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Factors Affecting the Learning of Foreign Language Vocabulary: Imagery Keyword Mediators and Phonological Short-term Memory

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In order to investigate the cognitive processes involved in learning Foreign Language (FL) vocabulary, this study evaluates different methods of instruction. It demonstrates that keyword techniques are effective for receptive learning but that repetition is a superior strategy for learning to produce the foreign word. Performance is optimal when learners combine both strategies. The nature of the keyword is crucial—whereas imageable noun keywords promote learning, verb keywords actually impede it. A theoretical analysis of the roles of phonological short-term memory, imagery, and lexical factors in FL vocabulary learning is presented.

Keyword Methods for Receptive Vocabulary Learning

As early as 1862, the potential for learning French vocabulary by means of an associative link between the English and French word had been realized by the Rev. J.H. Bacon (see Desrochers & Begg, 1987). He described learning the French word *arbre*, meaning tree, by imagining the arbour at the foot of his garden, which was in the shade of an overspreading tree. The mental process described by Bacon can be represented as follows:

arbre(word) → arbour(word) → arbour(image) → tree(image) → tree(word).

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The keyword method enables subjects to combine in a single associative image the referent of one native word with that of a second native word that sounds like the foreign word to be learned. It is usually supposed that recall involves two stages. The first is to remember the native word that sounds like the foreign word; the second stage is accessing an image and naming the object that is linked in the image with the referent of the native word.

Atkinson and Raugh (1975) reported an experiment in which they compared learning FL vocabulary by means of mnemonics with a control condition in which subjects used their own strategies. In the experimental condition subjects were presented with a Russian word and its English translation, together with a word or phrase in English that sounded like the Russian word. For example, the Russian word for "battleship" is *linkór*. American student subjects were asked to use the word "Lincoln", called the keyword, to help them remember this. Atkinson and Raugh found that subjects who had used the keyword method learned substantially more words than did the control group, and this advantage was maintained up to six weeks later. Numerous subsequent studies have confirmed the effectiveness of the keyword method in foreign language (FL) vocabulary learning (see Cohen, 1987; Desrochers & Begg, 1987; Levin & Pressley, 1985; Paivio & Desrochers, 1981; Pressley, Levin, & Delaney, 1982; for reviews). However, in a comprehensive survey of almost 50 studies of the keyword technique, Pressley et al. (1982) note that the vast majority of this research has addressed receptive vocabulary learning (i.e. foreign → native); very little experimentation has been done on the effect of the keyword technique on productive vocabulary learning (native → foreign). Yet this is a question of vital importance—people learn FLs as much to utter and write as to understand and read.

Pressley, Levin, Hall, Miller, and Berry (1980) report three studies in which they investigated the effectiveness of the keyword method. As usual, the keyword method consistently proved most effective for receptive learning. For productive learning, those subjects who were instructed to combine keyword mediation with repetition of the word pairs performed better than those using keyword mediation alone; subjects who used repetition alone performed better than those who were not instructed to use any particular method. Although these differences were not statistically significant, it is noteworthy that the trend for repetition to be superior to the keyword method for productive learning is in the opposite direction to that for receptive learning. Only in one experiment (3b) of the series was there any hint of an advantage of the keyword method for productive learning. As Pressley et al. (1980) point out, "There is no mechanism in the keyword method to allow retrieval of the whole word from the keyword. Thus it is not surprising that the use of the method did not increase *whole* foreign word recall" (italics added).

Pressley and Levin (1981) reasoned that the keyword method might have a facilitative effect on productive retrieval only once the unfamiliar responses were integrated in memory. They therefore carried out an experiment in which learners were familiarized with the target responses prior to learning their meaning. When cued by the definitions, subsequent recall was higher in the keyword than in the free-strategy control condition. These results imply that the keyword method does not facilitate productive recall unless the new response items are already available in memory (Paivio & Desrochers, 1981; Desrochers & Begg, 1987). In practice, of course, there are few FL learning situations where the learner knows the words of the FL, their pronunciation, and their spelling, but not their translations (Cohen, 1987).

There is thus considerable reason for concern over the effectiveness of keyword strategies for productive vocabulary learning. Yet given the plethora of publications on the keyword method since the early 1970s, we can be fairly sure that if there had been positive effects of the keyword method in productive vocabulary learning, then they would have been reported by now.

Repetition

What other techniques are there for FL vocabulary learning? One strategy is rote-repetition, which has long been out of fashion in educational circles. Certainly within psychology, the levels-of-processing view of memory (Craik & Lockhart, 1972) implies that primary processing—i.e. maintenance rehearsal of an oral representation—does not necessarily lead to long-term retention, and associated research provides considerable evidence that "deeper" processing, whereby semantic associations are accessed and elaborated, is necessary for the formation of long-term representations.

Nevertheless, there may well be a role for repetition in productive vocabulary learning, as the apparent advantage of the control (repetition) conditions (relative to the no-strategy baseline) in some studies of keyword effects on productive FL learning suggest. As well as those studies referred to above, Seibert (1927) investigated the productive learning of French vocabulary and demonstrated that saying the words aloud brought about faster learning and better retention than did silent rote repetition of vocabulary lists. He emphasized that learning the novel pronunciation of FL words is as much a matter of motor development as of auditory perceptual memory.

In summary, numerous studies suggest that the use of keyword imagery mediation strategies is optimal for receptive vocabulary learning. From a relative dearth of reports concerning productive vocabulary learning, it may be argued that repetition is more effective for this aspect of language use. But people learn a language both to understand and to produce, and

there is therefore a need for the present study, which investigates the relative effectiveness of keyword image mediation and repetition when individuals are trying to acquire both receptive and productive skills. The specific aims of the experiment reported below were to investigate the immediate and long-term effectiveness of the keyword method compared with repetition and "own strategy" conditions in relation to direction of translation between foreign (German) and native (English) words. The effects of the imageability of the keyword and of the part of speech of the keyword and of the word to be learned were also investigated.

METHOD

Subjects

Thirteen male and 34 female psychology undergraduates participated in this experiment. The mean age was 24.2 (SD 6.2) years. None had previously studied German.

Procedure

All testing was done individually by means of a Macintosh computer programmed in Hypercard. The entire experiment was performed by means of the computer and one standard instruction leaflet, thus eliminating any possibility of experimenter effects (Jung, 1971).

