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# The Role of Semantic Information in Episodic Retrieval

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In two experiments, subjects studied lists of categorized words and then were tested for recognition of those words. Response time for a test word was speeded whenever the immediately preceding test word was from the same category. This was true even for test words (lures) from categories never studied. Thus it is argued that semantic information not present at the time of study affected retrieval. This finding is discussed with respect to the distinction between episodic and semantic memories.

Episodic memory (memory for personal events) has often been distinguished from semantic memory (general world knowledge). In recent discussions of this distinction, Tulving (1983; 1984) has argued that the two kinds of memories have different properies, and that they represent either separate systems (1983) or, in his 1984 treatment, one system (episodic) embedded in the other (semantic). In support of the episodic/semantic distinction, he cites both experimental and neurological evidence. In general, this evidence takes the form of findings that show a dissociation between the effect of a variable in a semantic task and the effect of the variable in an episodic task. Tulving's (1983) position has been criticized in a variety of ways by a number of people (e.g., Baddeley, 1984; Hintzman, 1984; McKoon, Ratcliff, & Dell, 1985; Roediger, 1984). We will not review these criticisms here, but instead will focus on an issue that is central to any characterization of the episodic/semantic distinction, the role of semantic information in the retrieval of episodic memories.

Semantic information could affect the retrieval of episodic information in different ways. One way would be if semantic information was included in an episodic trace at the time of encoding. Then the semantic information would be part of the trace and so could affect retrieval of the trace. This effect would be expected whether episodic and semantic were viewed as separate memory systems or as different kinds of information in a single system. With respect to the semantic/episodic distinction, the important question is whether semantic information not included in an episodic trace at the time of encoding can affect retrieval of the trace. This question has been addressed directly and answered in the negative by Herrmann and Harwood (1980).

Subjects in Herrmann and Harwood's (1980) experiment studied lists of categorized words, and then were presented with pairs of words for a recognition test (responding *old* if both words had been studied, *new* if neither had been studied, and *mixed* for one old and one new word). The key results were those for pairs in which neither word had been studied. When other members of the categories had been studied, response times were faster if the two words were related, (i.e., from the same category) than if they were unrelated (i.e., from different categories). But when other members of the categories had not been studied, response times for related and unrelated word pairs were equal. Herrmann and Harwood (1980) and Tulving (1983) interpreted these results by saying that the category membership variable had an effect when it was defined episodically (by presenting other category members for study) but not when it was defined semantically (no other category members presented for study). Thus, this dissociation was

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Table 1
*Experimental Conditions and Results of Experiment 1*

| Condition | Study condition | Type of response | Response time | Proportion of errors |
|---|---|---|---|---|
| 1 | prime: category studied<br>target: related, category studied | yes<br>yes | 708 | .05 |
| 2 | prime: category studied<br>target: unrelated, category studied | yes<br>yes | 849 | .08 |
| 3 | prime: category studied<br>target: related, category studied | no<br>no | 868 | .13 |
| 4 | prime: category studied<br>target: unrelated, category studied | no<br>no | 1016 | .16 |
| 5 | prime: category not studied<br>target: unrelated, category studied | no<br>no | 884 | .22 |
| 6 | prime: category not studied<br>target: related, category not studied | no<br>no | 664 | .00 |
| 7 | prime: category not studied<br>target: unrelated, category not studied | no<br>no | 732 | .00 |

*Note.* Response time is in milliseconds and errors are shown as proportions. A related target is a target from the same category as the prime; an unrelated target is from a different category.

support for the separation of episodic and semantic memory systems.

However, it may be that the effect of semantic information on episodic retrieval can be observed, even when the episodic information was not encoded during study, by using procedures different from Herrmann and Harwood's (1980). If such an effect can be demonstrated, it would constrain theorizing about the episodic/semantic distinction. Herrmann and Harwood's results are consistent with a view of episodic retrieval in which unencoded semantic information is bypassed. If there exist some circumstances under which unencoded semantic information does affect episodic retrieval, then the idea that episodic memory is a separate system (Tulving's 1983 position) becomes less tenable. The claim that episodic memory is embedded in semantic memory (Tulving's 1984 position) would not be so clearly challenged, but such a finding would, nevertheless, need to be accommodated.

