baseline phase confirms the absence of any systematic effects of shock presentation on barpressing during the complex multiple phase of this experiment.

These results appear to be incompatible with theories that emphasize preference or choice (Premack, 1969; Bloomfield, 1969) in the generation of behavioral contrast. Theorists who ascribe behavioral contrast to relatively labile emotional effects of nonreinforcement or withholding of responding (Amsel, 1971; Terrace, 1972) will find these data comforting.

REFERENCES

- Amsel, A. Positive induction, behavioral contrast and generalization of inhibition in discrimination learning. In H. H. Kendler and J. T. Spence (Eds.), *Essays in neobehaviorism: A memorial volume to Kenneth W. Spence*. New York: Appleton-Century-Crofts, 1971. Pp. 217-236.
- Bloomfield, T. M. Behavioral contrast and the peak shift. In R. M. Gilbert and N. S. Sutherland (Eds.), *Animal discrimination learning*. New York: Academic Press, 1969. Pp. 215-241.
- Premack, D. On some boundary conditions of contrast. In J. T. Tapp (Ed.), *Reinforcement and behavior*. New York: Academic Press, 1969. Pp. 122-147.
- Terrace, H. S. Discrimination learning, the peak shift, and behavioral contrast. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 727-741.
- Terrace, H. S. By-products of discrimination learning. In G. H. Bower (Ed.), *The psychology of learning and motivation*. Vol. V. New York: Academic Press, 1972. Pp. 195-265.

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Priming effects on recognition performance*

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Ss memorized a target list of 40 nouns, half of which were from one semantic category (animals) and the remainder from another (body parts). In a recognition test, Ss were presented with a series of 40 targets (list items) and 40 distractors. Every item in the test sequence was preceded by an item that was either a target or distractor and semantically related (from the same semantic category) or unrelated (from the other category). In addition, any two targets tested in succession were chosen such that half were also adjacent to one another in the memorized list. Thus, half the target items were tested in the same context in which they were studied, and half were not. The results were interpreted in terms of a model that identifies independent encoding and decision stages in recognition memory. Semantic priming apparently facilitated the encoding stage since Ss were faster when successive items were semantically related, but accuracy of recognition was unaffected. Contextual priming effects were independent of semantic priming effects and apparently affected the decision stage of recognition. Providing the same study and test context improved accuracy and resulted in a nonsignificant decrease in response latency.

Recognition tests of memory usually begin with the presentation or definition of a target set of items followed by the presentation of test items that include targets and distractors. Performance in such tasks has

been improved by the presentation of *priming stimuli* immediately before or during the test of target items. For example, target words are recognized more often if the test context is identical to that presented during study (Light & Carter-Sobell, 1970; Thomson, 1972; Tulving & Thomson, 1971). These results include, but are not limited to, the use of words semantically related to specific target items as contextual priming stimuli. Semantic priming effects that are independent of any study context have been reported by Meyer and Schvaneveldt (1971; Meyer, Schvaneveldt & Ruddy,

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1972; Schvaneveldt & Meyer, 1973). In these experiments, successive presentations of two semantically related words resulted in improved identification of the second word.

The purpose of the present study was to compare contextual and semantic priming effects on recognition performance. A standard recognition paradigm was used in which Ss made positive or negative decisions about whether or not specific test items were members of a memorized target set (e.g., Juola, Fischler, Wood & Atkinson, 1971; Sternberg, 1966). Atkinson and Juola (1973, 1974) have proposed a general model for such tasks which includes successive encoding, decision, and response stages. The encoding stage of the model includes all processes that occur between onset of the test stimulus and retrieval, from memory, of a subjective familiarity value for that item. The decision stage operates on the familiarity output by the encoding stage by first evaluating it with respect to two decision criteria. If the familiarity falls above a high criterion or below a low criterion, a fast positive or negative response is made. Intermediate familiarities result in delaying the response until after a directed memory search has established whether or not the test item is in the target set. If priming effects are due to changes in encoding processes, then similar facilitative effects should be obtained on positive and negative trials. If, on the other hand, priming effects are due to familiarity changes, then the effects should be opposite for target and distractor items. Specifically, increases in familiarities should result, on the average, in faster and more accurate decisions for targets, and slower decisions and more errors for distractors (Juola, 1973; Juola, Taylor & Young, *in press*).

METHOD

The Ss were 35 undergraduates who participated to satisfy an introductory psychology course requirement.

The stimuli were 80 nouns, three to nine letters in length, drawn from the Battig and Montague (1969) category norms. The selected items were 40 of the first 46 exemplars from the category "A Four-footed Animal" and 40 of the first 45 exemplars from the category "A Part of the Human Body."¹ The words were typed in Orator typeface with an IBM Selectric Typewriter onto white 6 x 9 in. cards for presentation in an Iconix tachistoscope. The items varied in length from 0.8 cm to 1.0 cm, and when placed into the tachistoscope they appeared about 0.5 cm (i.e., about 36 min of visual angle from S's viewpoint) below a central, dark fixation point.

