formally distinct (HD), high in association value and formally similar (HS), low in association value and formally distinct (LD), and low in association value and formally similar (LS). An additional group (A) attended to motor task stimuli during 216 nonverbal pretraining trials, while a control group (I) learned medium association value distinct syllables to stimuli different from those which subsequently appeared in the motor task. Errors and correct responses were recorded.

Subsequent to verbal or attention pretraining, all Ss were given 36 trials on a discriminative motor task provided by the Star Discrimeter. Errors and correct responses were recorded for each Star trial.

A significant interaction on motor performance was found between the distinctiveness and association value variables, indicating that in some manner the association value of pretraining responses is an effective variable. Significant differences among experimental groups HD and HS, LD and LS, and between groups HD and I were taken as compatible with the postulation of a verbally mediated cue for the prediction of differential criterion performance after different kinds of verbal pretraining.

In verbal paired-associates learning, the application of an AB-AC paradigm is expected to produce negative transfer effects. Positive transfer of training has been demonstrated with the same paradigm when a) responses C are discriminative motor responses and b) the stimuli A are certain colors, geometric shapes, or other nonverbal units.

The facilitation of the performance of Ss receiving relevant pretraining (AB-AC) over Ss pretrained on criterion-irrelevant stimuli (IB-AC) has been predicted by three alternative theoretical formulations. Each implies a change in the generalization among relevant stimuli as the result of learning verbal responses to them.

A perceptually-oriented differentiation hypothesis is advanced by Gibson (1940). At the outset of pretraining a certain amount of generalization exists among a set of similar stimuli. Because in the course of pretraining only the correct response to each

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stimulus is reinforced, generalized responses are extinguished and correct discrimination is enhanced. The subsequent learning of new responses to the same stimuli is facilitated because they have already been differentiated from one another. Gibson (1940) and later, Gagne and Baker (1950) refer to this type of situation as stimulus predifferentiation. According to this conception, the nature of the verbal response is irrelevant to the amount of motor task facilitation. The learning of verbal responses is simply the event by which generalized responses are reduced.

A second theoretical view has its origin in the writing of Dollard and Miller (1950), Hull (1930, 1939), Miller (1948), and Miller and Dollard (1941). As a verbal response is elicited during pretraining it carries with it a corresponding introceptive cue (sv) which through the verbal learning process becomes attached to the gross external stimulus (S). If response-produced cues thus acquired are more mutually distinctive than the original stimuli, inter-stimulus generalization will be reduced. If sv's are acquired those intralist similarity is greater than that of the original stimuli, stimulus generalization will be increased. These two situations are referred to as the acquired distinctiveness and acquired equivalence of cues. In contrast to Gibson's predifferentiation formulation where stimuli remain effectively the same and Ss' perception of them changes, the Miller-Dollard formulation implies a change in the stimulus events themselves, an adding of either more distinct or more similar implicit stimulus elements.

The third theoretical scheme has been developed from suggestions of Dollard and Miller (1950) and Miller and Dollard (1941). They assume that during pretraining, Ss learn to make discriminative or observing responses to the stimuli. The discriminative response carries with it an interoceptive cue (sd) which through the verbal learning process becomes attached to the gross external stimuli and facilitates the distinction of one stimulus event from another.

The primary purpose of the present study was to test the efficacy of predictions based on response-produced cue mechanisms in both distinctiveness and equivalence pretraining situations, For this purpose verbal responses were mastered during pretraining which differed in the two parameters of formal similarity and association value.

The association value of responses has been found to be an effective variable in verbal paired-associates learning (Cieutat, Stockwell & Noble, 1958; Hunt, 1959; Underwood & Schulz, 1960) However, Dysinger (1951) found that the learning of meaningful

two-syllable adjective and low association disyllables during relevant pretraining produced no differences in subsequent discriminative motor task performance. The adjectives and disyllables used by Dysinger were not formally equivalent, nor was information reported as to the initial distinctiveness of his stimulus items (line drawings). A second purpose of the study reported here was to test Dysinger's hypothesis using stimuli of a reported initial distinctiveness and verbal responses of known formal comparability.

Method

Design.—The experimental design for the pretraining phase is shown in Table 1. Four experimental groups received relevant S verbal pretraining; the stimuli were identical with those encountered subsequently on the criterion task. Two additional groups were run. The irrelevant control group (I) received verbal pretraining on stimuli similar to but not identical with those of the motor task. The attention group (A) received no verbal pretraining, but simply observed similarities and differences among relevant stimuli during the pretraining period. Subsequent to pretraining, all Ss were given 36 criterion trials on the Star Discrimeter.

