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| **TABLE 1.** Summary of key studies examining form representations and form-form mappings |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
| Atkinson (1972) | German-English | 120 students enrolled at an English-speaking university, no prior knowledge of German | Can a comparison of four instructional strategies, and recommendation of an optimal strategy, improve learning for participants vs. the learning strategies they would use on their own? | Four methods of spacing testing trials compared: RO = random order, SS = subject selected order, OE = optimal computer assessment of subject learning, assuming items are of equal difficulty, OU = optimal computer assessment of subject learning assuming items are of unequal difficulty | During training, performance was best for RO, intermediate for both SS and OE, and worst for OU. At delayed testing the order completely reversed so that best performance was for OU, then SS, then RO. |
| Bahrick, Bahrick, Bahrick, & Bahrick (1993) | English-French; English-German | 4 participants with some prior training in a language | What is the course of vocabulary learning and forgetting over an extended period? | 300 words assigned to six training conditions: 2 retraining sessions (13 or 26) × 3 spacing between sessions (14, 28, 56 days). Four retention intervals (1, 2, 3, or 5 years). | Shorter spaces between sessions were better for initial acquisition but differences leveled off over time. For retention, there was a large benefit of a longer gap between sessions. Greater number of training sessions led to better recall for all spacing intervals. |
| Kang, Gollan, & Pashler (2013) | English-Hebrew | 100 English-speaking undergraduates | Is retrieval practice better than imitation for later recall? | Participants trained on Hebrew words in one of two conditions: (a) retrieval condition, saw a picture and tried to produce a Hebrew word, and then after a pause heard the correct pronunciation, or (b) imitation condition, saw picture paired with pronunciation of Hebrew word, and asked to repeat the Hebrew word. | Two testing tasks: comprehension task, heard a Hebrew word, asked to point to corresponding picture, and production task, saw a picture and asked to produce the Hebrew word. On both immediate and 2-day delayed tests of translation production, there was an advantage for words trained in the retrieval condition over the imitation condition. |

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| **TABLE 1** (continued) |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
| Lawson & Hogben (1998) | English-Italian | 40 English speakers in Year 2 Italian | Is repetition training effective for immediate and delayed recall of both concrete and abstract L2 words? | Trained with repetition or elaborated keyword method. Day 1 was training, returned on Day 3 for additional training and testing. Returned 3 days later, 7 days later, and 10 days later for additional testing. | Repetition training was significantly less effective than the keyword method on immediate and delayed L2-L1 written translation production tests. Concrete word advantage for both repetition training and keyword method. |
| Moore & Surber (1992) | English-German | 140 students, 3 levels of German proficiency | Is repetition training, semantic context, or the keyword method more effective for training L2 vocabulary, and does this differ with learner proficiency? | Control condition given list of word pairs and instructed to memorize them for a test. Context condition given words in sentences and instructed to learn the meaning from contextual clues. Keyword method trained on method and then instructed to form their own keyword links between the L1 and L2 words. | Found significant variations with proficiency levels. Repetition training was always worst for Level 1 and 2, but was best for Level 3 in both posttest conditions and the English translation production immediate test. |
| Pavlik & Anderson (2005) | English-Japanese | 40 English-speaking students with no knowledge of Japanese | What are the effects of practice and spacing on learning and retention of L2 vocabulary? | 4 word exposures (1, 2, 4, 8) × 3 spacings (2, 14, 98 intervening trials) × 2 retention intervals (1 or 7 days) | Session 1, lower performance with wider spacing, but interaction of spacing and forgetting – wider spacing in training resulted in less forgetting in testing. Session 2, significant interaction of repetition and spacing – benefit of spacing went up with more repetitions. |

