Table 2
Mean Magnitudes of Response to Components
from the Original Pairs on Transfer Test Trials
N = 30

Components	Transfer Trial I	Transfer Trial II
From reinforced pair (+)	1.11	1.15
From nonreinforced pair (-)	1.08	.98
Difference	.03	.17
t	.20	1.55

This was followed by two test trials on the original learning compound stimuli, then four more test trials on components.

For extinction, Ss were divided randomly into three groups. In the dominant component group, extinction trials were administered to the component from the original reinforced compound which yielded the largest magnitude of response on postacquisition tests; in the nondominant component group, extinction trials were given the component from the original reinforced compound which gave the smaller magnitude of response on postacquisition tests. The third, control, group received extinction trials on one of the components from the nonreinforced compound stimulus. Four extinction trials on the selected components were followed by a test of the compound stimulus originally reinforced in acquisition. This was followed by four more extinction trials on components and another test of the compound.

RESULTS

Responses with a latency from 1 to 6 sec following CS onset on test trials were read from start of response to peak, in the unit square root of change in conductance. This value was averaged for test trials on originally trained compounds to evaluate for degree of initial discrimination conditioning. That information is shown in Table 1 where it can be seen that a significant difference in magnitude of response to reinforced and nonreinforced compounds occurred at the mid-acquisition test trial and at two postacquisition test points.

To test for transfer of differential response from compounds to components, means for the component from the reinforced compound stimulus and the

component from the nonreinforced compound stimulus on two posttest trials were computed and are shown in Table 2. As in the previous study, there is no evidence of transfer of differential responding, unless note is taken of the fact that such differences as occurred are in the expected direction and increase in magnitude as extinction progresses.

Comparison of magnitudes of response to the compound stimulus (++) after extinction trials on various component stimuli suggested a transfer of extinction effect determined in part by the strength of the component. The response was smallest for the dominant component group, intermediate for the nondominant group, and maximum for the control group. These differences, however, were only marginally significant ($p = .10$).

DISCUSSION

Present results agree with those in the previous study, showing that differential responding established to simple compound stimuli composed of pairs of colored lights does not transfer to produce differential responding to components. Presumably, initial conditioning was sufficient to provide clear differentiation for the S between compound stimuli in acquisition and component stimuli as tested at the conclusion of acquisition. Considerations for possible further exploration were provided by weak evidence that extinction of the components will transfer to extinction of the compound and that the degree of transfer is related to the dominance of the component in original conditioning.

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NOTES

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2. Now at University of California Medical Center, San Francisco, California.

antonyms of the original stimulus words. Responses to antonyms were reliably different from synonyms in the direction of complementarity ($1 - \pi_i$), even when associative values of antonyms were considerably higher than synonyms. By allowing for complementary responses, this paradigm provides a particularly useful tool for the examination of semantic and associative properties of words.

The principal purpose of these experiments was to examine the generalization of probabilistic training with words as stimuli—or predictors—to synonyms and antonyms of those words. The basic model for this method, using nonmeaningful stimuli as predictor cues, has been previously studied in this laboratory (Gentile & Schipper, 1966; Schipper, 1967; among others). Ss learned conditional probabilities (π_i) of occurrence of a particular event (red light) given single predictors (green lights) in arrays of two, three, four, or five predictors. After training, occurrence of the event light was predicted, without feedback, from the individual and combinations of predictor lights.

Substitution of words for green lights as predictors in learning and substitution of additional words for light combinations provide a new way to examine the semantic and associative values of word pairs. Although these properties have been extensively studied by the mediated generalization paradigm (Jenkins, 1963; Mandler, 1963), only half of the potential generalization scale was available. There was either some degree of generalization, or there was none. The methods did not allow for a "negative generalization," an opposite response. Ss are, in the studies to be reported here, provided the opportunity to respond in a complementary manner to synonyms and antonyms and other (neutral?) words.

METHOD

Experiment 1

Three predictor words were selected on the basis of the high association value of their synonyms and antonyms, but with respective antonyms higher than synonyms (Shapiro & Palermo, 1968). The words were FAST with associates SWIFT and SLOW, BIG with associates LARGE and SMALL, and ROUGH with associates COARSE and SMOOTH. Three nouns, DOOR, LAMP, and PARK, were selected as control words because of their low association with all nine test words.

Stimulus words were projected individually on a screen for 4 sec during which time Ss predicted whether the following slide projected would be a five-pointed star or a blank slide. Predictions were made by pressing one of two buttons on hand-held response boxes. Consecutive

Probability learning with words¹

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In two experiments in multiple

probability learning, Ss were trained with conditional probabilities (π_i) of outcomes associated with two or three stimulus adjectives. After training, they predicted the same outcomes without feedback, but stimuli now included synonyms and

Table 1
Experiment 1: Mean Percentage Star Predictions Without Feedback

	Treatment		
	T1: S-A	T2: S-N	T3: A-N
Fast (1/7)	26	17	27
Swift	31	35	—
Slow	40	—	37
Big (3/7)	56	52	46
Large	52	48	—
Small	51	—	40
Rough (6/7)	86	83	79
Coarse	75	77	—
Smooth	37	—	41
Door	—	—	—
Lamp	—	30	44
Park	—	—	—

trials followed each other with an intertrial interval of approximately 1 sec.

