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WHY ARE RHYMES EASY TO LEARN?[1]

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The question was why a list of rhyming paired associates is learned faster than a list of unrelated pairs. It is proposed that the rhyming relation restricts the range of response alternatives to the stimulus, practically converting recall into a recognition test. Several tests of this hypothesis proved confirmatory. First, an assonance (change of last phoneme) rule for pairs, which restricts alternatives about as much as a rhyming rule, facilitated performance as much as did a rhyming rule. Second, when response alternatives were equated by multiple-choice tests for memory, the advantage for rhyming pairs vanished. A third experiment showed that the presence of some rhyming pairs in a list induced *S* to generalize this rule inappropriately to other pairs, thereby suffering interference on those pairs composed by re-pairing rhyming units.

It is a well-known fact of everyday life, and even of the laboratory, that rhyming is an aid to memory. Poetry, at least rhyming verse, is more easily learned than prose (McGeoch & Irion, 1952). The popular mnemonic systems (e.g., Furst, 1948) propound and exploit the power of rhymes, and most of us have learned the alphabet, the number of days in the months, and the order and names of cranial nerves, etc., by one or another rhyming mnemonic. These mnemonics, or the poetry, songs, and limericks which they resemble, display two organizing features for the memorizer: rhythmic pattern, or meter, and rhyming of the end word in successive repetitions of the rhythmic pattern.

The mnemonic function of rhythmic pattern may stem from its counting and place-keeping features, i.e., it tells *S* the number and order of stressed syllabic units in each constituent (line). But putting aside any analysis of rhythmic pattern, we shall here focus on the rhyming feature of poetry. Paring matters down to the merest bones, rhyming is a relationship between two words or phonological compounds. Specifically, a word which rhymes with "hat" is a word obtained by altering the first phoneme but leaving the remaining phonemes the same (as in "cat," "mat," and "bat").

This suggests that one can study the influence of rhyming at the elementary level of paired associates, as was done here. There is little doubt that adult *S*s would learn a list of rhyming pairs much faster than a list of unrelated pairs. The interesting question is why this is so. What is it about rhymes that makes them memorable? Is it their frequency of cooccurrence in the language? Is it common associative linkages? Is it simply a result of formal graphemic similarity? Will rhymes be better in all circumstances, or can one create conditions where they lose their advantage over unrelated pairs? Can one construct a list of nonrhyming pairs which, because of a simple structure, will confer the same memorial benefit as do rhyming lists?

One obviously seeks for some hypothesis to explain why rhymes work in most cases. The search need not go very far because on closer examination, an elementary hypothesis suggests itself. The hypothesis is that rhymes are normally easily learned because knowledge of the rhyming relation considerably restricts the range of response alternatives that need be considered for a given stimulus. That is, knowing the stimulus term and knowing that the correct response rhymes with the stimulus, one is able to exclude many list responses from consider-

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ation, restricting consideration to only the rhyming candidates. Furthermore, this knowledge suffices to reduce an ostensible recall task almost to a recognition task since *S* can often implicitly generate most of the plausible rhyming responses and he need only select that response candidate recently experienced in this list context.

This hypothesis supposes that there are two important components that determine performance on rhyming pairs: First, *S* must know or believe that a given stimulus has a rhyming response; and second, this knowledge then enables him to restrict the response alternatives to the stimulus. The former knowledge can be given by a whole-list rule, viz., all pairs rhyme, which *S* will quickly learn. Or it can be provided by an external discriminative stimulus, as was done here (viz., stimulus words printed in red have rhyming response terms). But even if these external cues are lacking, *S* may nonetheless adopt a rhyming strategy for generating guesses to unlearned items if there are sufficient rhyming pairs in the list to make this strategy worthwhile. So even without cues distinguishing rhyming from unrelated pairs, performance may be superior on rhyming pairs due to such strategic response biases.

