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The Effects of Levels of Processing on Word Recall

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Abstract

The effects of levels of processing on word recall were tested by measuring the number of words recalled after orthographic, phonological, and semantic processing. Psychology undergraduates at the University of Texas at Austin were shown three sets of words and asked questions to facilitate orthographic, phonological, or semantic information processing. After a distracter task, they were asked to free recall as many words as possible. The mean number of words recalled after phonological processing was significantly greater than after orthographic processing, and the mean number of words recalled after semantic processing was significantly greater than after orthographic and phonological processing. These findings suggest that deeper levels of processing contribute to increased word recall.

Keywords: levels of processing, word recall, explicit memory, semantic

The Effects of Levels of Processing on Free Recall

Most cognitive models agree on four assumptions of human information processing capabilities—limited capacity, control mechanism, two-way flow, and genetic predisposition. The mental system has limited processing capacity, a large portion of which must be devoted to an executive "control mechanism." It must also simultaneously process information gathered through the senses and information already stored in memory. Lastly, all humans are born with a genetic predisposition to certain cognitive structures. We are interested in whether deeper levels of processing cause an increase in word recall.

Craik & Lockhart (1972) rejected distinctions between sensory, short-term, and long-term memory, stressing that memory is simply a product of depth of processing. Perception exists as a continuum from shallow processing, which consists of preliminary analysis of physical or sensory features, to deep processing, which requires matching input against stored information and creating semantic connections between the two. This often called "depth of processing" or "levels of processing" (Craik & Lockhart, 1972).

According to Craik & Lockhart (1972), deeper levels of processing contribute to stronger trace persistence. Rehearsal or repetition of information prolongs accessibility but does not make it easier to recall information after processing has stopped. Once attention is diverted, information will be lost, more slowly for deeper levels of processing because of the degree of stimulus elaboration (Craik & Lockhart, 1972).

This occurs because the mental system is primarily concerned with the meaning of a stimulus, so it is more beneficial to store information that has undergone deep processing than information that has undergone shallow processing—the latter does not require elaboration to

strengthen meaning. Furthermore, existing cognitive structures allow the mental system to process a greater quantity of information more easily (Craik & Lockhart, 1972).

In the present study, we manipulated the level of processing (phonological, orthographic, or semantic) of a series of words by asking participants to answer specific questions that facilitate each level of processing. We studied how deeper level of processing affects total word recall through a free recall task.

We have suggested that there is a strong correlation between depth of processing and greater word retention, so semantic processing, which requires deeper analysis and elaboration, will contribute to greater word recall than phonological and orthographic processing, which require only preliminary analysis.

Method

Participants

Twenty-five students (16 women, 9 men, *M* age = 22.11 years, age range: 18-55 years) in a Statistics and Research Design course at the University of Texas at Austin received partial course credit for their participation but were given the option of declining without penalty. All participants were capable of seeing and reading the words presented during the study.

Design

The present study used a one-way within subjects design with three levels—orthographic, phonological, and semantic processing. The independent variable was the level of processing of three sets of words by the participants. The dependent variable was the total number of words recalled for each level.

Materials

Seventy-two nouns chosen from category norms standardized by Battig & Montague (1969) were block randomized using three different lists of 24 words (x, y, and z). Three sections of 24 words were randomly chosen without replacement from these lists, with eight words coming from list x, eight from y, and eight from z. In each section, every word was randomly assigned a letter (A, B, or C) until there were eight of each letter. The words were arranged in a Microsoft PowerPoint presentation on a Mac OS X computer and projected on two blackboard-sized screens at the front left and right of a University of Texas at Austin computer lab using an LCD overhead projector.

Three different response sheets, labeled 1, 2, or 3, were created, each containing three columns of 24 successive numbers for a total of 72 numbers. Each number was followed by a blank where participants could record a response. Printed at the top of each response sheet were instructions consisting of three different questions: (A) “Does the word end in a vowel?”, (B) “Does the word have more than one syllable?”, and (C) “Does the word name a living thing?”. These facilitated orthographic, phonological, and semantic processing, respectively. Each of the questions was assigned a different letter for each of the three different response sheets in order to counterbalance for item effects.

Procedure

The response sheets were distributed face down in successive order, alternating between 1, 2, and 3, before participants entered the lab. Because seating arrangements were random, a random third of participants received each response sheet. After all participants were seated, they were asked to turn over their response sheets and read the instructions carefully.

The instructions asked participants to write “Y” for “yes” and “N” for “no” in the blanks next to each number depending on which letter preceded the word. On the PowerPoint

presentation, an instruction letter (A, B, or C) was shown for three seconds, a stimulus word was shown for two seconds, and an asterisk was shown for five seconds to allow participants time to record responses. The first list of 24 words was shown in this manner, followed by a two-minute break, the second list, a two-minute break, and the third list.

After all three lists of 24 words had been presented, the participants were given 30 seconds to complete the distracter task of crossing out all the odd numbered responses and circling all the even numbered responses. The participants were then given five minutes to complete the free recall task of recording on the back of their response sheets as many words as they could recall in any order from the 72 words that were previously presented. Lastly, the experimenter displayed the complete list of 72 words on the two screens, so participants could identify the level of processing of each word they recalled. The mean word recall for each level of processing (orthographic, phonological, and semantic) was calculated using the results.

Results

The mean numbers of words recalled for the orthographic, phonological, and semantic levels of processing, respectively, are illustrated in Figure 1. The apparent increase in words recalled as a function of levels of processing that is indicated in Figure 1 was confirmed by a within-subjects analysis of variance (ANOVA) performed on the data, which revealed a significant main effect of levels of processing on words recalled, $F(2, 48) = 36.99$, $p < .0001$.