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| **TABLE 2.** Summary of key studies examining meaning representations and form-meaning mappings |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
| Barcroft (2007) | English-Spanish | 24 native English speakers learning Spanish, low Spanish proficiency | Will retrieval opportunities improve vocabulary learning? | 2 conditions (retrieval vs. control) × 2 orders (retrieval first vs. control first). | Significant main effect of condition – mean number of items recalled was higher for words that had retrieval opportunities during training. |
| Barcroft (2002) | English-Spanish | 51 English-Spanish students, lower proficiency | What are the effects of semantic vs. structural processing? | Three within-subjects elaboration groups: semantic, structural, and none. Semantic trials were pleasantness ratings, structural trials were counting letters, control trials were simply learning words. | L2 free recall: no elaboration highest, then structural, then semantic. L1 free recall: no elaboration highest, but here semantic was better than structural. Translation production: means higher for structural than semantic, but highest for no elaboration. |
| Barcroft (2009) | Spanish-English | 114 adults; lower- and higher-intermediate students | What are the effects of synonym generation on L2 vocabulary learning? | Assigned to incidental (read for meaning) or intentional (read for test) learning groups. Read L2 passage with low-frequency L2 words and their translations. Half of each learning group instructed to generate L1 synonyms for the target words, and the other half did not receive that instruction. | Recall better for intentional learning and no synonym generation conditions. Synonym generation was worse for both incidental and intentional. Effects of conditions did not differ for higher vs. lower proficiency groups.  |
| Coomber, Ramstad, & Sheets (1986) | English-nonwords | 134 undergraduates from an English-speaking university | What are the effects of rehearsal vs. elaboration methods of vocabulary training? | Experimenter read aloud words and definitions. Participants saw words in three training conditions: (a) write word next to definition in list of possibilities, (b) write word next to example of word in list of possibilities, (c) write a sentence using the target word. | Sentence writing better than examples and definitions on tests of definitions, examples, and sentence writing. Examples did better than definitions on all three types of test. Best performance was for words trained with sentence writing and tested on definitions; worst performance was for words trained with definitions and tested on sentence writing. |

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| **TABLE 2** (continued) |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
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| Finkbeiner & Nicol (2003) | English-nonwords | 47 monolingual English speakers | Should L2 vocabulary be taught in semantic groupings? | Related (semantic blocks) and unrelated (random blocks) in both training and testing. | Same pattern of results for training and testing (both L1-L2 and L2-L1 translation): training in the unrelated condition led to faster translation times than training in the related condition, and testing in the unrelated condition led to faster translation than testing in the related condition. Translation was always slowest for training in the related condition and testing in the unrelated condition. Negative effect of semantic grouping in training. |
| Moore & Surber (1992) | English-German | 140 students, 3 levels of German proficiency | Is repetition training, semantic context, or the keyword method more effective for training L2 vocabulary, and does this differ with learner proficiency? | Repetition training condition given list of word pairs and instructed to memorize them for a test. Context condition given words in sentences and instructed to learn the meaning from contextual clues. Keyword method trained on method and then instructed to form their own keyword links between the L1 and L2 words. | Found significant variations with proficiency levels. Repetition training was always worst for Levels 1 and 2, but was best for Level 3 in both posttest conditions and the English translation production immediate test. |
| Sagarra & Alba (2002) | English-Spanish | 778 third semester L2 learners of Spanish at an English-speaking university | Does deeper processing lead to better retention than shallower processing? | 3 condition (repetition training, keyword method, and semantic mapping) × 3 presentation order (1, 2, or 3) × 2 posttest (immediate and delayed), within-subjects. | Decrease in accuracy from immediate post-test to delayed post-tests, decrease was smallest for the keyword method (23%), then repetition training (26%), then semantic mapping (31%). Repetition training was significantly better than semantic mapping, but the keyword method was significantly better than both semantic mapping and repetition training. |