Session 1

Language Knowledge. First the subjects' knowledge was tested using a modification of the procedure of Naiman, Fröhlich, Stern, & Todesco (1978). They were asked to consider each language that they knew in addition to their native English. For each additional language they were asked to rate their proficiency with regard to four aspects—namely "speaking", "understanding", 'reading", and "writing"—by positioning a cursor on a 12-cm visual-analogue scale that was shown on the screen and included 0.15 cm divisions. There were four markers on the scale: at points 0 cm: "below elementary"; at 4.0 cm: "elementary proficiency"; at 8.0 cm: "working knowledge"; and at 12 cm: "advanced". For each aspect this was expressed as a proportion of the maximum, "advanced", and for each subject a score was calculated for (1) NLANG—the total number of languages that they knew, (2) FORLANG—the sum of their mean scores over the four measures for each of the languages that they knew other than their native tongue. The mean NLANG score for the subjects was 1.75 (SD 0.85), and the mean FORLANG was 0.87 (SD 1.50). Thus, on average, the subjects reported knowing 0.75 foreign languages, and their mean estimated proficiency over the four aspects was 0.87.

Modern Language Aptitude Test. Next, the subjects completed a computerized adaptation of a subtest of the Modern Language Aptitude Test (MLAT: Carroll & Sapon, 1955), so as to ensure that the four experimental groups were equated in prior aptitude. The subtest used was Paired-Associate Learning of "Kurdish" vocabulary. Subjects were told that they would be given 2 min to learn 24 words of "Kurdish". After these instructions had been presented, two columns of 12 "Kurdish" → English vocabulary pairs (as in the MLAT) were presented on the VDU, and a clock started counting backwards in seconds from 120 on the right-hand side of the screen. When the 2 min were completed, the 24 "Kurdish" words were presented one at a time, along with five multiple-choice responses (one correct response and four foils), as in the MLAT. For each "Kurdish" word, the subject was requested to type in the letter (*a* . . . *e*) that labelled the appropriate English translation. This procedure was thus as nearly as possible a computerized replica of the original Paired-Associate Learning subtest of the MLAT (Carroll & Sapon, 1955).

For each subject a score on this subtest was calculated ranging from zero to 24. The mean score was 13.94 (SD 4.74).

German Vocabulary Learning Stage 1. Subjects were randomly allocated to one of four groups, all of which had the same exposure to German vocabulary but under different instructions. The groups were instructed as follows:

Own stategy group:

"Please now do your best to learn the German translation of the following English words."

Repetition group:

"In order to learn the English → German pairs of words, please repeat aloud each pair of words continuously until presentation of the subsequent pair of words. Please now do your best to learn the German translation of the following English words."

Noun keyword and verb keyword groups:

"To help you learn the words, the computer will display for each German word an instruction to IMAGINE a specific scene that links the sound of the English and German words together in some way. You must try to produce in your mind's eye as vivid an image as possible of the scene. You may find it helpful to close your eyes while you think about it, but remember to study the German word properly first, and to open your eyes in good time for the next word-pair. The linking of the sounds may only be approximate, but you will find that the process of imagining a visual scene will help you to recall the

words subsequently. Please now do your best to learn the German translations of the following English words."

The computer randomly assigned subjects to groups; this resulted in there being 10 subjects in the own-strategy group, 10 in repetition, and 8 and 19, respectively, in the noun and verb keyword groups. (The unequal group sizes were the result of a late-discovered "bug" in the random number algorithm.)

In the vocabulary learning session the subjects were introduced to the procedure with the 12 practice words, order of presentation being randomized for each subject.

The procedure for each learning trial was as follows: the English word was presented in a box at the top left-hand corner of the screen, with the German translation accompanying it in an equivalent format at the top right-hand side. At the same time as a stimulus was presented, the appropriate German word was spoken. The speech in this experiment was recorded by a native female German speaker and digitized for later use using "MacRecorder". If the subjects were in either of the keyword conditions, the appropriate imagery mediation sentence was presented in a field underneath the two stimuli. After 7 sec the German word was spoken again. The trial finished after 10 sec when the screen cleared for 1 sec before the next trial.

After a block of learning trials, the subject was tested on the material just presented. In all cases this was done twice. The first test block was German → English. The 12 German words were re-ordered randomly, and for each test trial the German word appeared at the top left-hand side of the screen, it was spoken at the same time, and the subject was invited to type in the English translation. The computer recorded the response. After the 12 German → English test trials, the identical procedure was repeated in the reverse direction, with the exception that the English word was not spoken.

On completion of the practice phase (12 trials learning, 12 trials German → English test, 12 trials English → German test), the subjects entered the main vocabulary learning phase. Here they repeated the above procedure three times for the 12 word-pairs of Block A; they did the same for blocks B and C (see Appendix 1).

The German words used in this experiment are shown in Appendix 1, along with their English translations and the mediating sentences for the keyword conditions.

The independent variables were: condition (own strategy/repetition/noun keyword/verb keyword); cycle (whether it was the first/second/third presentation of the pair of words to be learned); part of speech of the words to be learned (noun/verb); and direction of translation (German →

English; English → German). The dependent variables were: total correct (whether the response was completely correct) and overlap score—the number of letters in common between the response and the correct translation, starting from the first letter and terminating at the first difference.

The covariates were: NLANG = the number of languages that the subjects knew; FORLANG = their mean foreign language proficiency scores; and MLAT = their score on the MLAT "Kurdish" paired-associate learning task.

Session 1 took a little over an hour to complete.

Session 2

The subjects completed a second experimental session approximately one month (mean 31.4 days, SD 4.5) after the first.

German Vocabulary Learning Stage 2. This phase was similar to Stage 1. The subjects were tested for recall of the 12 practice pairs with the same testing procedure used in Stage 1—first they gave the English translations for the 12 German words presented in random order and then gave the German translations when presented with the English words. It should be noted that at this point there was no feedback on the correctness of their responses. The only deviation from the procedure of Stage 1 was that after the subjects had typed each response, they were asked to report how they had remembered that word by typing one of the following letters:

a I used a keyword and I can recall the IMAGE connecting the English and German Words.
b I used a keyword and I can recall the SENTENCE connecting the English and German words.
c I learned this word because it SOUNDS LIKE a word I know in another foreign language.
d I learned this word by PARROT-FASHION repetition.
e I learned this word because the German and English forms are SIMILAR.
f I used some method other than the ones listed above.
g I don't know why I remembered this word/I just knew it.
h I didn't remember this word!

Subjects were instructed that they could only type one letter.