To test the prediction that a semantic level of processing would produce better recall than either orthographic or phonological levels of processing, and that the phonological level of processing would produce better recall than the orthographic level of processing, three pair-wise comparisons, with a Bonferroni correction to maintain an alpha level of .05, were conducted to compare the individual condition means. The comparison of semantic and phonological

processing revealed the mean correct word recall after semantic processing (M = 5.48, SE = .459) was significantly higher than the mean correct word recall after phonological processing (M = 2.76, SE = .273); $p < .0001$. The comparison of semantic and orthographic processing revealed that the mean correct word recall after semantic processing was significantly higher than the mean correct word recall after orthographic processing (M = 1.48, SE = .224); $p < .0001$. The comparison of phonological and orthographic processing revealed that the mean correct word recall after phonological processing was significantly higher than the mean correct word recall after orthographic processing, $p < .025$.

Discussion

The results from the study show that semantic processing contributes to significantly greater word recall than orthographic and phonological processing. This supports the hypothesis. The study also shows that phonological processing contributes to significantly greater word recall than orthographic processing.

The study supports the "levels of processing" theory proposed by Craik & Lockhart (1972). Deeper levels of processing contribute to stronger trace persistence, and, once attention is diverted, information will be lost more slowly for deeper levels of processing because of the degree of stimulus elaboration (Craik & Lockhart, 1972). The question "Does the word name a living thing?" required participants to process words using semantic connections and existing cognitive structures. The deeper level of processing and elaboration contributed to higher word recall. The question "Does the word have more than one syllable?" required participants to consider the word's sound, while the question "Does the word end in a vowel?" required participants to consider the word's appearance. Phonological processing seems to be easier and contribute to higher word recall than orthographic processing.

Because the mental system has limited processing capacity, a large portion of which must be devoted to an executive "control mechanism," it must prioritize information processing in order to avoid being overwhelmed. Semantic processing is more relevant to existing cognitive structures and beneficial to the organism. It is also more time-consuming because it incorporates both directions of the two-way flow. Further research is needed into whether deeper levels of processing or the time taken to process is the specific cause of greater word recall.

The levels of processing model could be beneficial in educational settings that are predominantly verbal as a way of facilitating greater recall. Further research could explore whether semantic processing is more effective than phonological and orthographic processing, and whether phonological processing is more effective than orthographic processing, in other tasks such as graphic recall.

References

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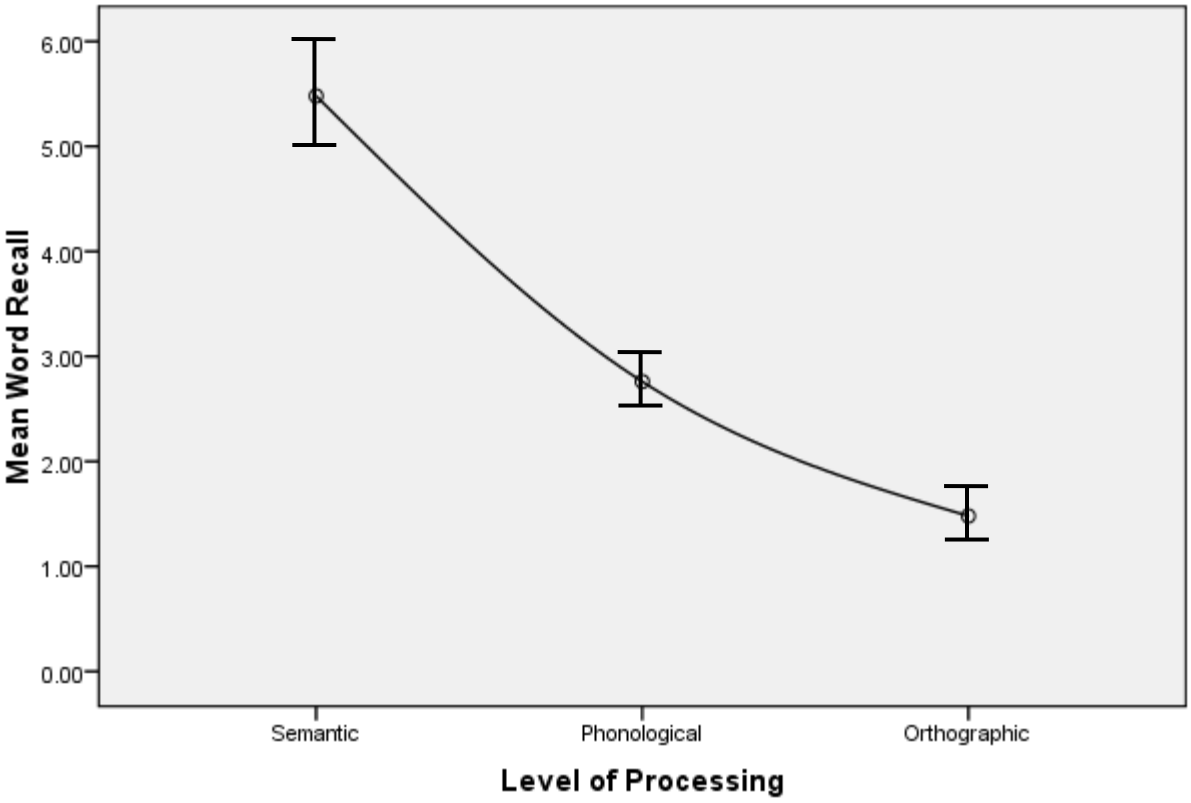

Figure 1. Marginal means representing word recall for each level of processing. Standard errors are represented in the figure by the error bars attached to each point.