The 80 stimulus items were combined and then randomly divided in half, with the constraint that each subset contain 20 animal names and 20 body part names. For half the Ss, the first subset served as the target list and the other subset served as distractors. For the remaining Ss these subsets were reversed, so that over the experiment as a whole every item was used equally often as a target and as a distractor. The test sequence contained all 80 items. Each item fell into one of 10 treatment conditions depending upon its relationship to the item tested on the preceding trial. The item tested on Trial *n* fell into a related condition if the item on the preceding trial belonged to the same semantic category, and into the unrelated condition if the

previously tested item was from the other category. Thus, every target or distractor item was preceded by a target or distractor that was related or unrelated. In addition, any two targets tested in succession were chosen such that the item tested on Trial *n* - 1 was always located either immediately before the word tested on Trial *n* in S's study list (adjacent condition) or eight serial positions before the word tested on Trial *n* on the study list (nonadjacent condition). Thus, the study context and the test context were identical for half the target pairs, and different for the other half.

Three different randomly-ordered test sequences were constructed with the constraint that all 10 treatment conditions be distributed evenly throughout the test sequence. For each test sequence, two study lists were prepared. These study lists were pseudorandomized so that the adjacency conditions were maintained. Ss were randomly assigned to specific test sequence and study list combinations.

Each S was contacted about 24 h before the experimental session and given a list of 40 words and the labels of the two categories from which the words were drawn. The Ss were instructed to memorize the words in serial order.

The experimental session began with a written serial recall test. Any S who made errors on this test was allowed to study the list for a few minutes, and a second test was administered. No S made errors on the second test. Next, S was seated before the tachistoscope, and the test procedure was explained. The S received 20 practice trials using a modified Sternberg task to familiarize S with the procedure. For these trials, S was told to make a positive response if a digit from 0 to 4 was presented and a negative response if the test digit was 5 to 9. All 10 digits appeared twice in a random order.

The procedure for the practice trials was identical to that for the test sequence. Each trial began with E placing a test stimulus card into the tachistoscope and giving a ready signal to S. The S then depressed a foot switch initiating a millisecond timer. The tachistoscope was programmed to illuminate a preexposure field with a dark fixation point 10 msec after S pressed the footswitch. This field was maintained for 490 msec and was immediately followed by a 450 msec exposure of the test stimulus. The field then was dark until the next trial, a period of approximately 15 sec. The S was instructed to rest his hands on a small response panel upon which two 3.2-cm circular buttons were mounted about 8.9 cm apart. When either button was pushed, it activated a microswitch, stopping the timer. Every S was told to indicate positive responses to target items with his dominant hand and negative responses to distractors with his other hand.

RESULTS

The first 16 trials were considered practice and were excluded from all analyses. The mean response latencies for correct responses and mean proportions of errors presented in Table 1 are thus based on Trials 17 through 80 for the 35 Ss. The overall mean error rate was 9.3%.

Two 2 by 2 by 2 by 35 within-Ss analyses of variance were performed, one on the reciprocal transformed mean correct response latencies and one on the arcsine transformed error proportions. The factors of the design correspond to stimulus type on Trial *n* (target vs distractor), stimulus type on Trial *n* - 1, the semantic relationship of the two items (related vs unrelated), and Ss. Responses to targets were significantly faster (760 msec) than to distractors (820 msec), $F(1,34) = 17.19$, $p < .001$, and the proportion of errors was significantly greater for targets (.120) than for distractors (.054), $F(1,34) = 20.61$, $p < .001$. Response

latencies were shorter for the related condition (780 msec) than for the unrelated condition (801 msec), $F(1,34) = 7.70$, $p < .025$. Finally, items preceded by targets resulted in marginally faster responses (782 msec) than items preceded by distractors (798 msec), $F(1,34) = 4.26$, $p < .05$. No other main effects and no interactions approached significance in these two analyses.

To test for contextual priming effects, the data for only those targets preceded by other targets in the test sequence were analyzed. Two 2 by 2 by 35 within-Ss analyses of variance were performed on the latencies for correct responses and error proportions. The design factors were adjacent vs nonadjacent in the study list, related vs unrelated, and Ss. Latencies were transformed to reciprocals and error proportions to arcsines prior to analysis. As for the overall data, responses to related items were faster (737 msec) than those unrelated items (758 msec), $F(1,34) = 4.75$, $p < .05$. The error analysis showed that fewer errors were made for targets preceded by adjacent targets (.078) than for targets preceded by nonadjacent target (.131), $F(1,34) = 4.31$, $p < .05$. No other main effects or interactions approached significance for either analysis.