The three experiments to be reported were testing various aspects of this hypothesis to explain the memorial benefits of rhyming. In the first two experiments, by instructions plus a discriminative stimulus, *S* knew which stimuli in the list had a rhyming response and which had an unrelated response. In the last experiment, this external cue was lacking, and *S* had to figure his way through a very interfering list of scrambled rhyming words.

Experiment I

The first experiment was designed for three aims, and for each a particular group of *S*s was run. The first aim was simply to demonstrate, for the formal record, that when appropriate discriminative information is available to *S*, he will perform much better on rhyming pairs than on unrelated word pairs. The second aim was to demonstrate that a facilitation similar to that conferred by rhyming could be produced by a different relational rule that does not involve rhyming. The relationship between the cue and response term in this case was a simple change in the *last* phoneme (e.g., HAT–*ham*, BIN–*bit*). With CVC word pairs, this assonance rule appears to be about as restrictive of response alternatives as is the rhyming rule. That is, for the CVC stimuli used, approximately the same average number of CVC response words could be derived from it using either the rhyming or the assonance rule. If the assonance rule is approximately as restricting of response alternatives as is the rhyming rule, it should produce a similar magnitude of facilitation in performance as compared to unrelated word pairs.

The third aim was to show more directly that the restriction of response alternatives was the main effect of the rhyming relation. To this end, a multiple-choice recognition test for memory was used in which the rhyming pairs and unrelated word pairs were equated with respect to restriction on the number of response alternatives. Furthermore, in half of the cases, the rhyming information was rendered useless by having all the multiple-choice alternatives rhyme with the stimulus term (e.g., the cue HAT and response alternatives *fat, cat, mat, bat, pat*). The idea was that by rendering the rhyming rule nondiscriminative with respect to these response alternatives, the performance difference between rhyming and unrelated pairs would disappear completely.

Method

Subjects.—The *S*s were 30 Stanford undergraduates fulfilling a service requirement for their introductory psychology course. They were run individually and assigned in random order to the three experimental conditions, with equation of male–female proportions in each group. There were 9 *S*s in the rhyme and end-change groups and 12 in the multiple-choice group.

Design and procedure.—The three groups each learned one list of 36 paired associates for nine anticipation trials; the pairs were tested and studied at a 2:2-sec. rate on a memory drum and shown in a new random order on each trial. All stimulus and response terms for all lists were CVC words, almost all nouns. The list for Group R (rhymers) consisted of 18 rhyming pairs typed in red letters mixed in with 18 unrelated pairs typed in black letters. The list for Group E (end-change) consisted of the same 18 unrelated pairs as in Group R plus 18 pairs in which the response word was related to the stimulus word by altering the last letter (phoneme). The latter 18 stimulus terms were the same as in the R list; only the response terms differed. In List E, the end-change pairs were typed in red and the unrelated pairs in black. The list for Group M (multiple-choice) consisted of 36 pairs divided into 6 pairs each of six different types, as follows: (*a*) rhyme–rhyme (RR) pairs, in which the stimulus and response rhymed and all four distractors on the multiple-choice tests rhymed with the correct response; (*b*) rhyme–unrelated (RU), in which the stimulus and response rhymed, but the four distractors were unrelated to the correct response; (*c*) unrelated–rhyme (UR), in which the stimulus and response were unrelated, but the four distractors rhymed with the correct response; (*d*) unrelated–unrelated (UU), in which the stimulus and response were unrelated and the four distractors were unrelated to the correct response; (*e*) rhyme (R), in which the stimulus and response rhymed and *S* had to recall or anticipate the correct response, not select it from a multiple-choice list; and (*f*) unrelated (U), in which the stimulus and response were unrelated and *S* had to recall or anticipate the correct response.