Table 1. Pretraining Design

Group	*Stimuli*	*Responses*
HD	relevant random shapes	high association distinct
HS	relevant random shapes	high association similar
LD	relevant random shapes	low association distinct
LS	relevant random shapes	low association similar
A	relevant random shapes	observation
I	irrelevant random shapes	medium association distinct

The following predictions about motor task performance were made on the basis of the earlier theoretical discussion:

1) The performance of groups receiving distinctiveness pretraining (groups HD and LD) would be superior to that of the irrelevant group (I).

2) The performance level of groups receiving equivalence pretraining (groups HS and LS) would be inferior to that of the irrelevant control and comparable distinctiveness pretraining groups (HD and LD).

3) There would be no significant differences in motor performance between groups learning high association words

(groups HS and HD) and corresponding groups pretrained on low association verbal units (groups LS and LD).

4) Assuming that Ss not required to give overt verbal responses during pretraining supply their own implicit responses, and that these responses would tend to be both meaningful and distinct, it was predicted that attention group Ss (group A) would perform at a level comparable to the HD group on the motor task.

No specification was made as to whether predicted differences would appear in trends or overall means.

Apparatus.—The motor task for all Ss was provided by the Star Discrimeter apparatus which is described elsewhere (J. Cantor, 1955). 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 correctly associated slot, a microswitch simultaneously activates the stepping switch (changing the stimulus) and the correct response counter. Entering any of the other five 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 one.

During pretraining, the motor response unit was covered. A slide projector mounted next to the unit projected the response words (white on black) directly beneath the circle of opal glass

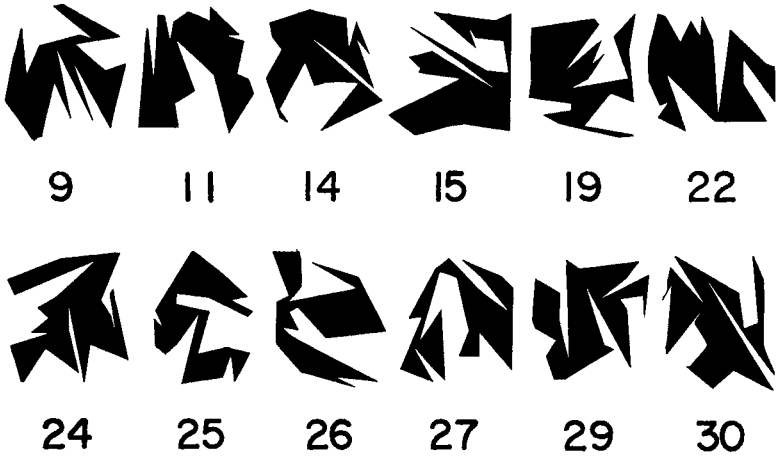

Figure 1. Twelve 24-point random shapes generated and numbered by Vanderplas and Garvin (1959).

on the stimulus panel. The stepping switch of the Star and the automatic slide projector (La Belle '33') were operated synchronously by five decade interval timers. Thus, relevant pretraining stimuli were presented by the Star and responses by means of the projector.

Stimuli.—From 12 low association value 24-point random shapes derived by Vanderplas and Garvin (1959), six were chosen for use as relevant stimuli. The chosen six, numbers 9, 11, 14, 22, 24, and 27 in the Vanderplas and Garvin list, were found to be approximately mutually equal in discriminability value (Carver and Marshall, 1961). The remaining six shapes, numbers 15, 19, 25, 26, 29, and 30, were used as irrelevant stimuli. Both relevant and irrelevant stimuli are shown in Fig. 1.

VERBAL RESPONSES.—Five lists of six verbal items each were required. Formally similar (LS) and formally distinct (LD) nonsense lists were chosen from the 0% and 6.67% lists of Glaze (1928). The chosen nonsense items are shown in Table 2 with their association values as determined by Glaze. Formally equivalent meaningful lists were then chosen, with distinct and similar lists having comparable mean association values as determined by Hager and Marshall (1961). These lists are also shown in Table 2 in addition to the 53% Glaze syllables learned by irrelevant pretraining Ss.

Table 2. Pretraining Response Items with their Association Values.

