Effect of Picture Similarity on Recognition Memory

Thesis
Under certain conditions, the typical test-item similarity effect should be reversed. Specifically, when distracters are very similar to pictures seen earlier in the study, but are not used as target pictures in the memory test, a positive relation between similarity and accuracy should result. The similarity of distracters to the information stored from the study must be very high in order to observe this positive correlation. Additionally, a negative correlation between accuracy and confidence in A-A' versus A-B' should occur.

Introduction
Recognition memory has been studied for decades and the notion that similarity plays a critical role in recognition memory is widely accepted. Logic would suggest that the more similar the study and test items are, the harder it would be to discern a difference between the two. For example, if given two pairs of pictures—two pictures of the ocean vs. a picture of a car and a picture of a pencil—it should be easier to discern the difference between the car and pencil.

The results of many experiments have suggested that the accuracy of recognition memory is inversely related to the similarity between old and new test items. In other words, as similarity increases, accuracy decreases. So in theory, a recognition test is made more difficult by making the distracter pictures very similar to the target pictures. However Tulving (1981) asserts a contrary theory. He proposes that under certain conditions, recognition accuracy has a *direct* and *positive* relation to picture similarity.

Tulving (1981) carried out two experiments. In experiment 1, subjects studied a series of pictures and used a two-alternative forced-choice recognition test, and compared performance in three test conditions: distracter is similar to target picture (A-A'), distracter is dissimilar to target, but similar to other previously studied pictures (A-B') and distracter is dissimilar to both target and other study pictures (A-X').

Tulving's stimuli consisted of pictures that appeared on two adjacent pages in a magazine, where A' is the other half of the target picture, B' is a picture seen in the study list and X' is a picture that has never been seen before. Similarity between study items and test items was manipulated by pairing different combinations of these picture types. Additionally, participants gave a confidence rating on a three point scale, resulting in six confidence judgment categories (3 old and 3 new).

Tulving (1981) hypothesized that accuracy in condition 3 (A-X') would yield the best performance, and there would be no difference in accuracy between condition 1 (A-A') and condition 2 (A-B'). The results indicated that hit rate was highest for A-X' which shows an inverse relation between similarity and accuracy (as was found in previous studies). These results support the hypothesis. Surprisingly, however, hit rates were higher for A-A' than A-B' across all participants. These results counter the hypothesis that there would be no difference in accuracy between A-A' and A-B'. This data opposes the usual test-item similarity effect by showing a positive relation between similarity and accuracy.

Previous studies have shown a positive correlation between confidence and accuracy. When comparing confidence ratings in A-A' versus A-X' Tulving's (1981) data also showed a positive correlation. So participants were more confident when the distracter was dissimilar from the target. However, upon examination of A-A' versus A-B' a negative correlation was found between confidence and accuracy. Therefore, although participants had a higher hit rate in A-A', they were more confident about their answers in A-B'.

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A post hoc analysis defined ecphoric similarity as the similarity between a test picture and the stored memory of that item. Ecphoric similarity is high in A-A' and A-B' and low in A-X'. Perceptual similarity was defined as the similarity between test pictures in a set (a test pair). Perceptual similarity is high in A-A' and low in A-B' and A-X'. The purpose of the post hoc analysis was to examine the relation between accuracy and ecphoric similarity of distracters in A-A' and A-B'. The results indicate that the similarity between test-item stimuli must be very high in order to observe the reversal to a direct correlation between similarity and accuracy.

Experiment 2 tested the relationship between 4 test conditions: A-A', A-A", A-B' and A-B". In this notation, single primes indicate high ecphoric similarity of distractors and double primes indicate medium ecphoric similarity. Condition A-X' was removed since it is obvious that performance in this condition will always be highest. Tulving (1981) wondered if a direct correlation between similarity and accuracy could again be seen when ecphoric similarity of distracters is high and if there would be a negative correlation when ecphoric similarity is medium.

Judges rated the pictures for perceptual similarity on a five-point scale. Half of the pictures were assigned to the high similarity group (A-A', A-B') and half to the low similarity group (A-A", A-B"). The results showed that the difference in hit rates in A-A" versus A-B" was not statistically significant. These findings support the usual inverse relation between similarity and accuracy when ecphoric similarity is not high. When comparing hit rates in A-A' versus A-B', however, the reversal of the typical test-item similarity effect was upheld, as in Experiment 1. Therefore participants are more accurate when the pictures are more similar. Confidence distributions showed a negative correlation between accuracy and confidence in A-A' versus A-B', as in Experiment 1.

Under certain conditions, Tulving (1981) concluded, the typical test-item similarity effect is reversed. Specifically, this reversal can be seen when distracters are very similar to pictures seen earlier in the study, but are not used as target pictures in the memory test. Similarity of distracters to the information stored from the study must be very high in order to observe this positive correlation. Also, there is a negative correlation between accuracy and confidence in A-A' versus A-B'.