In total, there were 18 rhyming pairs and 18 unrelated pairs, 24 pairs tested by multiple-choice recognition and 12 pairs by anticipation recall. All pair types appeared in a new scrambled order on each trial. The cue term for the rhyming pairs was typed in red, and the stimulus–response pair during the study interval was also in red. The unrelated pairs were typed in black letters. On recognition frames, the cue term appeared to the left, followed by a dash and then five response alternatives, the correct one plus four distractors in random order. After 2 sec., the memory drum turned to display the correct cue–response pair for 2 sec. For a given recognition item, the same five multiple-choice alternatives appeared over all nine trials, but in a different left–right order on each trial. The R vs. U recall items in this third list are essentially a small replication of the comparison provided in List R.

Before the experiment began, all *S*s were informed about the nature of their list, in particular that red cue terms had rhyming response terms (or end changes in List E). They were instructed to use this knowledge to make a guess even on the first trial before they had seen the correct S-R pairing.

Results

Recall learning.—Group R provides a within-list comparison of the ease of learning rhyming vs. unrelated pairs, and Group E provides a similar comparison for end-change pairs. The mean proportions of correct responses over trials for the two subsets of items in each list are shown in Fig. 1, Group R in Panel a and Group E in Panel b.

In Group R, there was a large advantage for rhyme pairs: they started at a higher level on Trial 1 and maintained their superiority over all nine trials. The mean correct responses over the nine trials per item per *S* were 5.95 for rhyme pairs and 4.11 for unrelated pairs. The mean difference, 1.84, is highly significant, $t\ (8) = 4.26$, $p < .001$.

In Group E, there was a similarly large advantage for the end-change pairs over the

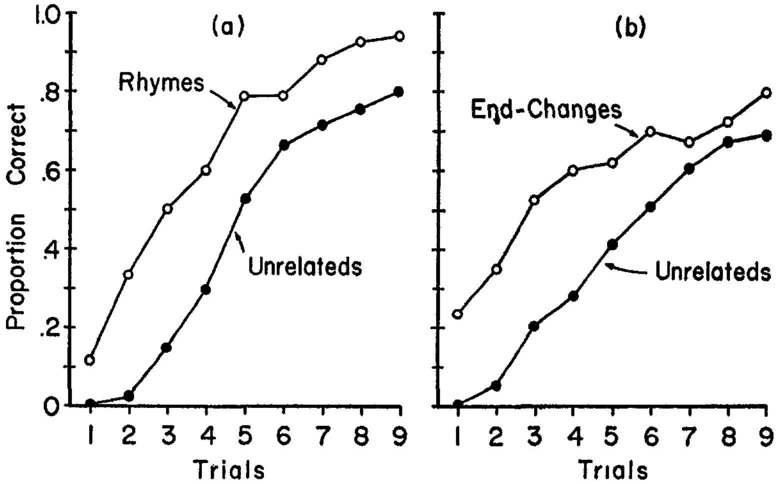

FIG. 1. Learning curves for a mixed list of (*a*) rhyming vs. unrelated pairs or (*b*) assonant (end-change) vs. unrelated pairs.

unrelated pairs: they started at a higher level on Trial 1 and maintained their superiority over all nine trials, with some irregularity in learning after Trial 6. The mean correct responses over the nine trials per item per *S* were 5.38 for end-change pairs and 3.61 for the unrelated pairs. The mean difference, 1.77, is highly significant, t (8) = 6.19, $p <$ .001.

The end-change pairs were somewhat more difficult than the rhyming pairs, but their means do not differ reliably. Similarly, the unrelated pairs are slightly, though not significantly, harder in the E list context than in the R list context. Importantly, the advantage conferred by the end-change rule (1.77) is not reliably different from the advantage conferred by the rhyming rule (1.84), t (16) = .21, $p >$ .20. This indicates that the rhyming effect can be mimicked by employing nonrhyming rules that are approximately equally restricting of the number of response alternatives. Thus, there is nothing uniquely special about the rhyming relation.

The R and U recall items in List M replicated the main results shown in Fig. 1a for List R. The R pairs were consistently ahead of U pairs from Trial 1 onward. The mean correct responses over nine trials per item per *S* were 4.97 for R pairs and 3.89 for U pairs in List M.