DISCUSSION

In finding that altered semantic context influences recognition performance, Light and Carter-Sobell (1970) concluded that recognition judgments based on item familiarity also depend on the particular semantic representation of the test item used in making the familiarity judgment. Thus, the semantic context provided during test would be expected to affect the encoding process. In the present study, Ss responded more rapidly to semantically primed items, but they were no more accurate in their decisions. These results are consistent with the idea that semantic priming affects the encoding, but not the decision, stage of the recognition model. The interpretation is that semantic priming affects the speed with which the appropriate encoded version of the test item is arrived at (Meyer & Schvaneveldt, 1971), and that this facilitation is the same for target and distractor items. If semantic priming increased the familiarity of the test item, the results should have shown opposite latency effects for targets and distractors along with more errors for distractors and fewer errors for targets.

The contextual priming data were consistent with the results of other studies of the effects of context on recognition (Light &

Carter-Sobell, 1970; Thomson, 1972; Tulving & Thomson, 1971) in that error rate was smallest when the study and test context were the same (adjacent condition). In terms of the model, decreases in error rates for target items indicate increases in the relative familiarities for those items. This change should also result in faster mean response times for contextually primed items, since the proportion of slow responses (i.e., trials on which the positive response was delayed until after the test item was found in a search of the target set) would decrease and the proportion of fast responses based on familiarity alone would increase (Atkinson & Juola, 1973, 1974). Although contextual priming also affected the latencies in the expected way, the trend was not significant. Other theoretical accounts for the facilitative effect of contextual priming could include changes in the search process itself; for example, one could assume that the accessibility of the relevant memory structure is affected by the test context. Assumptions of this type are not necessary in accounting for the present data, however.

In summary, the results indicate that semantic and contextual priming result in independent facilitative effects on recognition performance. These results are consistent with a model that views recognition as consisting of independent encoding, decision, and response stages. Semantic priming seems to act upon an encoding stage, enabling more rapid construction of an internal representation for semantically primed stimuli. Contextual priming seems to facilitate the decision stage, resulting in fewer recognition errors.

REFERENCES

- Atkinson, R. C., & Juola, J. F. Factors influencing speed and accuracy of word recognition. In S. Kornblum (Ed.), *Attention and performance IV*. New York: Academic Press, 1973.
- Atkinson, R. C., & Juola, J. F. Search and decision processes in recognition memory. In D. Krantz, R. C. Atkinson, R. D. Luce, and P. Suppes (Eds.), *Contemporary developments in mathematical psychology*. San Francisco: Freeman, 1974.
- Battig, W. F., & Montague, W. E. Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monograph*, 1969, 80(3, Part 2), 1-46.
- Juola, J. F. Repetition and laterality effects on recognition memory for words and pictures. *Memory & Cognition*, 1973, 1, 183-192.
- Juola, J. F., Fischler, I., Wood, C. T., & Atkinson, R. C. Recognition time for information stored in long-term memory. *Perception & Psychophysics*, 1971, 10, 8-14.
- Juola, J. F., Taylor, G. A., & Young, M. E. Stimulus encoding and decision processes in recognition memory. *Journal of Experimental Psychology*, in press.
- Light, L. L., & Carter-Sobell, L. Effects of changed semantic context on recognition memory. *Journal of Verbal Learning & Verbal Behavior*, 1970, 9, 1-11.
- Meyer, D. E., & Schvaneveldt, R. W. Facilitation in recognizing pairs of words: Evidence of dependence between retrieval operations. *Journal of Experimental Psychology*, 1971, 90, 227-234.
- Meyer, D. E., Schvaneveldt, R. W., & Ruddy, M. G. Activation of lexical memory. Paper presented at the meeting of the Psychonomic Society, St. Louis, Missouri, November 1972.
- Schvaneveldt, R. W., & Meyer, D. E. Retrieval and comparison process in semantic memory. In S. Kornblum (Ed.), *Attention and performance IV*. New York: Academic Press, 1973.
- Sternberg, S. High-speed scanning in human memory. *Science*, 1966, 153, 652-654.
- Thomson, D. M. Context effects in recognition memory. *Journal of Verbal Learning & Verbal Behavior*, 1972, 11, 497-511.
- Tulving, E., & Thomson, D. M. Retrieval processes in recognition memory: Effects of associative context. *Journal of Experimental Psychology*, 1971, 87, 116-124.

NOTE

1. The omitted animal names: rhinoceros, hippopotamus, cheetah, gazelle, turtle, gnu; the omitted body parts: trunk, nail, breast, pancreas, torso.

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Table 1

Mean Latencies for Correct Responses (in Milliseconds) and Error Proportions (in Parentheses) for Items Presented on Trial N

Item Presented on Trial N	Item Presented on Trial N - 1			
	Target		Distractor	
	Related	Unrelated	Related	Unrelated
Target	737* (.114)	758* (.102)	762 (.117)	784 (.148)
Distractor	802 (.051)	833 (.053)	818 (.049)	827 (.063)

*Latency and error proportions are pooled across the adjacency conditions nested within this cell.