Subjects in both of the experiments in this article received a series of study–test lists. In the study phase of each list, subjects were shown four words from each of three categories. In the test phase, single words were presented for recognition; subjects responded *yes* for words that had appeared in the study list and *no* for words that had not. The conditions of the experiments (shown in Tables 1 and 2) were defined by sequentially presented prime and target words in the test list. The prime was either related to the target (i.e., from the same category) or unrelated to the target (i.e., from a different category), the prime and target either did or did not appear in the study list, and other members of their categories did or did not appear in the study list. For example, in Table 1, Condition 4, the prime word itself had not been studied but other members of its category had been studied. The target was unrelated to the prime and it had not been studied, but other members of its category had been studied. So, if the category of animals had been studied, but not the word *horse,* and the category of sports had not been studied at all, the prime–target sequence of *horse* followed by *baseball* would exemplify Condition 4.

The conditions of particular interest were Conditions 6 and 7. In these conditions, the prime and target categories did not appear in the study list and so semantic information about these categories should not be encoded. Obtaining an effect of category membership in these conditions, that is, finding that re-

sponses in Condition 6 were faster than in Condition 7, would demonstrate that semantic information could affect recognition, even when the semantic information was not encoded during study.

## Experiment 1

### *Method*

*Subjects.* There were 12 subjects who participated in the experiment for extra credit in an introductory psychology course.

*Materials.* Sixty categories were used for the experimental design (the categories in Battig & Montague, 1969, plus four other categories). The seven most frequently given words in each category were chosen with the exception that no word could be used more than once. There were also 10 other categories (made up by the experimenters) with four words each that were used for fillers in the study and test lists, and there were 80 words (that did not appear in any of the categories) that were used for negative filler items in the test lists. These negative fillers were not chosen from categories, but they did not differ in any obvious characteristics from the category members.

*Procedure and design.* Stimuli and test words were displayed and responses were collected on a CRT terminal and keyboard connected to a microcomputer that was controlled by the Dartmouth Time-Sharing System.

A study–test procedure was used. There were 10 trials preceded by 2 practice trials; an example trial is shown in Appendix A. In the study phase of each trial, three categories were presented. First, the category name of the first category was displayed for 2 s, then four members of that category were displayed one at a time for 1.5 s each. Next the category names and members of the second and third categories were presented in the same way. The last member of the third category was followed by a row of asterisks (2 s) to signal the beginning of the test list. There were 27 words in the test list; for each one, the subject was to decide as quickly and accurately as possible whether it had appeared in the study list ("/" on the CRT keyboard for *yes*, "Z" for *no*). There were 9 positive words (words for which the correct response was *yes*) and 18 negative words. Each word was displayed on the screen until the subject made a response; then, after a 150-ms pause, the next test word was presented.

For each study–test list (not including the practice lists), six categories were chosen randomly (without replacement) from the set of 60. Two of these categories plus one of the filler categories were used in the study list. In each test list, each of the seven conditions of the experiment was represented once. These conditions are shown in Table 1. The response of interest in each condition is the response to the target word; the prime is the word that immediately preceded the target in the test list. For a given test list, all seven conditions were made up from the six categories chosen for that study–test list. Words from the two categories that had appeared in the study list were used for positive conditions (Conditions 1 and 2) and for the conditions in which the category but not the word had appeared in the study list (Conditions 3, 4, and 5). Of the other four categories (not appearing in the study list), a word from one was used in Condition 5, two words from the second were used in Condition 6, a word from the third was used as the prime in Condition 7, and a word from the fourth was used as the target in Condition 7. The test list was constructed by placing the seven prime–target pairs (4 positive words and 10 negative words) in randomly chosen sequential positions (except not in Positions 1 and 2) and then filling the remaining positions with filler words. There were 5 positive filler words from the words presented in the study list, and 8 negative words that were not members of any of the categories used in the experiment. Restrictions on construction of the test list were that no word could be used more than once, and that one member of a category could not precede another member of the same category by fewer than three test positions, except where required by Conditions 1, 3, and 6. The six assignments of categories to conditions were combined with six sets of categories (10 per set) and six groups of subjects (2 per group) in a Latin-square design. Order of presentation of materials and assignment of words in categories to conditions were randomized after every second subject.