In comparing performance on the R vs. U items (or E vs. U items), it should be noted that both the stimulus and response words differed in the two sublists. Stimulus and response factors could have been equated in a between-*S* design, with some *S*s learning only the R pairs and other *S*s learning the R pairs scrambled. But the latter condition might create associative interference, with the two rhyming words in the scrambled R list competing in recall to an unrelated stimulus, and that effect could contaminate the between-*S* comparison of R and U lists. Since the words used were familiar CVC nouns and stimuli were randomly selected for the large R and U item pools, it was believed that the R and U sets would be approximately equated in terms of frequency, meaningfulness, and concreteness of the items. In any event, it was felt that any differential in these factors remaining after random selection of items would have small effects on learning relative to the predicted effect of the pairwise rhyming rule.

Since Fig. 1a and 1b show that R or E pairs start ahead of U items on Trial 1, the question naturally arises whether the advantage for these pairs is merely in initial "guessing" probabilities, with no fundamental difference in learning rate once the differential guessing is partialed out of the performance (cf. Bower, 1962). To answer this question requires a presupposition about the learning curve and its parameters. It shall be answered with respect to the assumption that the mean learning curve for a given type of item can be described by the equation

$$p_n = 1 - (1 - p_1)(1 - \theta)^{n-1}, \qquad [1]$$

where p_n is the proportion correct on Trial n, p_1 is the proportion correct on Trial 1, and θ is the learning-rate parameter. This is a growth curve derivable from a variety of underlying assumptions about how learning occurs. Since *S*s were allowed to omit responses, the parameter p_1 summarizes the tendency to respond times the probability of guessing correctly given a response. Since R and E items were colored red and *S* was instructed regarding the significance of this cue, the tendency to respond was higher for R and E items than for U items. Sheer guesses on U items could hardly ever be correct. The analysis that follows would not be materially changed if p_1 is interpreted as simply the initial tendency to give the correct response under the given experimental conditions.

In terms of the parameters in Equation 1, we can be reasonably confident that the rhyming or assonance rules increase p_1 above that for unrelated pairs. The question is whether these rules also produce a difference in θ, the learning-rate parameter. To answer this question, θ values were estimated for each *S* for his two subsets of items (R vs. U or E vs. U) by (a) estimating p_1 from *S*'s proportion correct for each subset on his Trial 1 guess and (b) equating the sum of p_n from Trials 1–9 to his observed mean correct responses per item in that subset over the nine trials. The resulting θ estimates should be approximately normally distributed, and the difference between the two θ values for a given *S* (R-U or E-U) should also be normally distributed.

For Group E, the mean p_1 estimate was .250 for end-change items and .006 for unrelated items. The average θ value was .17 for E items and .14 for U items, and these are not significantly different. For Group R, the mean p_1 estimate was .123 for rhyme pairs and .006 for unrelated pairs. The average θ value was .28 for rhyme pairs and .17 for unrelated pairs. These latter θ values differ reliably by a paired t test, $t\ (8) = 2.63$, $p < .01$. Examining the R vs. U learning curves in Fig. 1a, however, the differential learning rates for R and U items are apparent only over the first trial or two. For example, the increment in correct response probability from Trial 1 to Trial 2 was 22% for R items and only 2% for U items. That the differential in net θ values is caused by the first-trial increment was shown in a reanalysis using Equation 1, but altered by replacing p_1 by the observed p_2 and estimating θ over Trials 2–9. By this analysis, the θ values for R and U items no longer differ reliably, $t\ (8) = 1.19$. This result suggests that on Trial 1, *S*s predominately selected the rhyming pairs for rehearsal and learning, postponing learning of the unrelated pairs for later trials.

With the latter emendation, these analyses of learning rates are consistent with the basic hypothesis; i.e., S-R rules restrict the range of response alternatives so that p_1 is strongly affected, while the learning rate θ is not significantly affected.