HD		*HS*		*LD*		*LS*		*I*	
CUT	10.600	COP	10.575	DAQ	6.67%	YOQ	6.67%	BIJ	53%
SON	10.550	COD	10.536	VUX	6.67%	YOX	6.67%	CAZ	53%
WEB	9.150	COT	8.650	YOZ	6.67%	YOZ	6.67%	DUP	53%
JIG	8.175	COB	8.450	CEF	0.00%	YOF	0.00%	KER	53%
POD	7.475	COY	7.450	JID	0.00%	YOP	0.00%	LOQ	53%
FAG	6.800	COG	6.950	ZIL	0.00%	YOV	0.00%	RFG	53%
Mean =	8.792		8.572		3.33=		3.33%		53%

Subjects.—Subjects were 120 male students from the elementary psychology course, 20 serving in each of the six groups.

Procedure.—For all relevant S verbal pretraining groups, a 2 sec. anticipation period occurred in which a shape appeared alone in the circle of opal glass on the stimulus panel of the Star. Then the projector flashed the appropriate work beneath the stimulus, and both stimulus and response remained on the panel for 2 sec. At the end of this period both stimulus and work disappeared and a new stimulus appeared, beginning the next 4 sec. cycle.

The sequence of stimulus and response presentation was identical for the irrelevant S group with the exception that both stimuli and responses were presented (black on white) by means of the automatic projector.

During pretraining, all Ss with the exception of the attention group were given 216 trials of paired associates learning on the

appropriate six stimulus and response items. Attention group Ss observed the stimuli presented by the Star in the same sequence and exposed for 4 sec. each. They were instructed to notice similarities and differences among the shapes. Thus, all groups were exposed to stimulus members for an equal amount of time.

The response required of verbally pretrained Ss was the spoken anticipation of a word or syllable to the visual presentation of a random shape. The six paired-associates were presented in six blocks of 36 pairs within 1 min. rest periods between each block. The pretraining response measure recorded was the number of correct anticipations on each trial.

Three minutes following the completion of pretraining, all Ss began practice on the Star Discrimeter. Thirty-six 20 sec. trials were given to all groups with a 10 sec. rest period between trials. The criterion response measures recorded were number of correct responses and number of errors per trial.

Results

At test for independent groups (Lindquist, 1956) was applied in evaluating differences among the five group means over the last 12 trials for pretraining. The hypothesis of equality of treatment population means could not be rejected at the .01 level for any comparison. Comparable performance levels for all groups at the end of pretraining was thus assumed.

An overall trend analysis of the type described by Lewis (1960) was applied to both correct and error responses on the criterion task. No significant trend or overall mean differences among group error measures was found when data were analyzed over blocks of four trials. No further analysis of error measures was made.

When the analysis was applied to correct response measures over blocks of four trials for all six groups, the trials effect proved highly significant, evidenced by the rising acquisition curves in Fig. 2. The F values for experimental conditions ($df = 8,114$) and for the trials by conditions interaction ($df = 40,912$) were 2.51 and 1.48 respectively, both significant beyond the .05 level. In order to establish the specific sources of variance producing these differences, the same type of analysis was applied to a comparison of the data for all relevant pairs of experimental and control groups. A .05 criterion of significance was chosen.

The hypotheses of parallel trend lines and equal overall means were rejected when an analysis was made of data from groups HD and I. The difference between the overall mean value for group HD (44.08) and group I (36.38) is emphasized by an ex-

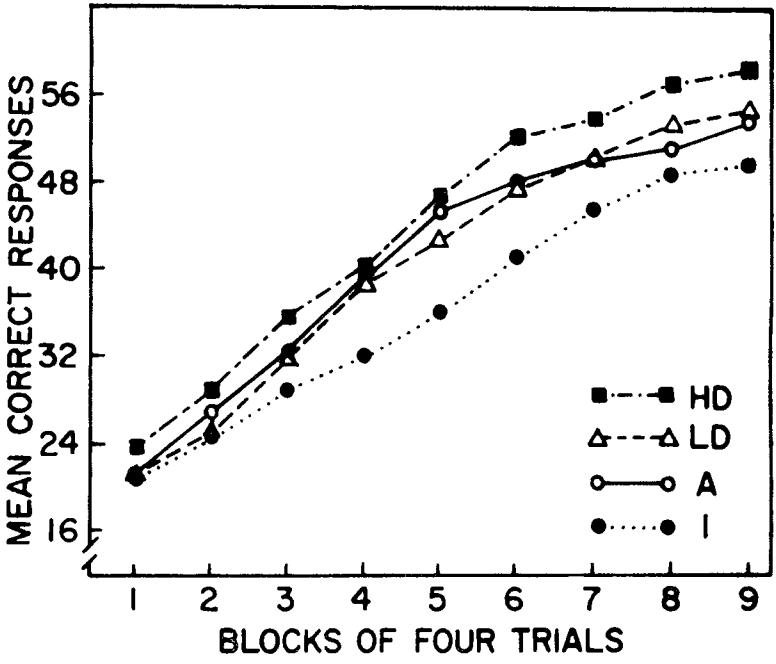

Figure 2. Motor acquisition trends in mean correct responses over blocks of four trials for high association distinct, low association distinct, attention, and irrelevant pretraining groups.