Possible explanations for these results are that A-A' may access one memory trace, whereas A-B' may access 2 memory traces. Therefore, A-A' would be more efficient. Another explanation could be that the common reference trace lets participants disregard features shared by the two pictures and instead focus on the features that distinguish one from the other. Or maybe the participant made a decision to engage more in the more similar conditions.

This experiment proposal will improve upon Tulving's experiments by continuously manipulating the similarity of stimuli by separating a single picture into six individual subsets. It would also be interesting to examine the effects of learning over an extended period of time, by paying participants to return many times over a prolonged period of time. With practice participants should become more familiar with the stimuli and should be able to discriminate between finer and finer detail changes. Another way to test this would be if we were to give participants more training (more blocks) in the currently experiment, then participants should be able to make finer and finer discriminations in the two-alternative forced-choice task. An additional idea that could easily be implemented in the proposed experiment would be if we generalize the two-alternative forced-choice task to an eight-alternative forced-choice task where the participant's task is to pick out the target from among 8 alternatives. (This situation is comparable to a lineup situation and allows many different conditions to be tested).

Objective

The purpose of my research is to examine the effects of picture similarity on recognition memory. Specifically, I will be improving on Tulving's (1981) experiments by continuously manipulating the similarity

of stimuli. This continual manipulation of similarity will allow me to make an enhanced assessment of the relationship between picture similarity and recognition memory performance.

Methods
Participants
UCI undergraduate students will be recruited on a voluntary basis from the Social Science Human Subjects Pool. Participants will be compensated with extra credit towards their course work.

Apparatus
The stimuli will consist of pictures that will be presented on a desktop personal computer equipped with Windows '98, a color monitor, and a standard keyboard. The specified keys that participants will use are "z", "x", "c", "b", "n" and "m".

Design
In this 2 x 8 factorial experiment, the independent variables of type (old/new) and similarity of alternatives to the study item (A1-A2/A1-A3/A1-A4/A1-A5/A1-B2/A1-B3/A1-B4/A1-B5) will be studied within subjects. Additionally, the A1-AX condition will be added as a control. The dependent measure will be accuracy, determined by percent correct on the recognition memory test.

To control for the buildup of confusion from prior blocks, a "Where's Waldo" cartoon will be inserted between blocks. The study and test trials will be randomized to counterbalance for order effects.

Procedure
There will be 4 blocks total, with blocks 1 and 3 being study blocks, and blocks 2 and 4 being test blocks. The study blocks will consist of 90 study pictures each, and the same 90 pictures will appear in both study blocks, but with a different random order. The test blocks will be comprised of 45 pictures and will test recognition memory performance in all 9 conditions. The conditions will be randomly ordered to counterbalance against order effects.

The difference in difficulty will be manipulated by breaking each picture into 6 subsections, with each subsection overlapping the last. The pictures will be broken up into subsections vertically, horizontally, and diagonally. Theoretically, it should be more difficult for the participant to discern the difference between two subsections that are close to each other (and thus very similar) and it should be easier to tell the difference between subsections that are farther from each other and have less overlap (and are dissimilar).

Participants will be given instructions to try to remember the pictures from the study trials. Then during the test trials, their task will be to identify which of the two pictures is old (previously seen in the study trial) or new. Confidence ratings will be collected when the participant presses the specially marked keys on the keyboard. The confidence ratings will be measured on a scale of 1-3 for a new picture and a scale of 1-3 for an old picture.

Prior Work Completed
I have been researching with Dr. Steyvers since winter quarter 2004, and we have done similar work to the proposed experiment.

Expected Results
When distracters are very similar to pictures seen earlier in the study, but are not used as target pictures in the memory test, a positive relation between similarity and accuracy should result. Additionally, a negative correlation between accuracy and confidence in A-A' versus A-B' should occur. Also with practice participants should become more familiar with the stimuli and should be able to discriminate between finer

and finer detail changes. Lastly, if the task were generalized to an eight-alternative forced-choice task, performance on the recognition memory task should decrease.

Student Responsibilities

Over the course of the summer, I will take responsibility for the following tasks:

--Meet with my faculty mentor at least once a week and communicate between meetings via email.

--Program the experiment in SuperLab Pro.

--Program additional randomizations of picture sequence to condition in SuperLab Pro.

--Recruit participants through the Social Science Human Subjects Pool.

--Reserve cubicles with computers to run participants in the experiment.

--Analyze the data and run tests for statistical significance.

--Analyze and interpret the results.

--Write a paper detailing a complete account of my research findings.

Timeline

The following is a weekly schedule of events:

--Week 1: Write program in SuperLab Pro.

--Week 2: Program additional randomizations of picture sequence to condition in SuperLab Pro.

--Week 3: Recruit participants, reserve cubicles, and begin running participants.

--Week 4: Begin data collection and data analysis while continuing to run participants in the experiment.

--Weeks 5, 6 & 7: Run participants in different randomizations of picture to condition and continue collecting and analyzing data.

--Week 8: Complete data analysis.

--Weeks 9 & 10: Write paper.

References

Tulving, E. (1981). Similarity relations in recognition. *Journal of Verbal Learning and Verbal Behavior, 20,* 479-496.