Levels of Processing: A Study of Retention under Three Conditions

NAME

Wofford College

DATE
Levels of Processing 2

Abstract

In the present study, researchers measured memory through a two-phase experiment. In the study phase, the subjects were asked to respond yes or no to a number of questions that fell into three conditions: physical (whether the given word has four letters); rhyming (do two words rhyme); and semantic condition (does a given word fit into the sentence). Accuracy and response time were the dependent variables. Accuracy in the study phase was the lowest for semantics condition and highest for rhyming and physical conditions, although each condition had accuracy rates above 95%. In the test phase, the subjects were given 180 words, one at a time, and asked to response yes or no to whether they had seen the word in the previous phase. Also, there were 60 new foil words that the subjects had never seen. Accuracy and response time were the dependent variables. The test showed that words that required a deeper level of processing (those that were in the semantics condition), were easily recalled in the test phase than other words. However, the new words had the highest accuracy rate.
Levels of Processing: A Study of Retention under Three Conditions

Memory is not a concrete variable and is not the same for every person, and therefore hard to measure and explain. The reasons why people remember certain things and cannot recall other information have been studied. A bigger research question is regarding the factors that influence memory. Craik and Tulving (1975) hypothesized that depth of processing is a main component of the durability of one’s memory. Depth of processing is defined by how information is encoded and how that changes how it is remembered. Craik and Tulving tested this in 10 experiments, each with a study phase and test phase. The objective was to determine if various types of encoding conditions would change retention. During the study phase, subjects were asked questions to induce word processing at a certain level. Accuracy of correctly answering the question, as well as the latency of response was measured. In the test phase, a memory test was conducted to see how well they remembered the words that appeared in the study phase. The first four experiments were similar; three to five different conditions were used (i.e. rhyming, capitalization, semantics) and results showed that deeper processing leads to better retention. The conditions that led to further processing were conditions that required fitting into a category or sentence (semantic processing). Craik and Tulving found that latency was not a factor that correlated with the retention rate. Subjects remembered words in the semantics condition better even though they were given as much time as they needed to answer all questions. Craik and Tulving also found in one of the experiments that when the subjects new the purpose of the study, results still remained consistent.

The present study examined levels of processing by manipulating the encoding of words at study in a physical, rhyming, and semantic condition. The independent variables were the three conditions and whether the correct response was “yes” or “no”; the dependent variables
were accuracy and time it took participants to respond to each question. The purpose of this study was to measure accuracy and response time during the study and test phase to determine what factors influence memory. It was hypothesized that the questions in the semantic condition would have less accurate results in the study phase than the physical condition, which would show to be most accurate. Similar results were predicted to occur for processing time. It was also predicted that the words that were in the semantics condition would be best remembered in the test phase. It was predicted that response time at test would have no effect on retention.

Methods

Participants

The participants in this study consisted of 30 students: 15 students from Experimental Psychology course at Wofford College, each of whom brought a friend to participate in the study as well. The class was not chosen randomly and no requirements were set for the friends the students chose. There were four men and twenty-four women in this study. (Note: Only 28 participants gave their demographics). The average age was $M = 19.71$, $SD = 1.36$. The mean GPA was $M = 3.16$, $SD = .47$. 2 subjects were receiving both a BA and BS degree; 11 were BA; 3 were BS; and 1 was undecided.

Materials

Participants took a memory test on one of two computers provided by the psychology department. They were given a sheet that provided step by step instructions on how to open the program and begin the test. The program was run on e-prime software. They also signed a consent form agreeing to participate.

Procedure
Before partaking in the experiment, each participant was asked to read and sign a consent form, which informed them of the purpose and benefits of the study as well as notifying them of the option to drop out at any time. They were also asked to fill out a demographics sheet, which asked for specifics about each participant consisting of: gender, age, ethnicity, year of graduation, type of degree, overall GPA, and participation in a formal athletic team. Then, they entered a designated lab room and asked to leave cell phones or any other possible distractions outside. No researchers were present while participants took the test. They logged on to the computers, opened up the e-prime software and began the test phase of the experiment. They read instructions that stated to press 1 if you agree and 2 if you disagree to the answer given about a certain question. The questions involved the physical, rhyming, and semantics. The physical questions asked if a word was 4 letters (“Does the following word have four letters?” “Brake”). Rhyming questions asked if the first word rhymed with the word that appeared second (“Does ball rhyme with the following word?” “Crawl”). Semantic questions involved choosing whether a word fit into a sentence (“The man _____ across the street.” “Ran”). The words used were the same group of words used in a study conducted by Craik and Tulving (1975). After the participants answered 60 questions, a surprise second test appeared that tested their memory. This was the test phase of the experiment. Words flashed on the computer screen one at a time and they were asked to recall if they had seen that word during the study phase. In both study and test phases, the word list was randomized for each participant; this included the order the words came in as well as which words appeared in which of the three question conditions. The order of the three conditions was randomized. There were 180 words: 60 were old words the participants had seen in the study phase and 120 new foil words. After each participant finished both phases, their results and demographics were put into an excel file. The
results consisted of the accuracy during both test and study phase, as well as the response time (of correct responses) during the study phase.