Recognition learning.—Learning curves for the four types of recognition items are shown in Fig. 2; the first letter (R or U) in the designation of the item type refers to the nature of the correct S-R pair, and the second letter refers to the relation between the correct response and the distractors on the multiple-choice test. The RU items begin at a high level on Trial 1 and remain high. This was expected, of course, since knowledge that red items rhyme is sufficient to enable *S* to select the correct response without further training on these RU items. The only puzzle is why this curve is not at 100% on all trials. It is suspected that disruption of perfect performance was caused

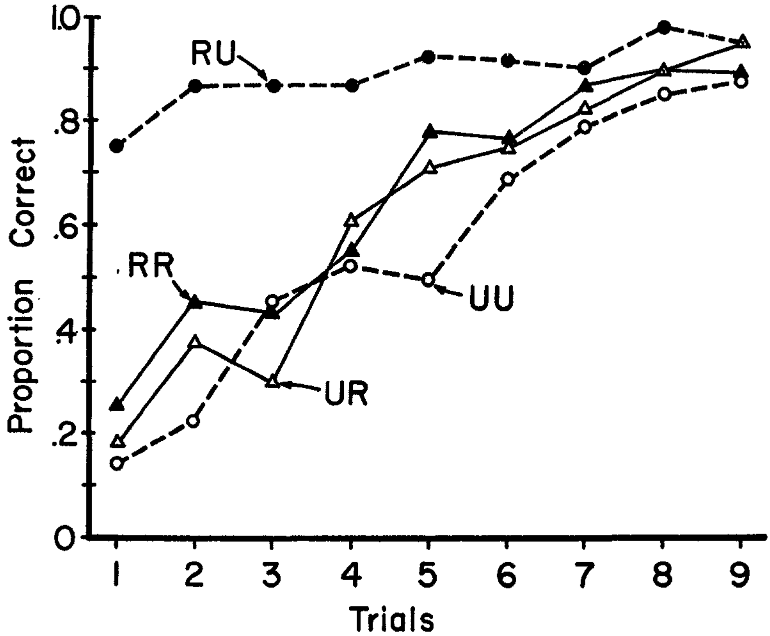

FIG. 2. Proportions of correct S-R recognitions over trials for the four types of recognition items in List M.

by the brief 2-sec. test interval, during which S had to read the stimulus word, classify it as red and a rhymer, and then look for a rhyming response among five alternatives.

The remaining three types of items, RR, UR, and UU, have similar learning curves, with no type being clearly superior to the others. They begin on Trial 1 at the chance level of 20%, as they should. An overall measure of total correct responses in nine trials per item per S gave 6.04 for RR items, 5.65 for UR items, and 5.04 for UU items. An overall F test for repeated measures on these three means yielded significance at the .05 level, F (2, 22) = 4.74.

The recognition procedure reduced the previous difference between rhyme and unrelated pairs found with the recall procedure in List R. However, the hypothesis had predicted that these three types of recognition pairs, RR, UR, and UU, would not differ since they were equated on the number of response alternatives and since, for RR items, the rhyme rule was rendered useless for selecting the correct response. Therefore, the significant difference in this three-way comparison was disturbing to the authors, and this led to Exp. II.

Experiment II

According to the hypothesis, the RR, UR, and UU recognition items in List M should not have differed in difficulty, yet they did at a marginal level. Why should that be? One possibility is that the RR and UR items were easier than the UU items because in the former cases, S really had to learn only the first letter of the correct response since the last two letters of all alternatives in RR and UR items were the same. This seemed implausible, given the usual belief that words are treated as intact units. A second possibility is that the three types of items were represented by an unfortunate specific sample of pairs that, by chance, turned out to be unequally difficult for idiosyncratic reasons unrelated to the basic hypothesis under test. By the nature of the experiment, one could not counterbalance over Ss the condition to which a particular pair was assigned. What one can do, however, is to try to replicate the result with a larger set of new pairs of the three types. If the RR, UR, and UU differences are real and important, then they should appear again with a new and larger sample of these item types. If, on the contrary, the former differences resulted from an unfortunate sample of items, the differences due to item types should vanish upon replication with new and larger samples.

