Intradimensional and extradimensional shifts using a total change design with word stimuli*

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The experiment compared intradimensional shift, wherein the assignment of stimuli to categories changed, but the relevant dimension did not change, to extradimensional shift, wherein a different dimension was made relevant after training. Word stimuli, a total change design, and a control group, shifted to entirely new dimensions, were used to evaluate the results. University students were trained to the same consecutive correct response criterion in a three-choice discrimination and then shifted to the various transfer conditions. The results showed that intradimensional shift was learned faster than extradimensional shift, but no significant positive or negative transfer was found. The absence of significant positive and negative transfer was discussed.

Various studies of discrimination learning have attempted to determine whether mediational responding or strict stimulus-response association principles operate when animals and humans have served as Ss. These studies have compared transfer conditions, wherein the assignment of stimuli to categories changes, but the relevant dimension does not change (postsolution reversal shift), to transfer conditions, wherein a different dimension is made relevant (extradimensional shift). Mediational theories of learning predict that postsolution reversal shift is easier to learn than extradimensional shift because the S is capable of responding to the dimension as well as to the dimensional cues. Forming a dimensional response (i.e., responding to a broad class of cues having a common stimulus property such as color or form) will facilitate the reversal, as opposed to the extradimensional shift. In addition, mediational theories explain the occurrence of positive transfer when it is found in reversal shift. The strict stimulus response theory of learning predicts that extradimensional shift will be easier to learn than reversal shift because it is harder to learn the reverse of a habit (e.g., reversal shift) than it is to learn to respond to another dimension of the stimulus complex (e.g., extradimensional shift). From the results of numerous studies, some Es have concluded that developmental differences in the ability to mediate exist within the human species, and that there are, as well, interspecies differences in this ability (Kendler & Kendler, 1962). However, inconsistent results have prevented any definitive conclusions on this subject (Dickerson, 1966; Kelleher, 1956; Kendler, Kendler, & Wells, 1960; LeBow, 1970a). In part, the inconsistencies with human Ss are due to differences in subject variables such as age and intelligence (LeBow, 1970b; Wolff, 1967). Slamecka (1968) has pointed out that these inconsistencies may also reflect differences in the transfer paradigms used to test mediation vs strict stimulus-response theory. To avoid confoundings, Slamecka proposed that a total change design be employed, wherein all the cues along the relevant and irrelevant training dimensions were changed in transfer. When a total change design is employed, the reversal shift is usually renamed intradimensional shift. Slamecka also proposed that symbolic materials (i.e., words) be used as the stimuli instead of the customary colored geometric forms. This would rule out the possibility of accounting for the data by invoking the notion of primary stimulus generalization. That is, results apparently consistent with a mediational model also can be accounted for by a nonmediational explanation if symbolic stimuli are not employed. A test of mediation vs strict stimulus-response theory, using the total change design and word stimuli, has been made (Slamecka, 1969). The data strongly favored the mediational interpretation (i.e., intradimensional shift was easier to learn than extradimensional shift, and positive transfer occurred in the former condition and negative transfer in the latter). In this experiment, however, the stimuli used were common nouns such as "Chicago" or "football" from dimensions of cities and sports, as opposed to the dimensions of shape, color, or number, typically used in concept shift research when geometric figures serve as stimuli. The present study was a further test of the mediational model using the total change design with word stimuli. But, to achieve a closer parallel with the large body of previous research, the dimensions employed were the same as those used most often in the past. On the basis of previous research, it was predicted that the intradimensional shift would be learned more rapidly than the extradimensional shift.

SUBJECTS

The pool of Ss from which the experimental sample of 72 was selected consisted of 96 introductory psychology students at the University of Manitoba. Of these 96 Ss, 24 were excluded from the experiment because they were unable to reach the training criterion. Nineteen of the Ss were from the control group, 2 from the intradimensional shift group, and 3 from the extradimensional shift group.

MATERIALS

The experiment was performed with each S seated at a table opposite E. The stimulus materials were placed on a shelf under the table, and responses were recorded in a notebook out of S's view. The stimuli used in the experiment were words typed in a line in the center of white 3 x 5 in. cards. There were three words on each card, each word representing a value along one of three dimensions. The words used are presented in Table 1. All possible combinations of these three-three value dimensions were represented, except for those combinations which formed meaningful phrases, such as number-color-form sequences (e.g., "two blue squares"). Although it was obvious which sequences were meaningful in Decks 1 and 2, in Deck 3 none of the sequences were meaningful. Therefore, to equate the number of cards in the three decks, all cards with sequences in the order of temperature-size-position (e.g., "hot large top") were eliminated from Deck 3. The resulting three decks were composed of 18 cards each. Three wooden response blocks were placed on the table throughout the experiment. These white blocks were 3½ x 3 x 1½ in. and had either a question mark, exclamation mark, or semicolon painted on them in black; these marks were used merely to enable S to discriminate between blocks, and all Ss were instructed that the marks were not significant. A bell located on the shelf under the table was rung when S emitted a correct response.

