# The effects of percent of association on discrimination shifts

DONALD R. YELEN
Washburn University, Topeka, Kans. 66621

The present experiment investigated the effects of changes in the percent of association between stimuli and responses on intradimensional and extradimensional shift problems. The results indicated that the percent of association differentially affects the frequency of responses and that the weighted frequencies of the responses are related to the choices made with stimulus compounds that simulate intradimensional and extradimensional shift problems.

Problems involving intradimensional (ID) and extradimensional (ED) shifts can be characterized by distinctive training to test changes in the percent of association (POA) between the stimuli forming the relevant and irrelevant dimensions and one of the available classifying responses. Consider, for example, a problem with two binary dimensions and two classifying responses. Each of the stimuli forming the relevant dimension would be associated with a different classifying response, and consequently, the POAs between these two stimuli and one of the responses would be 0 and 100. The stimuli forming the irrelevant dimension would be equally associated with both of the classifying responses, and therefore, the POAs between these two stimuli and one of the responses would be 50 and 50. Under ID shift conditions, since the same dimension is relevant during both training and test trials and only the responses are reversed, the training to test changes in the POAs with a response are, for the two stimuli forming the relevant dimension, 0 to 100 and 100 to 0; for the two stimuli forming the irrelevant dimension, they are 50 to 50 and 50 to 50. In contrast, under ED shift conditions, because the dimension that is irrelevant during training becomes relevant during test trials, the training to test changes in the POAs with a response are, for the two components of the dimension that is relevant during test trials, 50 to 100 and 50 to 0; for the two components of the dimension that is irrelevant during test trials, they are 0 to 50 and 100 to 50.

The purpose of the present experiment was to investigate the effects of the training to test changes in POA that characterize stimuli forming relevant and irrelevant dimensions under ID and ED shift conditions on the solution of simulated ID and ED shift problems.

## MATERIALS

Training and test lists of paired associates were used to reproduce the changes in POA found under both ID and ED shift conditions. Four stimuli, %%, $$, ==, and @@, and two responses, SUD and MEL, were used. The training lists were constructed to produce POAs of 100, 0, 50, and 50 between the four stimuli and the response SUD. Each stimulus appeared twice and each response appeared four times on each trial. One stimulus was paired with SUD twice, another stimulus was paired with MEL twice, and the two remaining stimuli were each paired with SUD on one occasion and with MEL on the other occasion. Thus, the POAs with SUD were 100, 0, 50, and 50 for the four stimuli, respectively. The test lists re-paired the stimuli and responses, changing the POAs between the four stimuli and the response SUD. Each of the four stimuli, then, can be identified by two numbers, the first indicating the POA on the training list, the second indicating the POA on the test list. For example, 100-0 indicates that the POA between the stimulus and SUD was changed from 100 during training to 0 during test trials.

Training and test lists were prepared so that the changes in the POAs between the stimuli and SUD were, in the ID shift condition, 0-100, 100-0, 50-50, and 50-50; in the ED shift condition, the changes were 50-100, 50-0, 0-50, and 100-50. The first two stimuli, under both ID and ED shift conditions, represent stimuli that form a relevant dimension during test trials, while the two remaining stimuli under each condition characterize the components of a dimension that is irrelevant during test trials.

The four paired-associate stimuli were also used to construct two pairs of stimulus compounds which simulated the materials used during ID and ED shift problems. The first pair of stimulus compounds, A, combined in the ID shift condition the 0-100 and 50-50 stimuli vs the 100-0 and 50-50 stimuli; in the ED shift condition the 50-100 and 0-50 stimuli vs the 50-0 and 100-50 stimuli were combined. The second pair of stimulus compounds, B, combined in the ID shift condition the 0-100 and 50-50 stimuli vs the 100-0 and 50-50 stimuli; in the ED shift condition the 50-100 and 100-50 stimuli vs the 50-0 and 0-50 stimuli were combined. In each pair of stimulus compounds, the combination that included the stimulus with a POA of 100 during training or test trials was considered correct.