Method

Design and procedure.—A single group of 12 Ss (Stanford undergraduates) had nine trials on a 36-item recognition list consisting of 12 items each of Types RR, UR, and UU. The RR items were typed in red, and the UR and UU items were typed in black. The Ss were instructed about the significance of this cue before the experiment started.

The 12 instances of each item type were new, with some derived partially from items used in List M of Exp. I. For example, six of the UR items were composed by assigning the former RR response terms to a former UU stimulus form. Six of the new RR items were composed by adding new R terms to the stimuli from the former UR pairs. Six of the new UU items were made by assigning a former UU set of response alternatives to a former RR stimulus term. The remaining six items in each condition were composed, some anew and some from the 18 R and U items in the former List R of Exp. I, using only those R and U items that had been of medium difficulty. It was hoped that by these complex machinations, we had equated or randomized out any differences in idiosyncratic difficulty of the items assigned to the three types.

The 36 items were presented in a new scrambled order each trial, with a guess required on Trial 1. The anticipation interval was lengthened to 4 sec. to give S more time to select and say aloud his response. After the anticipation interval, the correct S-R pair was shown for 2 sec.

Results

The mean learning curves for the three types of items are shown in Fig. 3. They start together at 20% on Trial 1 and are closely intertwined throughout the course of learning. There are no apparent differences in learning among the three item types, and this is confirmed by further analyses. The mean total numbers of correct responses over nine trials per item per S were 6.07 for RR items, 6.18 for UR items, and 6.13 for UU items. These means obviously do not differ significantly.

The lack of differences here with this larger sample of items makes plausible the presumption that the prior differences in List M of Exp. I resulted from misfortunes of small samples. If so, then the lack of differences in Exp. II would support the hypothesis, viz., that rhyming pairs benefit from restriction of response alternatives and that the effect vanishes when the alternatives are similarly restricted for nonrhyming pairs. However, since the anticipation interval was shorter in Exp. I (2 sec.) than in Exp. II (4 sec.), it is possible that the rhyming effect, that RR items exceed UU items in recognition, is genuine (not due to chance selection of items) but rate sensitive. That is, in order to perform successfully with brief anticipation intervals, *S* might be forced into recalling from the cue alone because there may be insufficient time for him to read and classify the stimulus word, then read five response alternatives, recognize the correct one, and say it aloud. If rapidly paced recognition tests encourage *S* to use the recall mode, then rhyming pairs would be favored over unrelated pairs, as Exp. I (see Fig. 1a) has shown. This interpretation requires checking by running the recognition list of Exp. II with the 2-sec. anticipation interval.

Experiment III

Experiment I showed that pairs exemplifying a rhyming relation are facilitated in performance relative to unrelated pairs. Experiment III was designed to show that inappropriate generalization of a rhyming rule could *retard* learning of selected pairs in the list. The 24-item list in Exp. III consisted of eight rhyming (R) pairs, eight unrelated (U) pairs, and eight rhyming-interference (RI) pairs, all printed in black letters, so there was no cue informing *S* which were the rhyming pairs. The RI pairs were constructed by re-pairing the stimulus and response words from eight rhyming pairs. For example, from the normal rhymes PIN–*fin*, CAT–*hat*, TAN–*ban*, the RI pairs might be