Results

Study Phase

The accuracy of the sentence condition during the study phase was significantly worse ($M = .96, SD = .05$) compared to the letter condition ($M = .98, SD = .03$) and the rhyming condition ($M = .98, SD = .03$), $F(2, 58) = 3.65, p = .03$. A paired t-test was conducted between the rhyming and sentence condition, $t(29) = 2.44, p < .05$. Processing time between each condition was statistically significant, with rhyming taking the fastest ($M = 1387.30 \text{ms}, SE = 52.66$) and sentence taking the most time ($M = 1730.09, SE = 63.41$). The letter condition fell in the middle ($M = 1536.82, SE = 103.52$), $F(2, 58) = 9.88, p < .001$ (see figure 2). The processing time between correct responses in yes questions ($M = 1445.68$, $SE = 60.80$) and no questions ($M = 1657.13$, $SE = 72.50$) appeared to be significant, $F(2, 58) = 17.68, p < .001$. A paired t-test was conducted between the sentence condition and the other two conditions: sentence and letter, $t(29) = -2.19, p < .05$; sentence and rhyming, $t(29) = -7.64, p < .001$. The pattern of processing time for yes and no responses appeared to not have a significant difference between the conditions, $F(2, 58) = 1.22, p = \text{ns}$. 

Test Phase

The new words presented at test were most accurately recognized by subjects ($M = .84$, $SD = .14$), then the sentence condition ($M = .75$, $SD = .18$), then rhyming ($M = .58$, $SD = .18$), and the least accurate was the letter condition ($M = .47$, $SD = .18$), $t(29) = 2.97, p < .01$ (see figure 1). A 3 x 2 repeated-measures ANOVA was conducted on accuracy of condition (3 levels) and correct response (2 levels), the main effect of each condition was significant, $F(2, 58) = $
Levels of Processing

37.42, \( p < .001 \). The means were also significantly different between correct responses of yes (57%) and no (62%) questions, \( F(1, 29) = 4.28, p < .05 \). However, there was no significant interaction between accuracy of correct responses between the three conditions, \( F(2, 50) = 2.32, p = \text{ns} \). The response times between the four test phase conditions were not significantly different from each other, \( F(3, 84) = 1.22, p = \text{ns} \).

Discussion

In the present experiment, levels of processing were measured through three conditions: physical (does the word have four letters), rhyming (do two words rhyme) and semantics (does a word fit into a sentence). Independent variables were condition and correct response (at study). Dependent variables included accuracy in their responses as well as response/processing time at study and test phase. This experiment had similar results that the previous study by Craik and Tulving (1975) found. Similar methods were used in measuring levels of processing. Conditions showed different results for accuracy and response time, further supporting the claim that depth of retention was found to be correlated with how deep the subjects processed the word or idea. For example, a subject was shown a random, abstract picture and was asked to draw it after the image was taken away. This task would be much easier if the subject related the image to something else (the bottom corner looks like an elephant’s trunk). This was a deeper level of processing than just glancing at the picture.

Study Phase

The results in the study phase were consistent with the hypotheses: Accuracy in the semantic condition was worse than the accuracy in the physical or rhyming conditions. This result was expected because the questions were harder. Researchers were interested in the ceiling effect occurring in this phase of the experiment. Although each condition showed high scores of
accuracy (all greater than 95%), a significant difference still existed. Also expected were the differences in processing time for each condition. The results were consistent; more time was needed for the semantic questions than the rhyming or physical conditions. There was no significant difference of accuracy for yes and no questions between all three conditions. The likelihood on getting a “yes” question wrong and getting a “no” question wrong was consistent in all three conditions. This was expected as well. Although the processing time between the two types of answers had a significant difference, the accuracy is getting a “yes” or “no” question right was not affected by the condition.

*Test Phase*

In the test phase of the experiment, the condition that was most accurate was the new condition, which included foil words that did not appear in the study phase. High levels of accuracy were found for words that appeared in the semantic condition compared to a lower accuracy for the physical and rhyming conditions, but each were significantly different from each other. This was consistent with the hypothesis. For students trying to memorize vocabulary for an exam, putting the word in a sentence or relating the word with their own knowledge will result in better memorization of the word, a better grade on a test, or the ability to use that word in daily conversation. A significant difference was found between ‘yes’ and ‘no’ responses where more ‘no’ responses were remembered than ‘yes’.

In future experiments studying memory and encoding processing, setting several conditions seems to be a successful way in measuring retention. However, other independent variables can be considered. Does retention differ between males and females? Do people from different socioeconomic statuses require different levels of processing to remember things? In another study, Rose, Myerson, Roediger, and Hale (2010) conducted an experiment comparing
people’s working memory (WM) and their long-term memory (LTM). They presented the subjects with a list of “to-be-remembered” target words with each target word followed by two other words. Depending on the condition, the subjects were to decide whether the word was the same color as the target word, rhymed with the target word, or was semantically related to the target word. After this process was repeated, the subjects were asked to recall the target words in order. The main question was if the semantic condition, which required deeper processing, would provide a greater benefit to the WM. Results showed that LOP manipulation did not greatly impact WM performance. After a 5-10 minute delay, it was discovered that performing the immediate recall tests resulted in better delayed recognition. Memory can be measured and assessed in numerous ways and researchers are continuing to find further evidence towards the benefit of deep levels of processing.
References


Figure 1.

Accuracy

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>letter</td>
<td>0.55 ± 0.05</td>
</tr>
<tr>
<td>rhyme</td>
<td>0.63 ± 0.05</td>
</tr>
<tr>
<td>sentence</td>
<td>0.78 ± 0.05</td>
</tr>
</tbody>
</table>

- yes
- no