Once the subjects had been tested for their retention of the translations in both directions for the 12 practice pairs, they then completed one set of trials re-learning the practice words under the same instructions and condition as in German Vocabulary Learning Stage 1. Subsequently there

was a German → English test pass, followed by an English → German test, as in Stage 1. This procedure was then repeated for Blocks A, B, and C.

The variables for recording and analysis were the same as Stage 1, with the addition of the subjects' judgement of their methods of recall.

RESULTS

Baseline Data

The random allocation procedure produced well-matched groups on the baseline variables—the groups did not differ significantly on NLANG [$F(3, 43) = 0.39$, n.s.], FORLANG [$F(3, 43) = 0.56$, n.s] or MLAT [$F(3, 43) = 2.53$, n.s.].

Although there were no significant group differences on MLAT or FORLANG, there was some variation between groups, and so these two variables were entered as covariates into the analysis to ensure statistical matching of prior aptitude and language background across the four groups. The means reported hereafter are adjusted for these covariates which jointly are significant predictors of accuracy, $F(2, 41) = 6.04$, $p < 0.01$. The more important direct predictor was MLAT; the product–moment correlation between subjects' accuracy over the experiment and MLAT was $r(45) = 0.58, p < 0.001$. FORLANG was only moderately and non-significantly correlated [$r(45) = 0.15$, n.s.].

Accuracy Data

The variable total correct, whether each response was entirely correct or not, was analysed as an ANCOVA with the following factors:

Four conditions (own strategy/repetition/noun keyword/verb keyword), with subjects nested within this factor; two directions of translation (German → English or English → German); five cycles (first/second/third presentation from Session 1, retest after a one-month delay, final test after relearning from Session 2); two parts of speech (noun or verb to be learned) with 18 words nested within each level of this factor.

Main Effects (Scores Are Proportion Correct)

Conditions. The mean accuracy over the blocks and cycles of the whole experiment for each of the four conditions was as follows: own strategy: 0.61, repetition: 0.68, noun keyword: 0.62, verb keyword: 0.55. There was considerable within-group variation, and this factor was therefore insignificant when analysed by subjects [$F(3, 41) = 1.32$, n.s.] although it was significant, $F(3, 105) = 48.24, p < 0.001$, by words (see Clark, 1973). A posteriori testing between condition means using the expected mean

square (EMS) of the "by-subjects" analysis is, of course, inappropriate: the non-significant F ratio demonstrates there to be no significant differences between them in this respect. Scheffé contrasts using the "by-words" EMS demonstrated that all contrasts were significant at the 5% level with the exception of that between noun keyword and own strategy.

Direction of Translation. German → English translation yielded significantly more correct responses than did English → German (respective means 0.68 and 0.53), both by subjects, $F(1, 46) = 43.22$, $p < 0.001$, and by words, $F(1, 35) = 46.98$, $p < 0.001$.

Cycles. There was significant improvement over Learning Cycles 1 to 3, a drop in performance after the one-month retention interval, and then a return to high levels of accuracy on relearning at Cycle 5. The means for the five cycles were: 0.48, 0.71, 0.81, 0.27, 0.76. This factor is significant both by subjects, $F(4, 184) = 175.01$, $p < 0.001$, and by words, $F(4, 140) = 382.21$, $p < 0.001$.

Part of Speech. The probability of correct recall of nouns was on average 0.68 and that of verbs 0.53. This difference is significant both by words, $F(1, 35) = 24.63$, $p < 0.001$, and by subjects, $F(1, 46) = 244.50$, $p < 0.001$.

Interactions

With such a complicated design, there are many possible interactions. We only present the second- or higher-order interactions that are either significant and/or of theoretical or applied importance.

Conditions × Direction of Translation. The means for this interaction are shown in Figure 1. This interaction is significant both by subjects, $F(3, 43) = 2.89$, $p < 0.05$, and by words, $F(3, 105) = 19.88$, $p < 0.001$. Scheffé contrasts using the EMS of the "by-words" analysis demonstrate that for English → German translation repetition is significantly superior to the other three strategies, which do not differ significantly; for German → English translation, noun keyword and repetition do not differ significantly but are superior to the own strategy control condition. In both directions of translation verb keyword was significantly worse than all other strategies. That these trends are robust is shown by their replication across learning cycles (see Figure 2).

Conditions × Part of Speech. This interaction was insignificant, both by subjects and by words ($F < 1$), the advantage of nouns over verbs being 0.15 in the own strategy condition, 0.12 for repetition, 0.15 for noun keyword, and 0.15 for verb keyword conditions.

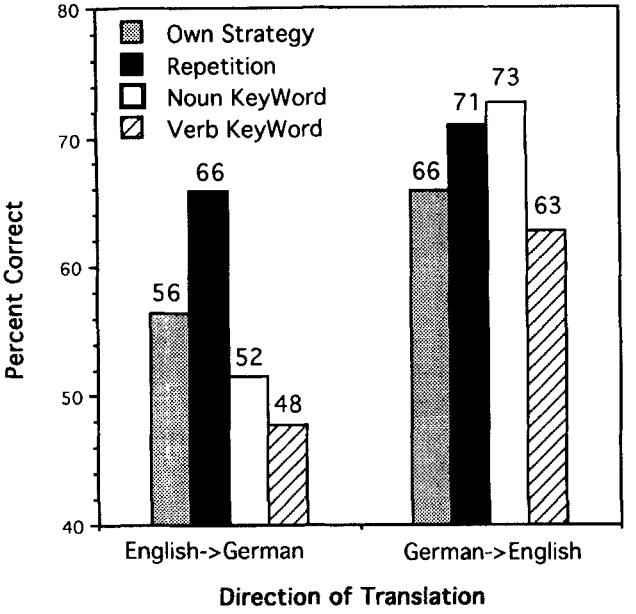


FIG. 1. Percent vocabulary learning accuracy by learning method and direction of translation.

Condition × *Cycles* × *Direction of Translation.* This interaction was significant both by subjects, $F(12, 172) = 2.01$, $p < 0.05$, and by words, $F(12, 420) = 3.19$, $p < 0.001$, and it qualifies the second-order Condition × Direction of Translation interaction. The interaction means are shown in Figure 2, where it can be seen that the main locus of the interaction lies in relative movement of the performance of the noun keyword group over cycles. Thus this group performs best in translation from German to English on Cycles 1, 2, 3, and worse on Cycle 4—the testing period after the one-month delay—and returns to superior levels again on Cycle 5 after being reminded of the keyword mediators.