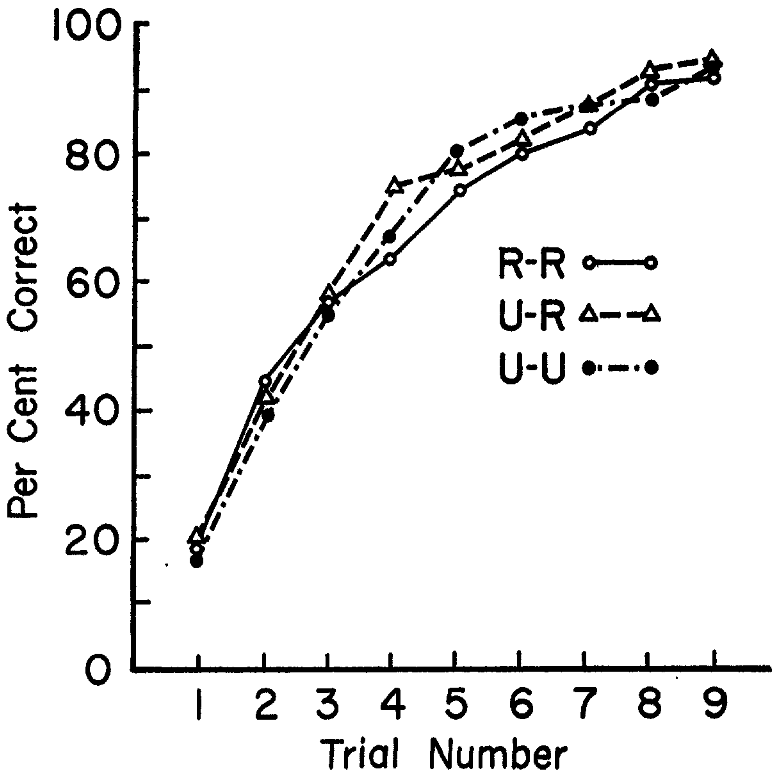

Fig. 3. Proportions of correct S-R recognitions over trials for the RR, UR, and UU items of Exp. II.

PIN–*hat*, CAT–*ban*, and TAN–*fin*. The difference between such RI pairs and the U pairs is that for the RI pairs, the rhyming unit to the stimulus is an available response in the list, but is assigned to another stimulus; on the other hand, the U stimuli did not have a specific rhyming response primed into availability by the list.

The *S*s were informed that some of the pairs in the list conformed to a rhyming rule. Since there were no cues distinguishing the rhyming items from the others, it was predicted that *S* would generalize this rhyming rule to other stimuli, using it as a response-selection strategy for unlearned pairs. Such inappropriate rule generalization should have particularly debilitating effects on the RI items, producing many intrusions and much response competition from their rhyming (incorrect) responses available in the list.

Method

Each *S* learned a 24-pair list by the anticipation method for nine trials, with a guess requested on Trial 1. The anticipation interval was 4 sec., and the S-R study interval was 2 sec., both controlled by external timers to a memory drum. The 24 pairs were selected from the lists of Exp. I. The 8 rhyming pairs were those of medium difficulty from Cond. R of Exp. I; the 8 U pairs were those of medium difficulty from the U pairs of Exp. I. The 8 RI pairs were composed by randomly repairing 8 remaining pairs from the R condition of Exp. I. The 24 items were printed in black type and occurred in a scrambled order each trial. The *S*s were told that the list to be learned contained a number of rhyming pairs and that they should try to guess the correct response even on the first trial.

The *S*s were nine males and nine females attending summer classes at Stanford. Eight *S*s were fulfilling a service requirement for their introductory psychology course, whereas 10 *S*s were paid for their participation. This variable produced no difference in learning proficiency, so the two subgroups were pooled. Each pair of *S*s received a different random order of the 24 items within each trial and varying across trials.