### *Results and Discussion*

Only correct responses to targets preceded by correct responses to primes were included in the analyses in order to be as sure as possible that both studied priming and studied target words were in memory. This procedure eliminates responses in which there were errors on targets (percentages shown in Table 1) and an additional number of responses in which there were errors on the prime and not the target (less than 4%, not varying across conditions). Means were calculated for each subject in each condition and means of these means are displayed in Table 1. Three analyses of variance were performed on these means, one on the positive conditions (Conditions 1 and 2), one on the negative conditions in which the tested categories had not been studied (Conditions 6 and 7), and one on the negative conditions in which the categories had been studied (Conditions 3, 4, and 5). The error terms of these analyses reflect the nonreplicability of treatment effects over both subjects and words because every second subject received a different assignment of words to conditions. The average standard error of the response time means was 31 ms.

For positive words, there is a clear priming effect. Responses in Condition 1, where the prime and target words were related, were 141 ms faster than responses in Condition 2, where the prime and target were unrelated, $F(1, 11) = 32.5$, $p < .001$. The difference in error rates approached significance, $F(1, 11) = 4.1$, $p = .065$.

Conditions 6 and 7 also show a priming effect. In these conditions, neither the tested words nor their categories were studied. In Condition 6, where the prime and target were related, responses were 68 ms faster than in Condition 7, where the prime and target were unrelated, $F(1, 11) = 7.9$, $p < .02$.

In Condition 3 the prime and target words were related, and, although neither word had been studied, the category had been studied. Responses in this condition were faster or more accurate than in Conditions 4 and 5. In Condition 4 the prime and target words were unrelated, but, as in Condition 3, only the categories and not the prime or target words had been studied. Responses were 148 ms slower than in Condition 3. In Condition 5, neither the prime word nor its category had been studied. For the target words, the category but not the word had been studied. Responses were less accurate than in Condition 3.

Analysis of variance showed significant differences in response times for Conditions 3, 4, and 5, $F(2, 22) = 6.7$, $p < .01$. Response times in Condition 5 were faster than in Condition 4, $F(1, 22) = 8.8$, $p < .01$. Similar analyses on error rates showed that the difference in Conditions 3, 4, and 5 did not reach significance, $F(2, 22) = 1.4$.

In conclusion the results of Experiment 1 show a priming effect for words that were not themselves studied nor were their categories studied. However, there is a problem with interpreting this result, and, that is, it could reflect an uninteresting strategy adopted by subjects. Subjects could have decided to give the same response to the second item tested from a category as to the first item tested from the category (when the two items appeared immediately one after the other in the test list). This strategy would lead to correct responses and would lead to the priming effects observed in Conditions 6 and 7 and in Conditions 1 and 2. Although this strategy is somewhat unlikely, a second experiment was designed to replicate the main findings of Experiment 1 in a situation where the strategy could not be applied.

## Experiment 2

Experiment 2 included many of the same conditions as Experiment 1, in particular, priming conditions in which neither the test word nor its category were studied. But there were also conditions in which two words from the same category appeared sequentially in the test list and required different responses. Thus, subjects could not use a strategy of giving the same response to two consecutive test words from the same category. The conditions are shown in Table 2.

### *Method*

*Subjects.* Thirty subjects participated in the experiment to fulfill a requirement in an introductory psychology course.

*Materials.* The same materials were used as in Experiment 1, except that the filler categories were not used.

*Procedure and design.* All stimuli and test words were displayed, and responses were collected on a CRT terminal and keyboard connected to a microcomputer that was controlled by an APPLE computer.

The study–test procedure was almost identical to that used in Experiment 1. The only differences were that 28 words in each test list were used (12 positive and 16 negative) instead of 27 and that every time the subject made an incorrect response, the word ERROR was presented for 2 s before the next test word. An example trial is shown in Appendix B.