amination of Fig. 2. Both hypotheses proved tenable, however, for the comparison of group LD with I, though the overall mean for group LD (40.61) lies appreciably above that for group I, indicating the possibility of some facilitation. No significant differences were yielded from the LD-HD comparison, nor did groups HD and A differ significantly in any respect.

Overall means and trend differences were not significant for comparisons of group HS (M=35.57) with I and group LS (M=37.57) with I. Figure 3 shows the comparability in performance level of these three groups. Experimental groups LS and HS did not differ significantly in any respect, while the trends for groups LS and HS both proved significantly different from that of group A.

Groups HS and HD differed significantly in overall mean value, though the hypothesis of parallel trends was tenable (see Fig. 4). The hypothesis of parallel trends was rejected for the LS-LD and A-I comparisons. In all cases, the hypothesis of zero slope was rejected.

The trend analysis used did not provide for an estimate of possible similarity by association value interaction effects. When overall means for high and low association value pretraining are

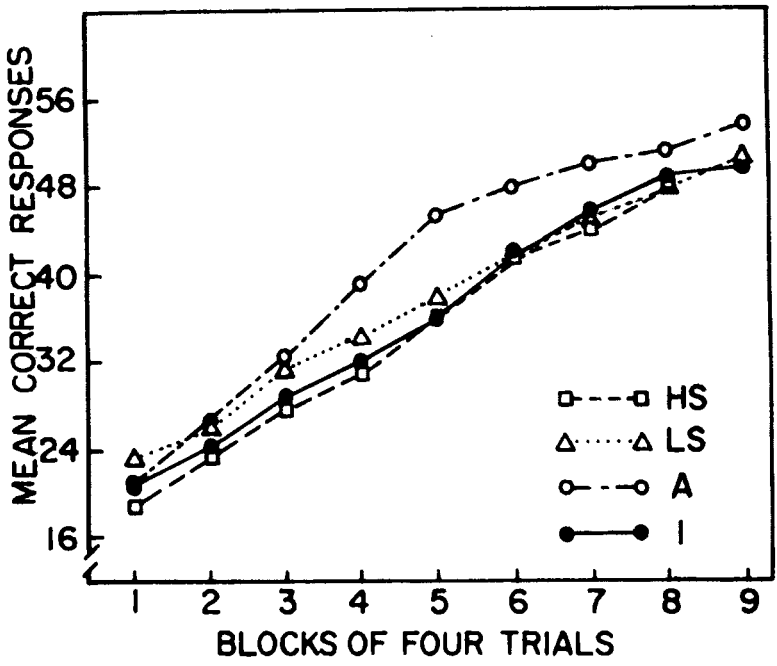

Figure 3. Motor acquisition trends in mean correct responses over blocks of four trials for high association similar, low association similar, attention, and irrelevant pretraining groups.

plotted for equivalence and distinctiveness groups, a tendency toward interaction can be observed (see Fig. 5). Subsequent to this observation, the correct response data for the four experimental groups were cast into a 2 X 2 factorial design and the similarity by association value interaction was tested against the within-cells term. The F value obtained was 12.55 for 1 and 76 degrees of freedom, significant beyond the .001 level.

Discussion

The prediction of superior criterion performance for distinctiveness pretraining groups received support from this study. Both HD and LD groups performed at a higher level than the I control group, though overall mean and trend differences were significant only for the HD-I comparison. The failure of the difference between LD and I to prove significant suggests that to some extent, the meaningfulness variable is an effective one.