Overlap Data

The pattern of results for the overlap measure (the number of letters that the response had in common with the correct translation, parsing from the left and stopping at the first error) is very similar to that for total accuracy described above, because these two measures are intimately confounded. The overlap measure is only of additional interest in the case of productive vocabulary spelling, as Pressley et al. (1980) found that there was an advantage for keyword imagery in productive learning if one considered just the keyword portions (i.e. the salient parts, usually at the beginnings)

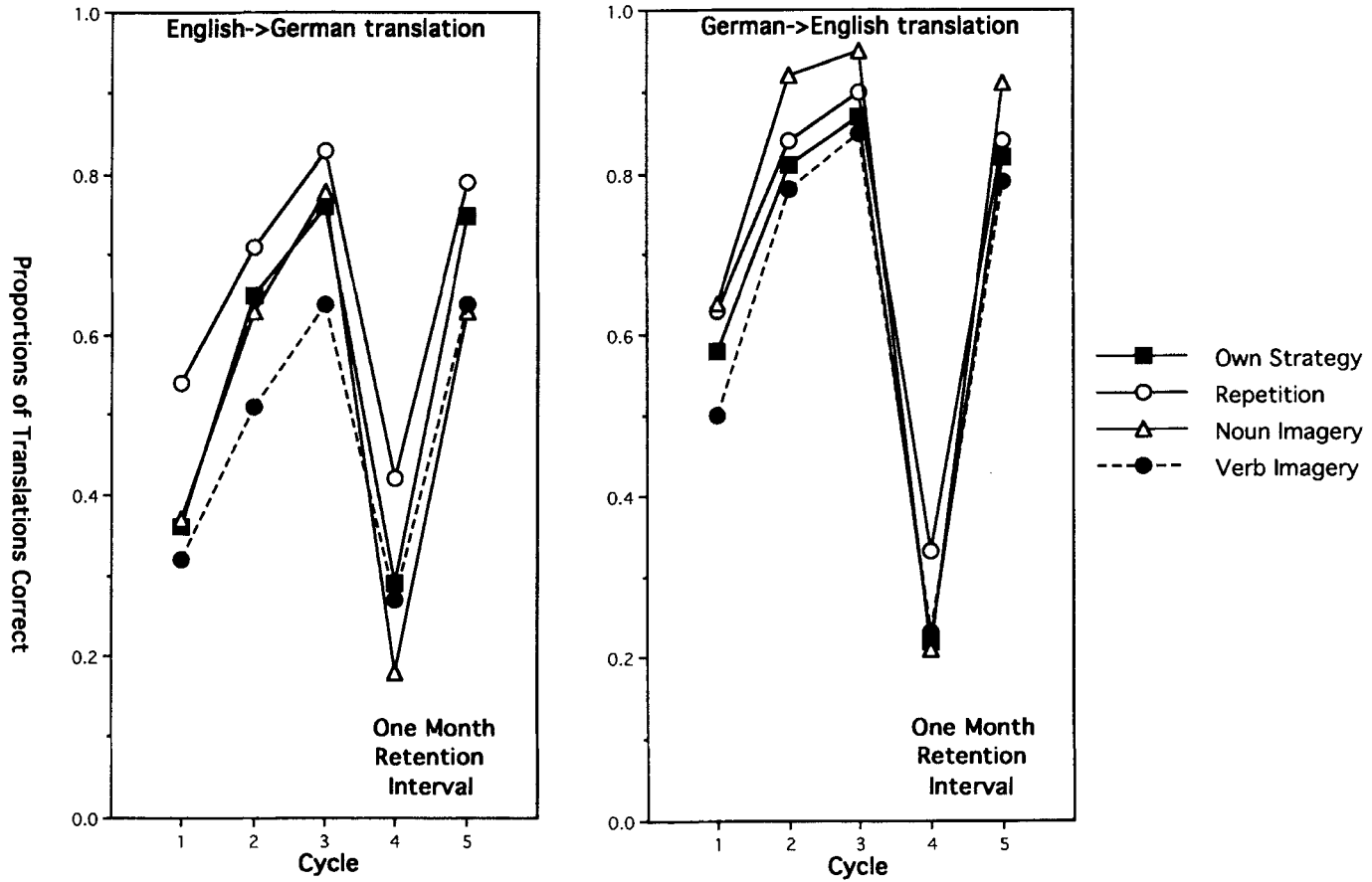


FIG. 2. The interaction of learning method and direction of translation over learning cycles.

of the foreign words. We therefore considered just the incorrect English → German responses over the whole experiment and analysed the degree of overlap between response and correct translation as a function of experimental condition. Of the 4307 incorrect responses in this direction, only 1793 (42%) had any letters in common with the target. i.e. the majority of the errors were null responses or totally incorrect. However, there was a tendency for the noun keyword group to be somewhat better than the other groups at remembering initial word parts, $\chi^2(9) = 92.64, p < 0.001$. These data are shown in Table 1, where it can be seen that 53% (100 − 47) of the noun keyword group's responses of this type had at least one letter in common with the target, compared with only about 40% (100 − 60) of the own strategy and repetition groups' responses.

Learners' Strategies

It is important to assess the strategies of learning and memory that learners thought they were using, in order to answer two questions:

1. Do learners really do what they are instructed to do when encouraged to use a particular FL learning method, however unjustified or unnatural that method may seem to them?
2. What do students left to their own devices in the "own strategy" condition do in order to learn some FL vocabulary?

For each word attempted in either direction of translation in the session following the one-month retention interval, the students were asked which of 8 statements (*a* . . . *h*) best described their memory for that translation.

The replicability of Methods *a–g* (excluding option *h*, "I didn't remember this word") was assessed under the assumption that the same

TABLE 1
The Percentage of Each Condition's Erroneous Responses in English → German Responding that Shared Letter Overlap with the Correct Target

	Condition							
Number of Letters Overlap	*Own Strategy*		*Repetition*		*Noun Imagery*		*Verb Imagery*	
	%	*n*	%	*n*	%	*n*	%	*n*
0	60.2	488	59.9	430	47.0**	411	62.3**	1185
1–2	19.9	161	16.9	121	26.7**	234	15.9**	303
3–4	12.8	104	15.2	109	19.0**	166	12.1**	230
5+	7.2	58	8.1	58	7.3	64	9.7**	185

**Cell actual frequency more than 4 Haberman's standardized residuals deviation from expected.

method is used, and the subject is equally aware of using that method, in retrieving the association between foreign and native words in both directions (German → English and vice versa). The analysis spanned both word-pairs and subjects. The proportionate agreement was 0.81. The statistic Cohen's Kappa is appropriate as a measure of reliability here as it corrects for chance agreements. The value of Kappa is 0.75, a high enough reliability to allow further analyses of these reports of learning method to address the above two questions.