Training, i.e., multiple probability learning, consisted of 231 trials (11 blocks of 21 randomized trials) with the three predictors, FAST, BIG, and ROUGH, followed by the star, with $\pi_i = 1/7, 3/7$, and $6/7$, respectively. After training, predictions of star-blank were made without feedback. Instead of seeing the star or blank, the next word was immediately presented. Predictions of what should occur were made in the same way as in probability learning. Nine stimuli were presented, seven times each in random order, in the following three experimental conditions: T1: synonym-antonym (S-A): FAST, SWIFT, SLOW; BIG, LARGE, SMALL; ROUGH, COARSE, SMOOTH (N = 27); T2: synonym-neutral (S-N): FAST, SWIFT; BIG, LARGE; ROUGH, COARSE; DOOR, LAMP, PARK (N = 29); T3: antonym-neutral (A-N): FAST, SLOW; BIG, SMALL; ROUGH, SMOOTH; DOOR, LAMP, PARK (N = 29). All Ss were male volunteers from the introductory psychology classes at The Pennsylvania State University.

Table 2
Experiment 2: Mean Percentage Star Predictions Without Feedback

	Treatment	
	T1: Fast (.14)- Big (1.00)	T2: Big (.14)- Fast (1.00)
Swift	23	87
Slow	30	74
Large	82	33
Small	52	37
Door	84	29
Lamp	78	32

Instructions in both parts of the study were to the effect that S was to maximize the number of correct predictions of star and blank slides.

Experiment 2

In this experiment only FAST and BIG were used as predictors. In T1, FAST was followed by the star slide on 1/7 of the trials, BIG, by the star on 7/7 (N = 33). In T2, FAST and BIG were reversed as 7/7 and 1/7 stimuli (N = 32).

There were 70 training trials for each of the two words arranged in 10 blocks of 14 trials. The procedure was exactly the same as in Experiment 1, except that Ss made predictions with paper and pencil. After training there was again no feedback and the following words were presented in both experimental conditions: SWIFT, SLOW; LARGE, SMALL and neutrals DOOR, LAMP. Originally-trained predictor words were not presented here.

Subjects were 65 volunteers (27 males and 38 females) from the introductory psychology classes at The Pennsylvania State University.

RESULTS

Experiment 1

Subjects who had not learned the probabilities associated with the stimulus words were excluded from analysis. Criteria for "learning" were at least six predictions of blank following FAST and at least six predictions of star following ROUGH in the last two blocks of seven training trials. These criteria excluded 14 Ss: four from T1, five from T2, and five from T3.

Mean percentage star predictions for the stimuli during no feedback are given in Table 1.

Experiment 2

Criteria for learning were the same as for Experiment 1: at least six predictions of blank following the low-probability (1/7) word and six predictions of star following the high-probability (7/7) word were required in the last two blocks of seven training trials. These criteria excluded four Ss, two from each treatment. Mean percentage star predictions without feedback are given in Table 2.

DISCUSSION

In Experiment 1, the synonym-antonym group showed reliable differences in the predicted direction for COARSE vs SMOOTH (75% vs 37%, $t = 4.80$, $df = 22$, $p < .001$). Comparison on the antonym responses of A-N with synonym response of S-N showed a reliable difference only for

coarse vs smooth (77% vs 41%, $t = 4.47$, $df = 46$, $p < .001$).

Experiment 2 was designed to determine whether some of these results were functions of the idiosyncrasies of the particular words used. Synonym vs antonym comparisons for the two separate probability levels showed a reliable difference in the expected direction for the high training probability ($t = 4.03$, $df = 60$, $p < .001$) but not for the low, indicating that the high π value, rather than the particular word set, is critical. The use of two equivalent complementary events rather than an event (star) vs no event (blank) might alleviate this difficulty.

The Ss' responses to neutral words in Experiment 1 are not immediately explainable. Presumably, the semantic and associative effects of the training and test words, as well as their assigned π values, are the factors influencing responses to neutrals. In Experiment 2 they might have been rating the neutral words on the size-BIG, LARGE, SMALL. The extreme nature of responses to neutrals in this experiment is startling.

The fruitfulness of this paradigm is that the dimension of stimulus generalization is extended beyond complete lack of generalization to what might be termed "negative generalization."

Further studies in progress in this laboratory are designed to assess the relative importance of semantic and associative relationships by systematically manipulating both variables with and without feedback, singly and in combination, and by retraining. Early returns are encouraging.

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NOTE

1. A major portion of this paper was presented by the second author at the 1968 meetings of the Psychonomic Society.