In the statistical trend analysis, differences attributable to the association value factor failed to attain significance for both equivalence (HS-LS) and distinctiveness (HD-LD) pretraining groups, verifying Dysinger's earlier results. The factorial analysis, however, yielded a significant interaction between association value and similarity. This information supports the sugges-

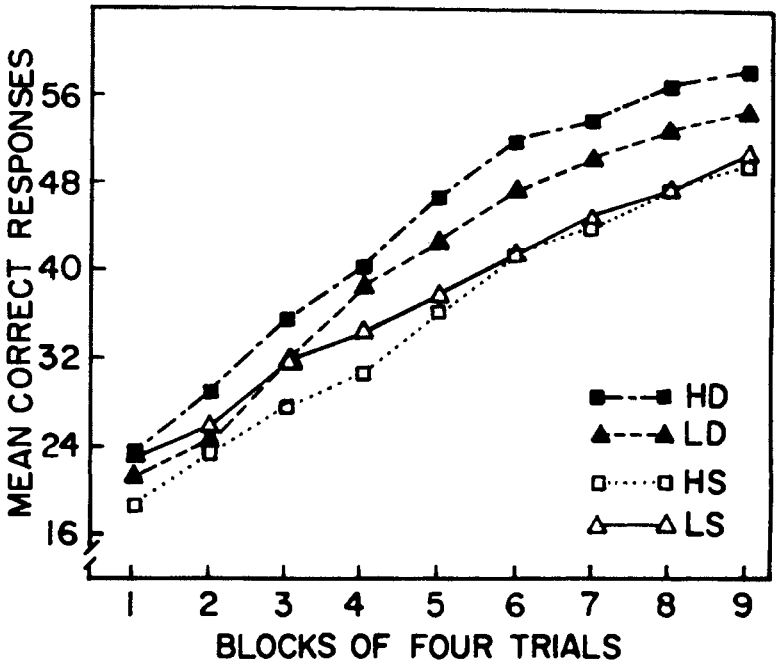

Figure 4. Motor acquisition trends in mean correct responses over blocks of four trials for high association distinct, high association similar, low association distinct, and low association similar pretraining groups.

tion that meaningfulness is an effective variable and further, that previous failures to obtain a significant index of its effectiveness may have been due to complex interactions with other response dimensions not specifically controlled.

As hypothesized, equivalence pretraining groups (HS and LS) performed at a lower level than distinctiveness pretraining groups (HD and LD). For high association value groups, the difference between overall means of the distinctiveness and equivalence groups was statistically significant, while for low association value groups the difference between trends was significant. The superiority of distinctiveness pretraining, taken together with the observation that all groups reached a comparable performance level on the pretraining task, suggests that the kind of verbal pretraining response learned is an effective variable in determining the amount of facilitation in criterion performance. The Gibson differentiation hypothesis fails to account for these results since, in addition to attaining comparable mastery of the pretraining task (and thus equivalent extinction of generalized responses), Ss were exposed to the relevant stimuli for the same number of trials. For the same reasons, it is unlikely that the observed differences between distinctiveness on

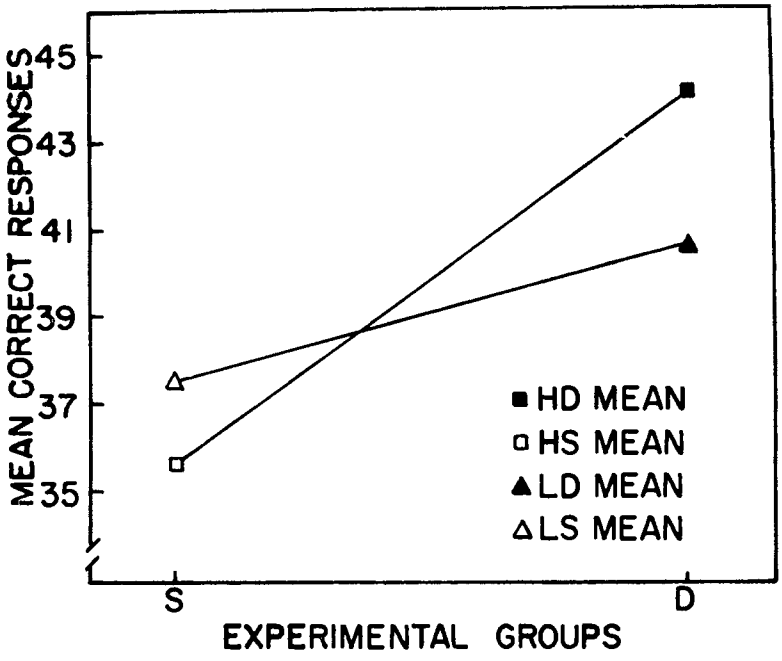

Figure 5. Mean correct motor responses over nine blocks of four trials for high association distinct, high association similar, low association distinct, and low association similar pretraining groups.

the basis of the discriminative response-produced cue. Th involvement of some sort of verbally mediated cue seems necessary to account for the rank order of performance of distinctiveness and equivalence pretraining groups, and the significance of the differences between HD and HS, and LD and LS performances.