For each study–test list (not including the practice lists), 6 categories were chosen randomly (without replacement) from the set of 60. Three of these were used in the study list. In each test list, each of the 10 conditions of the experiment (shown in Table 2) was represented once. The 6 categories were used to make up the 10 conditions in the following way: Words from the 3 categories presented in the study list were used for the positive conditions (1 and 2) and for all the conditions in which, for either the prime or target or both, either the category or the word and its category had been studied. Words from the 3 categories not studied were used for Conditions 5 and 6; one of these categories was used for Condition 5, one for the prime of Condition 6, and one for the target of Condition 6. The test list was constructed by placing the 10 prime–target pairs (8 positive words and 12 negative words) in randomly chosen sequential positions (except not Positions 1 and 2) and then filling the remaining positions with filler words. There were four positive fillers and four negative fillers (words not from any category used in the experiment). Restrictions on construction of the test list were that no word could be used more than once and that a member of a category could not be placed either immediately before or after another member of the same category, except as required by the experimental conditions. The six assignments of categories to conditions were combined with six sets of categories (10 per set) and six groups of subjects (5 per group) in a Latin-square design. Order of presentation of materials and assignment of words in categories to conditions was randomized after every second subject.

### *Results*

As in Experiment 1, only correct responses preceded by correct responses were included

in the analyses (eliminating less than 4% of responses due to errors on the prime), and means were calculated for each subject in each condition. Means of these means are displayed in Table 2, with the results of analyses of variance and standard errors. Separate analyses were performed for each pair of conditions (same versus different category of prime and target) because variance differed across conditions.

Table 2
*Experimental Conditions and Results of Experiment 2*

| Condition | Study condition | Type of response | Response time | Proportion of errors |
|---|---|---|---|---|
| 1 | Prime: category studied | yes | | |
| | Target: related, category studied | yes | 633 | .07 |
| 2 | Prime: category studied | yes | | |
| | Target: unrelated, category studied | yes | 747 | .11 |
| Condition 1 vs. Condition 2: | $F(1, 29)$ | | | |
| | RT: 13.4* SE: 22 E: 11.6* | | | |
| 3 | Prime: category studied | no | | |
| | Target: related, category studied | no | 740 | .07 |
| 4 | Prime: category studied | no | | |
| | Target: unrelated, category studied | no | 845 | .12 |
| Condition 3 vs. Condition 4: | $F(1, 29)$ | | | |
| | RT: 5.0* SE: 33 E: 1.2* | | | |
| 5 | Prime: category not studied | no | | |
| | Target: related, category not studied | no | 615 | .02 |
| 6 | Prime: category not studied | no | | |
| | Target: unrelated, category not studied | no | 651 | .00 |
| Condition 5 vs. Condition 6: | $F(1, 29)$ | | | |
| | RT: 19.9* SE: 6 E: 1.3 | | | |
| 7 | Prime: category studied | no | | |
| | Target: related, category studied | yes | 659 | .06 |
| 8 | Prime: category studied | no | | |
| | Target: unrelated, category studied | yes | 771 | .13 |
| Condition 7 vs. Condition 8: | $F(1, 29)$ | | | |
| | RT: 17.6* SE: 19 E: 5.7* | | | |
| 9 | Prime: category studied | yes | | |
| | Target: related, category studied | no | 745 | .10 |
| 10 | Prime: category studied | yes | | |
| | Target: unrelated, category studied | no | 783 | .12 |
| Condition 9 vs. Condition 10: | $F(1, 29)$ | | | |
| | RT: 4.8* SE: 12 E: <1 | | | |

*Note.* Response times and *SE*s are shown in milliseconds. RT = response times; E = errors; *SE* = standard error of response times.
* $p < .05$.

As can be seen in Table 2, for every pair of conditions, response time for the target was significantly faster when the prime was related to the target than when it was not. For all conditions which appeared in both experiments, the results of Experiment 2 replicated those of Experiment 1. (Conditions 1, 2, 3, 4, 6, and 7 of Experiment 1 correspond to Conditions 1–6 of Experiment 2, respectively.)

For filler positive words (including priming words), response times averaged 724 ms with 13% errors. For filler negatives from studied categories, response times averaged 863 ms with 12% errors. For filler negatives that were not from any categories used in the experiment, corresponding figures were 716 ms and 1%. (The corresponding filler data for Experiment 1 are not available.)

## Discussion

The purpose of Experiments 1 and 2 was to show that semantic information could affect performance in recognition, even when the information was not encoded during study. This was accomplished because it was found that the response for a *new* test word was speeded when the immediately preceding test word was from the same category, even when the category was not represented in the study list.