PROCEDURE

Each S served individually in the experiment and, upon entering the

*The preparation of this research was partially supported by the National Research Council of Canada, 311-1665-12.

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Table 1
Stimuli Used in the Experiment

Deck 1			Deck 2			Deck 3		
yellow	three	triangles	orange	seven	hexagons	large	bottom	cold
purple	six	ovals	blue	five	squares	small	center	warm
green	four	rectangles	red	two	circles	tiny	top	hot

experimental room, was administered the necessary instructions.

Each S was assigned randomly to one of the 24 experimental conditions. Each of the training and transfer conditions was a three-choice discrimination with one relevant and two irrelevant dimensions. Stimuli were always presented successively, one at a time.

TRAINING

All of the experimental Ss were given the three-choice discrimination task. One-third of the experimental Ss were given a color-relevant problem, another third were given a form-relevant problem, and the remaining third were given a number-relevant problem. Equal numbers of control Ss were trained on size-, position-, or temperature-relevant problems. A trial began when a stimulus card was presented, and S responded by moving one of the three response blocks forward. (E had privately assigned one of the three cues along the relevant dimension to each block.) The stimulus card was removed immediately after S responded and placed under the table. When S emitted a correct response, E rang the bell. Before the next stimulus presentation, E moved the response block back into position. At the conclusion of each block of 18 trials (one deck), the response blocks were rearranged and the stimulus cards shuffled. Training continued until eight consecutive correct responses were made. If S did not reach the training criterion by the 200th trial, he was dropped from the experiment.

TRANSFER

Immediately after reaching the training criterion, S was given an intradimensional, extradimensional, or control shift, by using a second deck of cards with new stimuli on them. One-half of the Ss were shifted to Deck 1 and the other half to Deck 2. For the intradimensional-shift Ss, the dimension that had been relevant in training remained relevant. For the extradimensional shift Ss, one-half of those who had been trained on a color-relevant problem were shifted to a form-relevant task and one-half to a number-relevant problem. Similarly, those Ss trained with form as relevant were shifted to color or number, and those trained with number as relevant were shifted to color or form. The control Ss, who had been trained with size, position, or temperature as relevant, were shifted to the color-, number-, or form-relevant problems. Trials continued until S made eight consecutive correct responses or until the 100th trial was reached.

DESIGN

The experimental design was a 3 by 3 factorial incorporating both dimensions (e.g., color, form, and number) and transfer operations (e.g., intradimensional, extradimensional, and control). Because they had no significant effect and served only as precautions against confounding, the variables of relevant training dimension in extradimensional shift and deck shifted to in transfer were not considered in any of the major analyses. Thus, only nine conditions were analyzed in transfer.

RESULTS

The dependent variables of primary interest were trials and errors to criterion. Since these two measures were highly correlated ($r = .97$ and $.98$ for training and transfer, respectively), only the analyses of errors will be considered.

Training

Analyses of variance of errors were conducted which revealed that no training group was significantly different from any other training group before transfer. This result is essential for an unbiased comparison of intradimensional and extradimensional shift performances.

Transfer

An analysis of variance based on errors to criterion revealed a significant transfer effect [$F(2,63) = 6.21$, $p < .01$], with intradimensional shift being easier than either the control or extradimensional shift tasks. The magnitude of this relationship was not large ($E = .12$). The dimension effect (i.e., form, color, or number) as well as the Dimension by Transfer interaction were both nonsignificant. Thus the main effect of type of shift was uncomplicated by any interaction with dimensions. A Duncan multiple range test was performed on the transfer effect, indicating that the difference between the intradimensional and extradimensional shift tasks was significant ($SSR = 17.085$, $p < .01$). The differences between the two experimental transfer conditions and the control group were each nonsignificant; the difference between the extradimensional shift and the control shift, however, was close to the .05 level of significance. Thus, while no significant positive or negative transfer was found, extradimensional shift was the most difficult task and intradimensional shift the easiest.