The paired-associate lists and the pairs of stimulus compounds were presented with a Bell and Howell projector and 40-unit slide trays. In each tray, Slides 1-16 were used for the paired-associate items, Slide 17 was blank, Slides 18 and 19 were used for the A and B pairs of stimulus compounds, and Slide 20 was blank. This sequence was repeated in the second half of each tray. Two trays were used for each training and test list. The items for a given list were arranged in two different orders in each of the two trays. The pairs of stimulus compounds were presented in an ABBABAAB order over the two trays. Hunter timers controlled the projector, so that the slides were changed at a 2-sec rate.

## PROCEDURE

The Ss were given instructions for paired-associate learning by the anticipation method and for the problem-solving task. Problem-solving instructions indicated that Ss were to choose the combination in each pair of stimulus compounds that was most highly associated with the response SUD. One stimulus combination appeared at the top of the slide, the other combination at the bottom. Ss indicated their choices by saying "top" or "bottom." Ss were not told whether their choices had been correct or incorrect. After the instructions had been given, a training list of paired associates and the A and B pairs of stimulus compounds were presented for 12 trials. These trials were followed without interruption by the presentation of a test list of paired associates and the two pairs of compounds for an additional 12 trials. The frequency of the response SUD during the paired-associate task and the Ss' choice during the problem-solving task were recorded.

## SUBJECTS

A total of 80 introductory psychology students served as Ss. Half of the students were assigned to the ID shift condition; the remaining students served in the ED shift condition.

## RESULTS

Previous investigations of ID and ED shifts (e.g., Kendler & D'Amato, 1955) have usually required Ss to reach a stringent criterion on the training task before the test task was presented. In order to be consistent with these investigations, only the data from the Ss who reached a criterion of perfect performance with the stimuli representing the components of a relevant dimension during the last three paired-associate training trials will be presented here. A total of 24 ID Ss and 25 ED Ss reached this criterion.

Table 1 shows the relative frequency of the response SUD to stimuli in the ID and ED shift conditions during the 12 paired-associate test trials. An analysis of variance of these data, with shifts (ID and ED) as a between-Ss effect and the POA between stimuli and SUD during test trials (100, 0, 50, and 50) as a within-Ss effect, indicated that the Shifts by POA interaction was significant ($F = 11.90$, $df = 3/141$, $p < .01$). Tests of the simple effects of this interaction indicated, first, that the relative frequency of SUD was significantly ($p < .05$) greater to the 0-100 stimulus than to the 50-100 stimulus and was significantly ($p < .05$) less to the 100-0 stimulus than to the 50-0 stimulus. These results indicate, then, that the training to test changes in POA that characterize the stimuli forming a relevant dimension under ID shift conditions result in faster changes in the occurrence of a response than the training to test changes in POA that characterize the stimuli forming a relevant dimension under ED shift conditions. Tests of the simple effects of the Shifts by POA interaction also indicated that the relative frequency of SUD was significantly ($p < .01$) less to the 0-50 stimulus than to the comparable 50-50 stimulus and was significantly ($p < .01$) greater to the 100-50 stimulus than to the comparable 50-50 stimulus. These results indicate that the training to test changes in POA that represent components of an irrelevant dimension under ED shift conditions tend to maintain the frequency of the training response at a high level during the test trials.

Figure 1 shows the proportion of correct choices during test trials with both A and B pairs of stimulus compounds under ID and ED shift conditions. Inspection of Fig. 1 shows that the proportion of correct choices was higher in the ID shift condition than in the ED shift condition with both A and B pairs of stimulus compounds. An analysis of variance of these data, with shifts (ID and ED) as a between-Ss effect and pairs of stimulus compounds (A and B) as a within-Ss effect, indicated that the main effect of shifts was significant ($F = 12.18$, $df = 1/47$, $p < .01$) and that the Shifts by Pairs interaction approached, but did not reach, the .05 level of significance ($F = 3.84$, $df = 1/47$, $.10 > p > .05$). Thus, the

Table 1
Relative Frequency of SUD During Test Trials

| ID Condition | | ED Condition | |
|---|---|---|---|
| Stimuli | P of SUD | Stimuli | P of SUD |
| 0-100 | .83 | 50-100 | .70 |
| 100-0 | .09 | 50-0 | .25 |
| 50-50 | .52 | 0-50 | .32 |
| 50-50 | .45 | 100-50 | .69 |

data presented in Fig. 1 replicate the usual finding that college students solve ID shift problems faster than they do ED shift problems.