Results

The performance curves for the different types of items are shown in Fig. 4. The conditions are consistently ordered, with R items best and RI items worst. The mean numbers of correct responses over nine trials

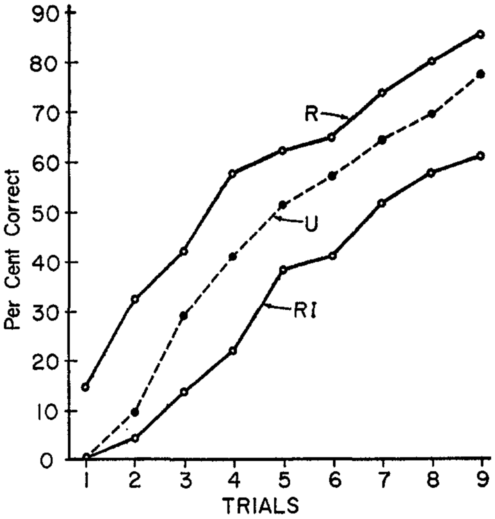

FIG. 4. Mean correct recall percentages for the R, U, and RI pairs of Exp. III.

per item per *S* were 5.12 for R items, 3.97 for U items, and 2.91 for RI items. The overall *F* test comparing these means is significant ($df = 2,\ 51,\ p < .001$), and Newman-Keuls comparisons show that all pairwise differences are significant at least beyond the .025 level. So, relative to the unrelated pairs, rhyming facilitates and rhyming interference retards performance.

Further analyses revealed relevant sources of errors. Next to omissions, the largest class of errors are intruding responses that rhyme with the stimulus word. For R and U items, these rhyming errors are necessarily extralist intrusions; they account for 58% and 27%, respectively, of the overt errors to R and U items. There are many more rhyming errors to RI items (2.5 times the number for U items); 44% of these intrusions to an RI item came from its lone rhyming response in the list (which was not paired with the RI stimulus). A rhyming response primed into availability by its appearance in the list thus intrudes inordinately, compared to any particular extralist rhyming response.

To summarize the results of Exp. III, the presence of some rhyming pairs in the list leads *S* to adopt a rhyming response bias on unlearned pairs, especially if the rhyming response is available in the list. The consequence of this generalized rule is facilitation of performance on R pairs and interference with performance on RI pairs. In a small experiment run to secure this analysis, nine *S*s were run 10 trials on a list of 24 pairs composed only of U and RI items in equal proportions, and the instructions contained no mention of rhymes. Since *S*s should not adopt a rhyming strategy in this case, one would expect no difference in performance here to the U and RI items. This was verified: mean correct responses over the 10 trials per item per *S* were 4.77 for U items and 5.13 for RI items. The small difference (in the opposite direction) is not significant, $t\ (8) = 1.15, p > .10$. This pattern of results means that the differential error rates for U and RI items depend on *S* having a rhyming response bias, which was induced in Exp. III by instructions and the presence of rhyming pairs in the list.

Discussion

A final comment is required concerning the analysis of how S-R rules facilitate performance. It appears likely that a response-restricting rule will facilitate performance only if *S* can in fact readily generate elements of the restricted response set from the stimulus plus rule. The rhyming and assonance rules, which facilitated performance in Exp. I, restrict the response term so as to match the stimulus term in the final or initial phonemes, respectively. These are good cues for generating alternatives. Experiments by Horowitz, White, and Atwood (1968) have shown that initial and final phonemes are good cues for retrieving words from memory, whereas middle fragments of a word are appreciably poorer cues. For instance, __ogn__ is a poor retrieval cue for the word "recognize." Such results tell us something about the phonetic indexing of words in long-term memory.

Reflections on the phonetic organization of the verbal store suggest an alternative formulation of the present hypothesis about rules. The alternative formulation is that the stimulus word plus the rule specify an indexing code with which *S* can enter his memory to locate the response word. This index either directs *S*'s search to a restricted region of memory or, alternatively, is used like a "call number" to retrieve a restricted set of responses from which the list response can be selected (because it has been recently tagged in the experimental context). But if long-term memory for words is organized phonemically in specific ways, then certain types of indexing codes will be relatively useless in that they will retrieve nothing. A literal interpretation of the Horowitz et al. (1968) results is that words in long-term memory are not filed or indexed according to their middle phonemes. This would imply, e.g., no facilitation of performance if the stimulus and response words of a pair overlapped, say, in the middle three of nine letters. Most *S*s would simply be unable to find or generate acceptable candidate responses from such an index code.

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