DISCUSSION

Although the data showed that intradimensional shift was easier to learn than extradimensional shift, neither positive transfer in the intradimensional shift task nor negative transfer in the extradimensional shift task were found to be significant; a trend in this direction, however, was evident. As previously stated, Slamecka (1969) did find these positive and negative transfer effects. While no definitive statement about this discrepancy at present can be made, it may be that both the number and the type of dimensions and stimuli used in the two studies are, in part, responsible for the differences obtained. That is, Slamecka employed five dimensions with two cues along each dimension in his study, while in the present experiment, three dimensions with three cues along each dimension were utilized. Also, Slamecka used common nouns such as radish and trumpet for his experimental Ss, while the present authors employed words representing colored geometric figures.

The type of dimensions and stimuli used in training for the control Ss in the present experiment might have been responsible for the large number of these Ss who failed to reach criterion. Because of the operation of a S-selection artifact produced by the more difficult control training task, a control group of fast learners was probably formed. In light of this artifact, the number of errors produced by the control group in transfer should be considered spuriously low. It would be expected, however, that a more representative control group would have resulted in an extension of the intradimensional-control difference, but an attenuation of the obtained extradimensional-control difference. Thus, more of a trend toward positive transfer for the intradimensional task might have resulted, and less of a trend toward negative transfer for the extradimensional task might have been obtained. The same trends in transfer as found in the present experiment, therefore, would probably have resulted. That is, the intradimensional task would still have been learned with fewer errors than the control, and the extradimensional might still have been learned with more errors; the latter conclusion, however, would have to be tested. In any event, the intradimensional-extradimensional difference obtained in the present experiment would have been unaffected.

In conclusion, the main result of this experiment is consistent with the major prediction of a mediational interpretation of discrimination learning free from the potential biases Slamecka (1968) delineated (i.e., intradimensional shift was easier to learn than extradimensional shift). The discrepancy between the present results and Slamecka's (1969) result suggests that variables such as type of stimuli and number of dimensions used, in addition to S and other task variables, may be important in concept shift experiments.

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Relational mnemonics in category clustering: The correlates of word frequency, familiarity, and category-name variables

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The reported use of relational or rote recall techniques in a category-clustering paradigm was examined as a function of (1) the frequencies of occurrence of the nouns being recalled, (2) the familiarity scale values of the nouns, and (3) the availability of instructions containing category-name cues. Results indicate that: (1) with relational techniques being used in higher proportions than rote techniques, the difference between types of techniques was an increasing function of frequency of occurrence; (2) for low-familiarity words, the use of relational techniques increased more rapidly with increasing frequency of occurrence for instructed groups than for uninstructed groups; and (3) increasing word frequency was associated with decreasing differences between familiarity conditions for both types of techniques. An explanation, based upon assumptions concerning associative relationships, is offered for the results.

There has been a growing interest in the mnemonic rules, codes, or strategies which Ss use in organized recall (e.g., Pollio & Gerow, 1968). Evidence suggests that the reported use of associative or relational strategies is related to better free recall than is the reported use of rote strategies (Eagle, 1967). Therefore, it would seem valuable to determine if, in *organized* recall, the reported use of relational and rote strategies is related to the manipulation of variables commonly used in the study of learning and coding.

The Ss were asked to report the strategies used in a category-clustering investigation which manipulated the frequency of occurrence and familiarity scale values of the words and the availability of category names (Bowen, 1970). The proportions of relational and rote strategies are reported here as functions of those variables.

METHOD

The treatment variables were: (1) three T-L frequencies of occurrence of the stimulus words—.22 < 1 words per million (wpm), 1-4 wpm, and 5-100+ wpm (Thorndike & Lorge, 1944); (2) two levels of familiarity scale values—low (L) and high (H) familiarity; and (3) two levels of category-name instructions—instructions (I) and no instructions (NI). A complete description of the familiarity scaling and frequency characteristics of the words is to be found elsewhere (Bowen, 1969a)

Words in each combination of frequency of occurrence and familiarity level were equally subdivided into four conceptual categories: names of occupations, animals, articles of dress, and persons. The I groups were told the names of the categories immediately prior to stimulus presentation and again immediately prior to recall. The NI groups were not told category names.

The words were presented once to the Ss in each experimental group, and, following presentation and an opportunity for writing recalls, the Ss were asked to describe the techniques which they had used in attempting to remember the words.

Techniques were classified by first reading all responses and taking notes with key phrases from the responses. Second, general descriptions were developed for the response categories. Responses then were classified independently by two judges, the E and his assistant, without reference to each S's treatment combination or

*The writer gratefully acknowledges the support of a research grant and faculty research fellowship from the Research Foundation of the State University of New York. Also acknowledged with gratitude is the assistance of Carlton Aldrich.