The results of the experiments have implications both for the issue of whether episodic and semantic memories are separate systems and for the study of recognition processes. With respect to recognition processes, it is noteworthy that priming was found in every condition in Experiment 2. No matter what the sequence of responses (*yes–yes, no–yes, no–no, yes–no*), the second response was faster when both words were from the same category. One way to account for this priming would be to attribute it to lexical access processes, the kind of processes that are defined as giving priming in lexical decision. To test this account, a subset of the category words was used in a lexical decision experiment (otherwise unrelated to the current experiments). Priming was obtained in the experiment with words related to each other either because they were high associates (e.g., *green–grass*) or because they had just been learned as a pair (e.g., *city–grass*). But the words related to each other by category membership did not prime each other (mean response times were 670 ms in the priming condition and 669 ms in the control condition). So, the facilitation due to shared category membership found in the experiments in this article cannot be due to simple lexical priming.

Another way to explain why the priming obtained in Experiment 2 was independent of response sequence effects is to suppose that category membership aids in discriminating studied words from nonstudied words. When the prime and the target words come from the same category but neither their category nor they themselves were studied, then a decision for the prime that nothing in the category was studied could aid a decision about the target. For example, if a decision that *horse* (a prime) was not studied involves the information that the category animals was not studied, then an immediately following decision about *dog* (a target) could be facilitated. When the prime and target come from the same category and it was studied, then a decision about whether the prime was one of the words of the category in the study list could aid the same decision about the target, whatever their respective responses. So if the category animals was studied, then a decision (positive or negative) about a prime, *horse,* could involve the category information and thus aid a decision (positive or negative) about the target, *dog.*

It should be noted that this explanation, and the results of Experiment 2, contrast with other findings in recognition in which the similarity of negative items to studied items adversely affects recognition performance. For example, a negative response to a synonym of a studied word is slower and/or less accurate than responses to other, control words (Atkinson, Herrmann, & Wescourt, 1974). The results of the current experiments also contrast with situations in which semantic relationships give inhibition in responding to targets. In the current experiments, the semantic relationship of category membership led to facilitation. But when the semantic relationship is simply high association value (e.g., bed–sleep), inhibition has been obtained (cf. McKoon & Ratcliff, 1979; Neely & Durgunoglu, 1985). It may be that category membership can aid in recognition but other, more item-specific relations cannot, because category membership information is more easily available as part of the kind of "global list context" (Neely, Schmidt,

& Roediger, 1983) that might be used in recognition judgments.

The results of Experiments 1 and 2 can be compared with previous results obtained by Neely et al. (1983) and by Herrmann and Harwood (1980). The experiments conducted by Neely et al. contained many of the same conditions as the experiments in this article, although their experiments did not contain the conditions of particular interest here, the conditions in which neither the prime nor target items nor their categories were studied. However, for those conditions that were the same, the current results replicated theirs in that response times for related targets were faster than response times for unrelated targets. These were all the conditions in which the categories of the prime and target were studied, including the conditions in which responses to prime and target were both *yes,* both *no,* or mixed.

The results of Experiments 1 and 2 differ from results obtained by Herrmann and Harwood (1980). In their experiments, no priming was obtained for a tested word if its category had not been studied, and no priming was obtained in the "mixed" condition (one word studied, the other word not studied). The reason for the differences between our results and theirs may be that experimental procedures were different. For example, in Herrmann and Harwood's experiments, study lists were memorized before the experiments began, and test words were presented in pairs so that each response required two decisions. Another reason might be that, when neither a word nor its category had been studied, the priming effects observed in the current experiments were small (36 ms in Experiment 2), too small to be detectable with Herrmann and Harwood's procedure in which the standard error was about 53 ms in one experiment and about 80 ms in another experiment. For the mixed condition, Neely et al., 1983) also obtained results that differed from Herrmann and Harwood's; as just mentioned, Neely et al. found priming in this condition. Thus it is not inconceivable that Herrmann and Harwood's negative results stemmed from a lack of power to detect small priming effects. Whether this is the reason for differences in the experimental results or whether the reason is differences in procedures, the results present a challenge for a dual store view. At a specific level, the problem is that Tulving (1983) has used the finding that semantic information does not affect episodic retrieval as support for a separation of the two memory systems. But now, in order to continue to use this finding as support, there must be an explanation of why semantic information sometimes does (Experiments 1 and 2) and sometimes does not (Herrmann & Harwood, 1980) affect episodic retrieval.