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| **TABLE 2** (continued) |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
| Tinkham (1993) | English-nonwords | 20 advanced English speakers (not all native), enrolled at an English university | Is there a benefit or detriment to learning new words in semantic clusters? | Participants heard and saw English-nonword pairs and then were instructed to repeat nonwords aloud. Then tested on number of trials to produce nonwords when given the English translations. | Main effect of relatedness: unrelated words required fewer trials to reach complete learning than related words. |
| Tinkham (1997) | English-nonwords | 48 native speakers of English | What are the effects of learning new words in semantic or thematic groups? | Words appeared in 4 training conditions: (a) semantic groups, (b) semantically unrelated groups, (c) thematic groups, and (d) thematically unrelated groups – 2 modalities: oral and written.  | Semantic groupings had a negative impact on recognition and production tests. Benefit for thematically related groupings over thematically unrelated groupings, semantically unrelated groupings, and semantically related groupings. |
| Tseng et al. (2017); Experiment 1 | English-Arabic | 36 native English speakers, no knowledge of Arabic, Hebrew, or Turkish | Will manipulating amount of lexical information provided during training and grouping words thematically affect learning? | 8 Session (1 through 8) – 2 Transliteration Condition (transliterations vs. no transliterations) – 2 Order Condition (thematic order vs. random order) mixed design. After training, participants completed a free recall task and an L1-L2 oral translation production task.  | Free recall data showed significant benefit for transliterations over no transliterations, and a four-way interaction of transliteration, session, grouping, and working memory span. Participants with higher working memory spans were less affected than participants with lower working memory spans by grouping or the presence or absence of transliterations. Results for translation production did not show an effect of grouping or transliterations.  |

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| **TABLE 2** (continued) |
| **Study** | **Language pair** | **Participants** | **Research question** | **Method** | **Findings** |
| van Hell & Candia Mahn (1997); Experiment 1 | Dutch-Spanish | 36 experienced foreign language learners, but no prior knowledge of Spanish | What are the effects of repetition training vs. the keyword method, as well as prior experience learning foreign languages, concreteness of target words, and quality of keywords on novel word recall? | Keyword condition: (a) learn Spanish-Dutch keyword associations (with pronunciations given), (b) create image of keyword and Dutch translation interacting. Repetition training condition: (a) see Spanish words in isolation, repeat and memorize, (b) see Spanish words and Dutch translations, repeat and memorize. | Accuracy: Keyword group recalled significantly fewer words than repetition training group. Concrete words recalled better than abstract words, and no interaction of instruction and concreteness. RT: Keyword slower to translate than repetition training group, and abstract were slower than concrete. |
| van Hell & Candia Mahn (1997); Experiment 2 | English-Dutch | 40 monolingual English speakers, inexperienced foreign language learners | Same as Experiment 1 | Same as Experiment 1 | Accuracy: No difference between keyword repetition training groups. Concrete words recalled better than abstract words. Interaction of concreteness and instructional method – concreteness effect larger for repetition training condition. RT: recall times slower for keyword than repetition training condition. |

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| **TABLE 3.** Future research directions |
| *Topic* | *Specific questions* |
| Classroom applications | 1. What is the most beneficial role of the L1 in L2 classrooms?
2. Is the use of the L1 in an L2 classroom more or less effective for teaching word forms vs. meanings?
3. What is the optimal spacing of encounters with a word over the course of one or more semesters in a classroom?
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| Spaced repetition learning | 1. How is the optimal spacing of encounters with words influenced by word or learner characteristics?
2. Can adaptive learning approaches to determining optimal spacing be effective training tools?
3. Is the forward testing effect beneficial for learning L2 vocabulary, and do the predictions of the RHM-RER hold in the context of this effect?
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| Working memory and phonological knowledge | 1. Do individual differences in working memory impact the efficacy of spacing or other training methods?
2. Would training methods that aim to enhance phonological representations be successful tools for L2 vocabulary learning?
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| Cross-language approaches | 1. To what extent does the direction of translation (L1-L2 vs. L2-L1) affect the patterns of results that have been reported so far?
2. Do the predictions of the RHM-RER hold for non-alphabetic languages?
3. Would training methods that use cross-language overlap (e.g., cognate status, word-like-ness, phonological similarity) improve effectiveness of existing training methods?
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