The students' ascriptions of method derived in Session 2 were pooled across subjects in a given condition and expressed as percentages. Thus, for example, 58% of the responses in Session 2 were ascribed statement (*h*), viz. "I didn't remember this word"; this is made up of 53% of the "own strategy" group's, 48% of the repetition group's, and 60% and 66% of the noun and verb keyword groups' responses, respectively. The remaining responses, which the students thought they had remembered, were similarly categorized into Options *a* . . . *g* and expressed as percentages of the total. These data are shown in Table 2, where the asterisked items reflect percentages that deviate markedly from the expected values for those cells. A chi-square analysis of the data demonstrates a significant association between condition and ascribed method, $\chi^2(18) = 412.4$, $p < 0.0001$. In line with the high reliability coefficient, there is no significant relationship between reported strategy use and direction of translation, and so it is reasonable to pool across direction of translation. These data are made clearer in Figure 3.

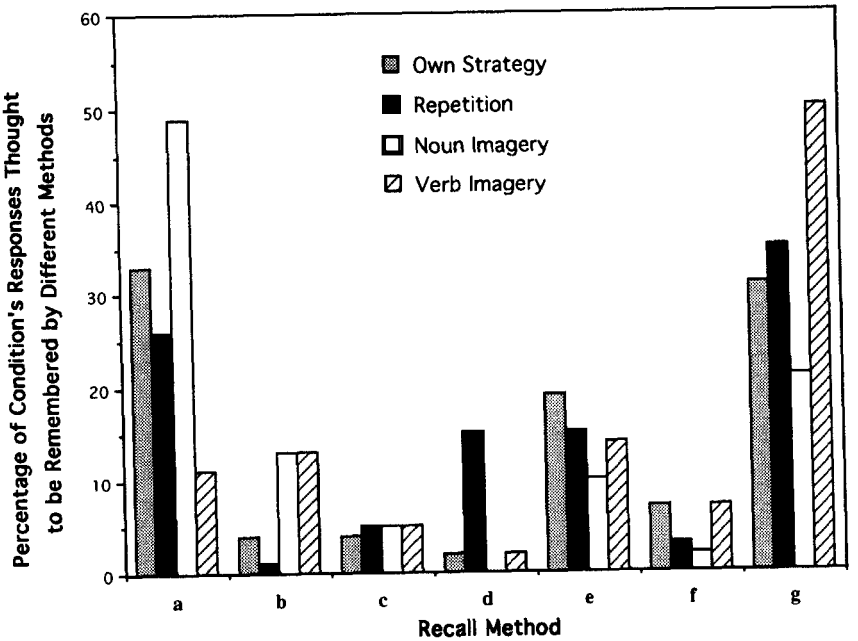
TABLE 2
The Reported Method of Recall as a Function of Condition

	Condition				
Method	*Own Strategy*	*Repetition*	*Noun Imagery*	*Verb Imagery*	*Overall %*
a Image	33*	26	49**	11**	26
b Sentence	4*	1**	13*	13**	8
c Sounds Like	4	5	5	5	5
d Repetition	2*	15**	0*	2*	5
e Similar	19*	15	10*	14	15
f Other	7	3	2*	7	5
g D/K	31	35	21**	50**	37

*Cell actual frequency more than 2 Haberman's standardized residuals deviation from expected.

**Cell actual frequency more than 4 Haberman's standardized residuals deviation from expected.

Note: The data are percentages of the condition's responses in Cycle 4 which subjects thought they remembered classified by method.



THE METHODS

a - I used a keyword and I can recall the IMAGE connecting the English and German words.

b - I used a keyword and I can recall the SENTENCE connecting the English and German words.

c - I learned this word because it SOUNDS LIKE a word I know in another foreign language.

d - I learned this word by PARROT FASHION repetition.

e - I learned this word because the German and English forms are SIMILAR.

f - I used some other method than the ones listed above.

g - I don't know why I remembered this word / I just knew it.

FIG. 3. Reported methods of recall in the different conditions.

Question i. It is clear that imagery mediation is a popular strategy in all conditions, whether instructed (noun and verb keyword groups) or not (own strategy, repetition groups). However, subjects in the noun keyword condition do seem to have used the instructed strategy more than those in other conditions, with this strategy constituting almost half of their responses. In contrast, subjects in the verb keyword condition report using this mnemonic less than do the other groups, presumably because the mediation sentences provided were ineffective. The repetition group reported remembering the pairs by repetition more than the other groups. These results taken together do suggest that subjects tried to perform as instructed. This justifies the use of printed instructions (and practice trials) in experiments of this kind (for a different opinion see Pressley, 1991).

Question ii. Many of the students in the own strategy and repetition groups reported using imagery mediation by composing their own keywords. The rate of spontaneous use of imagery mediation here (33%) is close to that of 25% observed by Raugh and Atkinson (1975).

The Association Between Learning Strategy and Accuracy

The major analyses in this respect have already been reported as the accuracy data for the four different conditions. However, the question of learners potentially using several learning strategies at once is of additional interest. It can be seen in Table 2 that individuals in all conditions report some associations remembered by imagery mediation. At least some learners in the repetition condition must have *both* repeated the foreign and native words and formed an imagery association on these trials, and it is therefore relevant whether these two strategies in combination result in more accurate recall. We therefore compared the accuracy of the items that the subjects in the four conditions reported remembering by imagery mediation (i.e. the *true* accuracy of the responses constituting the first row of Table 2). These were 62% (91/147) for the own strategy condition, 71% (92/130) for the repetition condition, and 53% (79/149) and 57% (37/65) for the noun and verb keyword conditions, respectively. This association is significant, $\chi^2(3) = 9.70$, $p < 0.05$, with the best performance coming from those in the repetition condition who were presumably both using imagery mediation and repeating the foreign and native words. The obverse analysis, i.e. investigating whether learners in the keyword conditions did particularly well when they also reported repeating the words, is not possible, as no subject in the noun keyword condition (the most effective of the two keyword conditions) ever reported also rote rehearsing the word pair (Table 2).