At a general level, the problem is more serious. In support of the separation of episodic and semantic memory systems, Tulving (1983) has cited a wide-range of kinds of evidence. But for almost every piece of evidence, whether experimental or neuropsychological, it is possible to find counterevidence (McKoon, Ratcliff, & Dell, 1985). The present experiments are a case in point; Herrmann and Harwood (1980) obtained a dissociation, we did not. Logically, there are several directions in which the argument might proceed in this situation. One would be to argue that only differences between the two memory systems are crucial; similarities between them would, of course, be expected even according to a dual-store view. So failure to find a particular dissociation (as in Experiments 1 and 2) is not critical, so long as some dissociation (or other kind of evidence) remains. The burden would be on the single-store theorist to counter every single piece of evidence that could be taken to support the dual-store view. We could, then, look forward to a long series of articles like the present one and others that have been published in the 12 years since the episodic/semantic distinction first claimed our attention (Tulving, 1972).

Instead, we argue that searching for evidence that favors or disfavors the episodic/semantic distinction will be problematic as long as there are no principles to guide the selection of which evidence does and which evidence does not address the distinction. For example, there are no principles to explain why the semantic relationship of category membership gives facilitation in recognition in our experiments but not in Herrmann and Harwood's, or to explain why one semantic relationship, category membership, can give facilitation but another semantic relationship, associative strength, gives inhibition (McKoon & Ratcliff, 1979; Neely & Durgunoglu, 1985). In the absence of theoretical principles that are more specific than are now available, we see no way in which

the status of the episodic/semantic distinction can be clarified.

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## Appendix A

### An Example of a Trial From Experiment 1

Press space bar to begin trial.
A Four-Footed Animal
dog
cow
horse
tiger
A Part of Speech
adverb
adjective
noun
verb
A Direction
east
west
north
south
**********

| | | | |
|---|---|---|---|
| east | yes | | |
| noun | yes | | |
| horse | yes | category studied | |
| cow | yes | category studied | Condition 1 |
| kingdom | no | | |
| water | no | category not studied | |
| juice | no | category not studied | Condition 6 |

| | | | |
|---|---|---|---|
| picture | no | | |
| pronoun | no | category studied | |
| elephant | no | category studied | Condition 4 |
| compass | no | | |
| north | yes | | |
| cat | no | category studied | |
| lion | no | category studied | Condition 3 |
| feather | no | | |
| admiral | no | category not studied | |
| hammer | no | category not studied | Condition 7 |
| tiger | yes | | |
| dog | yes | category studied | |
| adjective | yes | category studied | Condition 2 |
| sheriff | no | | |
| village | no | | |
| potato | no | category not studied | |
| preposition | no | category studied | Condition 5 |
| verb | yes | | |
| arrow | no | | |
| twilight | no | | |

## Appendix B

## An Example of a Trial From Experiment 2

Press space bar to begin trial.
A Religious Building
  church
  chapel
  temple
  cathedral
A Fish
  trout
  tuna
  herring
  salmon
A Precious Stone
  pearl
  diamond
  ruby
  emerald
**********

| | | | |
|---|---|---|---|
| nation | no | | |
| cathedral | yes | | |
| year | no | category not studied | |
| month | no | category not studied | Condition 5 |
| emerald | yes | | |
| herring | yes | category studied | |
| tuna | yes | category studied | Condition 1 |
| soldier | no | | |
| mosque | no | category studied | |
| catfish | no | category studied | Condition 4 |
| chapel | yes | category studied | |
| pearl | yes | category studied | Condition 2 |

| | | | |
|---|---|---|---|
| hero | no | | |
| ruby | yes | category studied | |
| jade | no | category studied | Condition 9 |
| tabernacle | no | category studied | |
| salmon | yes | category studied | Condition 8 |
| lumber | no | | |
| opal | no | category studied | |
| sapphire | no | category studied | Condition 3 |
| trout | yes | | |
| avenue | no | category not studied | |
| maple | no | category not studied | Condition 6 |
| synagogue | no | category studied | |
| temple | yes | category studied | Condition 7 |
| church | yes | | |
| diamond | yes | category studied | |
| goldfish | no | category studied | Condition 10 |

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