The prediction was made that equivalence pretraining groups would perform below the irrelevant control group. This prediction received no statistical support. Although the HS group mean (35.57) falls below that of the I group mean (36.34), the LS group mean lies above it (37.57). These data suggest that for the particular stimuli used there may be some ceiling effect involved in generalization among them. The possibility also remains that, as suggested by McAllister and Cantor (1957), discriminative response-produced cues are operating to decrease stimulus generalization while at the same time the verbal response-produced cue is increasing generalization. Their joint effect could produce a performance level comparable to that of the irrelevant control group which received no verbal pretraining on criterion stimuli.

In some previous studies (G. Cantor, 1955; Norcross & Spiker, 1957), an attention group was used as a control for the effects of

observational or discriminative responses. However, the prediction based on the assumption that attention Ss supply their own implicit verbal responses was supported by the present study, confirming the lack of adequacy of this kind of group as a control. The group A performance trend differed significantly from that of both equivalence pretraining groups. The overall mean performance of group A (40.88) falls between that of groups HD and LD and differs significantly from neither. Worth noting, however, is that the assumption concerning subject-supplied verbal responses need not be made to account for A group performance if the operation of the discriminative response-produced cue mechanism is assumed instead. The performance of group A could represent the facilitative effects of observational or discriminative responses alone.

The present data lend support to a group of earlier verbal pretraining studies in which motor performance facilitation was demonstrated following pretraining on criterion-relevant stimuli (Baldwin, 1954; G. Cantor, 1955; J. Cantor, 1955; Dysinger, 1951; Norcross & Spiker, 1957). In two other similar studies, no difference was found between relevant S and irrelevant pretraining groups (Arnoult, 1953; Farber & Murfin, 1951), while one investigator found interference due to relevant S pretraining, (McAllister, 1953). On the basis of the present study, such conflicting reports might be expected as attributable to the kinds of verbal responses learned during relevant S pretraining. For instance, McAllister's relevant S group learned two-syllable adjectives which, while formally quite distinct, possess common conceptual elements that could increase intralist generalization. What was referred to as a relevant S pretraining group may have received, in effect, equivalence pretraining which should be expected to interfere with motor performance.

The design and interpretation of future studies in the verbal pretraining area must be undertaken with consideration for both the formal and conceptual similarity between verbal responses members used. Ideally, sets of verbal response members should be developed which change incrementally over a wide range of similarity and meaningfulness. Only through such a technique can the nature of the function relating similarity and meaningfulness to amount of facilitation be determined.

Finally, before an unequivocal demonstration of the relative extent of the effects of different kinds of verbal pretraining can be accomplished, it will be necessary to develop sets of stimuli which are not only mutually equally discriminable, but also of a known level of difficulty (initial stimulus generalization).

SUMMARY

Four experimental groups of 20 Ss each were given 216 trials of verbal paired-associates training to 6 random shape stimuli subsequently encountered on a discriminative motor task. The four groups learned verbal responses which were, respectively, high in association value and formally distinct (HD), high in association value and formally similar (HS), low in association value and formally distinct (LD), and low in association value and formally similar (LS). An additional group (A) attended to criterion-relevant stimuli during 216 nonverbal pretraining trials, while a control group (I) learned medium association value distinct syllables to criterion-irrelevant stimuli. All Ss were given 36 trials on a discriminative motor task provided by the Star Discrimeter. The predictions and results are as follows:

1) The performance of groups HD and LD would be superior to that of group I. Mean and trend differences proved significant only for the HD-I comparison.

2) The performance of group HS would be inferior to that of groups HD and I; and the performance of group LS would be inferior to that of groups LD and I. The mean HS performance was significantly lower than that of group HD and the difference between trends for groups LS and LD was statistically significant. The prediction that HS and LS groups would perform below the I group received no statistical support.

3) Group HS would not perform significantly differently from group LS; and group HD would not perform significantly differently from group LD. Both hypotheses proved tenable.

4) The hypothesis that group A's performance would not be significantly different from group HD's was retained.

Since all experimental groups achieved the same level of pretraining mastery, the present results indicate the necessity for postulating some sort of verbally mediated cue in order to predict differential criterion performance following different kinds of verbal pretraining. At the present stage of empirical knowledge, however, a separation and a determination of the relative contributions of discriminative and verbal mechanisms is not possible.

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