DISCUSSION

The aims of this experiment were, (1) to investigate the immediate and long-term effectiveness of the keyword method in relation to the part of speech and the imageability of the keyword and of the word to be learned and (2) to compare the keyword method with simple rote repetition for both reception and production of vocabulary.

The main findings to be discussed are:

1. the superior level of recall for receptive use of language as compared with production;
2. the superiority of the noun keyword over the own strategy control condition for German into English and the superiority of the noun keyword over the verb keyword condition for both directions of translation.
3. The superiority of repetition over the keyword and own strategy conditions for translation from English into German but not for German into English. (For the latter direction of translation, the noun keyword scores exceeded those for repetition, although the difference between these conditions was not significant.)

1. It is clear from this experiment that learning a word for productive use is more difficult than for reception. Overall, receptive translation was 68% correct, compared to 53% accuracy for production. This is a common finding (Stoddard, 1929; Crothers & Suppes, 1967; Rogers, 1969) and is not surprising. However, rarely have studies of the keyword method compared its effectiveness for the two directions of translation (foreign → native; native → foreign). Although our experiment confounds the two directions in that German → English was always tested before English → German, it is noteworthy that our study is one of very few to look at this factor within the context of keyword mnemonics.

The reason for the extra difficulty of productive learning may lie at several doors: (1) It may require production of new output patterns—either the orthography for spelling, as in this experiment, or the articulatory routines for pronunciation. (2) The subjects may be more practised in reception than in production. (This is unlikely to hold here, because in the learning trials the two items were presented simultaneously and subjects were later tested equally in both directions.) (3) It may be a feature of the lexical system. A new FL item for a complete beginner has no associations with lexical entries other than its native language equivalent (or in relatively infrequent cases those associated by orthographic, phonological, or etymological similarity). In contrast, the equivalent native lexical entry (or logogen—Morton, 1969, 1979) has a host of semantic and co-locational

associations within the lexicon, and one outside—the specific linkage to the pronunciation routines for this native word (i.e. with the phonological output lexicon). All of these associations will be in a high state of activation when the logogen itself is "demonically" excited (Selfridge, 1959). The strength of the recent link to the entry for the newly learned FL equivalent must pall into insignificance when compared with the strength and spread of activation within the native lexicon. There are therefore many more competing active paths in production than in reception.

Another possible explanation of the superiority of production over reception has to do with task-demand characteristics. When the foreign word is given as the "stimulus", it is possible that only a small segment of the word may be sufficient to discriminate between alternative native language responses. One may have partial lexical knowledge of the foreign word, and seeing or hearing it is sufficient to elicit the appropriate native response. On the other hand, if the requirement is to give the foreign word on hearing or seeing the native word, the response is usually only scored if it is completely correct. The extent of any advantage for receptive over productive vocabulary learning will therefore depend upon the degree to which less than perfect responses are scored as correct. With a lax criterion the difference between productive and receptive learning will be less than with a strict criterion.

2. Our finding that the noun keyword condition was superior to the own strategy condition for German into English confirms the results of numerous studies referred to in the introduction to this paper, in particular, those of Desrochers, Gelinas, and Wieland (1989), who used a modified key-word technique in teaching German nouns to French-speaking Canadian students. An advantage for the keyword method of vocabulary learning for receptive use can be considered a standard finding in this field of research (but see Hall, 1988; critique by Pressley, 1991; and reply by Hall, 1991) and requires no explanation beyond what has already been put forward in the literature (see Introduction). The only point to be mentioned here is that the present result represents a conservative demonstration of the efficacy of keyword imagery mnemonics. This is because the particular keywords of this experiment were not chosen to be optimally effective but so that they could be used either as nouns or as verbs and thus allow us to satisfy one of the aims of the experiment. This constraint on the choice of keyword meant that some obvious and (to judge both from experience and the hindsight afforded by this experiment) highly effective keywords were not used.

Subjects in the verb keyword group performed consistently more poorly than subjects in the other groups. This was true whether receptive or productive vocabulary was tested (Figure 1) and at all learning cycles

(Figure 2). Furthermore, even though these subjects were trying to use the keyword strategy, they remembered far fewer images connecting the English and German words than the other groups, two of which (repetition and own strategy) were not directly instructed to utilize imagery mediation (Figure 3). This, together with the generally poor performance of the verb keyword group, implies that merely linking the two words to be learned in a single sentence is less effective than using interactive imagery, as demonstrated experimentally by Atkinson (1975) and Kasper (1983) (but see Pressley, Levin, & Miller, 1981).

In a related experiment we asked (a different group of) subjects to rate both the words to be learned and the individual keywords on imageability. The noun and verb keywords differed significantly in imageability, even though the mediating sentences in which the keywords were "embedded" were not rated as significantly different in this respect (Ellis & Beaton, in press). It has often been shown that high-imageability items are more effective retrieval cues and are more easily recalled responses in paired-associate learning than are low imageability items (Paivio, 1971; Rubin, 1980), and the same is true in FL vocabulary learning (Delaney, 1978; Paivio & Desrochers, 1979; Pressley et al., 1981). However, the relevant demonstrations concern the imageability of the native concept, not the keyword. Thus although there has been speculation on the importance of the imageability of the keyword (e.g. Atkinson, 1975; Desrochers & Begg, 1987), this is, to our knowledge, the first demonstration of the potency of this factor: ask people to use keyword mediation with low imageability keywords, and they perform very badly. It is important that keywords be highly imageable so that they can evoke a wide range of context-specific interpretations, allowing the individual to represent the keyword referent and the FL referent in a vivid composite image that uniquely specifies their interrelations (Desrochers & Begg, 1987).

The present experiment has also shown that nouns were remembered more often (68%) than were verbs (53%). This is a commonplace observation among teachers of foreign languages, but there are, in fact, few other experimental demonstrations of this effect (but see Rogers, 1969). Grammatical class effects are typical in verbal learning experiments and psycholinguistic performance generally, for example, in the magnitude of Stroop effects (Davelaar & Besner, 1988), in the reading of deep dyslexic patients (Patterson, 1981), and in aspects of word-association (Cramer, 1968). However, as far as we know, this is only the second explicit demonstration within the keyword context (the first being that of Raugh, Schupback, & Atkinson, 1977) that the part of speech of the word to be learned is important. The greater ease of FL learning of nouns presumably lies in their richer semantic representation.