## DISCUSSION

A single-unit theory, such as the one described by Kendler & Kendler (1968), can be used to interpret the problem-solving results of the present experiment. When applied to the present situation, this type of theory suggests that the probability of choosing the correct member of each pair of stimulus compounds would be related to the weighted sum of the frequencies of SUD to the relevant and irrelevant stimuli that make up the compounds.

When only the relevant stimuli in each compound are considered, Table 1 indicates that Ss in the ID shift condition would have an advantage over the Ss in the ED shift condition during the problem-solving task. That is, since SUD is given as a response more frequently to the 0-100 stimulus than to the 50-100 stimulus, the chances of choosing the correct member of the A and B pairs of stimulus compounds would be higher for ID Ss than for ED Ss. At the same time, the lower frequency of SUD to the 100-0 stimulus than to the 50-0 stimulus would make the probability of choosing the incorrect member in both pairs of stimulus compounds lower for ID Ss than for ED Ss.

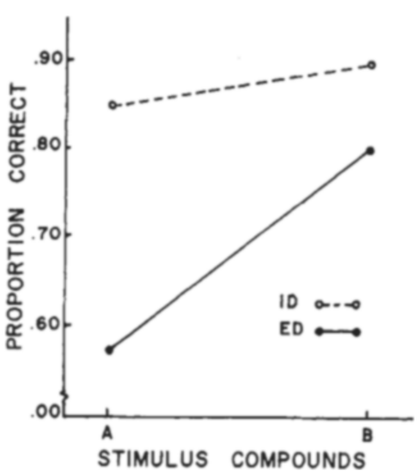


**Fig. 1. Proportion of correct choices during test trials with A and B pairs of stimulus compounds under ID and ED shift conditions.**

When only the irrelevant stimuli in each compound are considered, Table 1 indicates that Ss in the ED shift condition would be at a disadvantage with the A pair of stimulus compounds but would have an advantage over Ss in the ID shift condition with the B pair. With the A pair of stimulus compounds, the low frequency of SUD to the 0-50 stimulus would reduce the probability of ED Ss' choosing the correct member, while the high frequency of SUD to the 100-50 stimulus would increase the probability of ED Ss choosing the incorrect member. With the B pair of stimulus compounds, these expectations would be reversed; that is, the low frequency of SUD to the 0-50 stimulus would decrease the probability of ED Ss' choosing the incorrect member, while the high frequency of SUD to the 100-50 stimulus would increase the probability of ED Ss' choosing the correct member.

When the frequency of SUD to the stimuli forming a compound is summed, and if it is assumed that more weight is given to the effects of relevant stimuli than irrelevant stimuli, the probability of choosing the correct member in the A and B pairs of stimulus compounds would be higher in the ID than in the ED shift condition. With the A pair of compounds, the frequency of SUD to both the relevant and irrelevant stimuli gives an advantage to ID Ss, and, thus, when summed, a large difference favoring the ID shift condition would be expected. With the B pair of compounds, the frequency of SUD to relevant stimuli gives an advantage to ID Ss, while the frequency of SUD to irrelevant stimuli gives an advantage to ED Ss. If, as assumed, more weight is given to the effects of relevant stimuli than of irrelevant stimuli, then, when summed, a small difference in favor of the ID shift condition would be expected. Thus, the probability of choosing the correct member in each pair of stimulus compounds can be related to the weighted sum of the frequencies of SUD to the relevant and irrelevant stimuli that make up the compounds.

### REFERENCES


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