It is possible that verbs are inherently less "meaningful" than nouns, in the sense that verbs require agents for their execution. If one considers

the verb "to run", for example, some creature must do the running (ignoring metaphorical usage such as "to run a computer"). On the other hand, the things to which nouns refer have an existence independent of what happens to them or what they "do". They simply "are". But in simply "being", nouns, or more accurately their referents, have a large number of properties. For example, individual objects are big or small, hard or soft, they have component parts, they do certain things, and they are found in association with certain other objects. Meaningfulness in the sense in which we are using it here is synonymous with meaning as it is conceptualized in various theories of semantic memory. The meaningfulness of an item in semantic memory is represented in these accounts by the pattern of relations between this item and other items in the semantic network.

In our related experiment (Ellis & Beaton, in press) we asked subjects to rate the imageability of the words learned in the present experiment. The nouns were rated as more highly imageable than the verbs. It is thus possible that what we are discussing here as a part of speech effect may in fact be an imageability effect. Indeed, Paivio and Desrochers (1979) reported higher recall of concrete than abstract French words for English-speaking Canadians in an experiment using a peg-based imagery mnemonic. However, imageability itself can be related to meaningfulness in the sense in which we use it above. It is therefore arguable that imageability and meaningfulness are different ways of looking at the same thing. Another way of conceptualizing the relationship between imageability and meaningfulness is in terms of ease of predication (Jones, 1985). We have more to say on this in Ellis and Beaton (in press) (see also Ellis, 1991; Ellis, submitted).

3. Virtually all the experiments showing a keyword advantage concern receptive vocabulary learning. Our experiment shows that the advantage for the keyword technique depends, at least in certain circumstances, upon the direction of translation. Although the noun keyword group performed better than all other groups for German → English (though this was not significant for every comparison), the repetition group was significantly superior to the other three groups for English → German. Current work in cognitive psychology is relevant to this finding. Gathercole and Baddeley (1989) demonstrated in a longitudinal study that five-year-old children's native vocabulary scores were predicted by their short-term phonological memory ability (assessed by their ability to repeat non-words) one year earlier. Support for a causal connection between phonological STM and vocabulary acquisition comes from their training study (Gathercole & Baddeley, 1990) in which children poor on non-word repetition were found to be slower than children who were good on non-word repetition at learning new vocabulary (phonologically unfamiliar names, such as "Pimas" for toys). They were not slower to learn new mapping for familiar

vocabulary (familiar names, like "Thomas" for toys). Such findings implicate temporary phonological encoding and storage skills in the learning of new words. In our experiment it appears that the repetition group benefited from hearing themselves repeat the words to be learned and, possibly, from the articulatory representations established through repetition.

A second source of evidence for a relationship between phonological STM and vocabulary acquisition comes from the study of Baddeley, Papagno, and Vallar (1988) of an adult patient, PV, who appeared to have a highly specific acquired deficit of immediate phonological memory. PV was completely unable to make associations between spoken word–non-word pairs, despite showing normal phonological processing of non-word material. She had no difficulty, however, in learning new associations between pairs of words.

The involvement of temporary phonological memory in the long-term learning of unfamiliar phonological material holds for new words whether they are of native or foreign sources—for FL learning there are the studies by Papagno, Valentine, and Baddeley (1991) of Italian adults learning Russian and Spanish and the experiments of Service (1992), which involved young Finnish children learning English as a second language. Papagno et al. using a design comparable to ours and using Italian adults, (requiring productive vocabulary learning with written responses), demonstrated that articulatory suppression (which arguably disrupts the phonological loop component of working memory) interferes with the learning of Russian vocabulary, but not of native-language paired-associates. English subjects were not as disrupted in learning Russian; they were, however, when learning Finnish words, which were very dissimilar to English—a result that Papagno et al. attribute to the greater association value of Russian words for these subjects. This suggests that the phonological loop is used in FL vocabulary acquisition when the material to be learned is phonologically unfamiliar and when semantic associations via native language cognates are not spontaneously created; it can be circumvented if the material readily allows semantic association. Service (1992) demonstrated that the ability to represent unfamiliar phonological material in working memory (as indexed by Finnish children's ability to repeat aloud pseudowords that sounded like English) predicted FL (English) acquisition two and a half years later.

It appears, then, that phonological STM is involved in productive LT vocabulary acquisition, as (1) phonological STM span predicts vocabulary acquisition, (2) individuals deficient in phonological STM have difficulty in acquiring the phonological representations of unfamiliar words, and (3) interfering with phonological STM by means of articulatory suppression disrupts vocabulary learning when semantic associations between the native and foreign word are not readily available.

Gathercole and Baddeley (1989) argued:

> Acquiring a new vocabulary item . . . must minimally involve achieving a stable long-term representation of a sequence of sounds which is linked with other representations specifying the particular instance or class of instances. The locus of the contribution of phonological memory skills seems most likely to be in the process of establishing a stable phonological representation as, in order to do this, a temporary representation has presumably to be achieved first. Immediate phonological memory seems an appropriate medium for this temporary representation and presumably constructing the stable long-term memory representation of the novel event will interact with the adequacy of this temporary representation. By this analysis, the better the short-term representation, the faster the long-term learning. [Gathercole & Baddeley, 1990, pp. 451–452]

In our experiment, overt repetition—i.e. re-cycling material through the phonological loop component of short-term memory—leads to just such better long-term representations. The effect may come about because rehearsal simple reinforces the temporary phonological representations, thus preventing their decay (Baddeley, 1992), or it may be that it provides multiple redundant representations—articulatory representations in addition to two acoustic/phonological representations, because the word is spoken twice, once by the native speaker, once by the learner (Gathercole, personal communication). As Seibert (1927) emphasizes, the learning of the novel pronunciation of FL words is as much a matter of motor skill as of auditory perceptual memory, that "it is impossible to memorise speech material without articulating it in some form or another", and that this must be practised "since the golden-rule of sensori-motor learning is much repetition" (p. 309). The development of auditory-sensory memory for pattern recognition needs to be established by means of repeated exposure, and the articulatory motor programs for speech refined and routinized by repetitive practice. Input and output logogens require repetition for development—frequency of usage determines their accuracy and speed of operation (Morton, 1969, 1979).

Not only does repetition in short-term memory facilitate familiarity in long-term memory, but the reverse is also true. Thus Hulme, Maughan, and Brown (1991) demonstrated that memory span for real words is longer than for non-words of equivalent length. Service (1992) reported that Finnish children repeated non-words that resembled the structure of Finnish real words better than they repeated non-words that were structurally similar to English. Gathercole, Willis, Emslie, and Baddeley (1991) showed that the degree to which non-words were judged to be "wordlike" predicted English children's recall of these non-words. These are good grounds for believing that phonotactic regularity and ease of repetition are related. This relationship is directly demonstrated in our companion paper,

where the degree of phonotactic regularity of German words in relation to English correlated −0.55 with the time taken to pronounce them (short-term repetition) and 0.51 with longer-term learning by "own strategy subjects" tested for German production. Phonotactic regularity might allow a novel word to match better a learner's set of excitatory and inhibitory links between sequential phonological elements (Estes, 1972) for input processes, such as phonemic segmentation, or for output processes such as articulatory assembly (Gathercole et al., 1991; Snowling, Chiat, & Hulme, 1991). Thus, there may be better support from long-term memory for the representation in phonological short-term memory of familiar as compared with unfamiliar sound sequences. Short- and long-term phonological representations are thus mutually supportive (Gathercole et al., 1991; Ellis & Beaton, in press).

To summarize the findings of this experiment, we have shown that the keyword method of learning vocabulary is effective for foreign to native translation but that rote repetition promotes the productive learning of foreign vocabulary. Furthermore, there is evidence that a combined strategy is most effective of all. In addition, we have shown that the effectiveness of the keyword method depends upon the part of speech and/or the imageability of the keyword and, further that part of speech, and/or imageability, of the foreign word to be learned influences recall performance.

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APPENDIX 1

The Stimulus Material Used in this Experiment

German Word	*English Word*	*Noun Keyword Sentence*	*Verb Keyword Sentence*	*Part of Speech of Word to Be Learned*
BLOCK A				
Sperre	barrier	Imagine a SPARROW on a station BARRIER	Imagine you SPARE a penny at a station BARRIER	noun
Hose	trousers	Imagine TROUSERS wrapped round a garden HOSE	Imagine dirty TROUSERS and HOSE them down	noun
Nehmen	to take	Imagine you TAKE a NAME IN your address book	Imagine you TAKE and NAME a puppy	verb
Haben	to have	Imagine HARBOURS HAVE many ships	Imagine you HARBOUR criminals and HAVE doubts about it	verb
Ecke	corner	Imagine an ECHO in a CORNER	Imagine you ECHO the sentiments of the person in the CORNER	noun
Dohle	jackdaw	Imagine a JACKDAW with a DOLLAR in its beak	Imagine a JACKDAW and DOLE out some bread to it	noun
Kaufen	to buy	Imagine you BUY a COFFIN	Imagine you buy sweets and COUGH	verb
Fliegen	to fly	Imagine FLEAS FLY quickly	Imagine you FLEE quickly and FLY away	verb
Leiter	ladder	Imagine a LIGHTER at the foot of a LADDER	Imagine you light a fire at the foot of a LADDER	noun
Friseur	hairdresser	Imagine your HAIRDRESSER inside a FREEZER	Imagine your HAIRDRESSER and FREEZE HER	noun
Stellen	to put	Imagine you PUT STEEL girders in your house	Imagine you PUT one book down and STEAL another	verb
Brauchen	to need	Imagine BROKERS NEED much experience	Imagine you BROKE a pen and NEED it	verb
BLOCK B				
Teller	plate	Imagine a fortune-TELLER with a pile of silver PLATES	Imagine you TELL A story about silver PLATES	noun
Küche	kitchen	Imagine your KITCHEN and a COOK in it	Imagine your KITCHEN and COOK a meal there	noun
Mieten	to rent	Imagine you RENT MEAT to friends in your room	Imagine you RENT a room and MEET friends in it	verb
Zahlen	pay	Imagine SAILORS PAY for hot rum	Imagine you SAIL and PAY for hot rum	verb
Klippe	cliff	Imagine nail-CLIPPERS on a CLIFF	Imagine you CLIP a rope to a CLIFF	noun
Fahne	flag	Imagine a FLAG on a FAN	Imagine A FLAG and FAN yourself with it	noun
Rufen	to call	Imagine you CALL a friend to put a new ROOF on a cottage	Imagine you CALL a friend and ROOF your cottage	verb

German Word	*English Word*	*Noun Keyword Sentence*	*Verb Keyword Sentence*	*Part of Speech of Word to Be Learned*
Graben	to dig	Imagine CRABS DIG holes in the sand	Imagine you GRAB a spade and DIG with it	verb
Schere	scissors	Imagine SHEARS besides a pair of SCISSORS	Imagine you SHEAR off some hair with a pair of SCISSORS	noun
Rasen	lawn	Imagine your LAWN covered in RAISINS	Imagine your lawn and RAISE its level	noun
Stossen	to push	Imagine you PUSH STORES in a cupboard	Imagine you PUSH and STORE things in a cupboard	verb
Streichen	to paint	Imagine STRIKERS PAINT slogans on walls	Imagine you STRIKE out the old graffiti and PAINT new slogans	verb
BLOCK C				
Schalter	counter	Imagine a sea-side SHELTER with a candy-floss COUNTER	Imagine you SHELTER under a candy-floss COUNTER	noun
Flasche	bottle	Imagine a BOTTLE in a FLASH of lightning	Imagine a BOTTLE and FLASH a light onto it	noun
Streiten	to quarrel	Imagine you QUARREL about the Menai STRAITS	Imagine you QUARREL and STRAIGHTEN your tie	verb
Laufen	to run	Imagine bread LOAVES RUN down the street	Imagine you LOAF about and then RUN off	verb
Brücke	bridge	Imagine a small BROOK under a hump-backed BRIDGE	Imagine you BROOK no disagreement over the building of a hump-backed BRIDGE	noun
Messer	knife	Imagine a KNIFE in a MESS of gravy	Imagine a KNIFE and MESS it with gravy	noun
Treten	to step	Imagine you STEP on a stair TREAD	Imagine you STEP quietly as you TREAD on the STAIR	verb
Tragen	to carry	Imagine DRAGONS CARRY fire hoses	Imagine you DRAG and CARRY fire-hoses	verb
Nagel	nail	Imagine your KNUCKLE with a NAIL through it	Imagine you KNUCKLE down to fixing a NAIL	noun
Birne	pear	Imagine a PEAR on a gas BURNER	Imagine a PEAR and BURN it	noun
Sagen	to tell	Imagine you TELL someone SAGO is good for them	Imagine you TELL someone to SAY GO when you are ready	verb
Reissen	to tear	Imagine RICE TEARS a hole in a paper bag	Imagine you RISE up and TEAR a paper bag in half	verb