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Title: WORD FREQUENCY AND THE CONCEPTUALLY-DRIVEN/ DATA-DRIVEN PROCESSING DISTINCTION OF MEMORY RETRIEVAL

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The effects of word frequency and two encoding contexts were directly compared using semantic or graphemic cued recall. Subjects generated and read both common and rare words, but were given only one type of cued recall task. Semantic cued recall (i.e., a conceptually-driven task) required the recall of previously studied words when given cues that have the same meaning, whereas graphemic cued recall (i.e., a data-driven task) required the use of cues that have a similar physical appearance as previously studied words to aid recall. While generate and read study contexts dissociate conceptually-driven from data-driven tasks (Blaxton, 1989), the current results add that the frequency of stimulus items contributes to this effect. Generated common relative to rare words were recalled better in semantic cued recall. In contrast, graphemic cued recall was better for rare than common words when read without context during encoding. The results further indicate that the semantic similarities typically found between common words is likely to benefit

more by conceptual processes. Likewise, when semantic information is not available to guide the recall of rare items in graphemic cued recall, the physical of perceptual features will. The transfer-appropriate processing framework accounts for these results best in that the specific encoding operations that occurred with common and rare words overlapped greatest when matched with the retrieval demands for each cued recall task.

WORD FREQUENCY AND THE CONCEPTUALLY-DRIVEN/DATA-DRIVEN PROCESSING DISTINCTION OF MEMORY RETRIEVAL

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

When performance between two long-term memory tasks is not correlated, a dissociation between them exists. Methodologically, a variable that differentially affects the performances on Tasks X and Y provides a means for inferring those memory characteristics unique to each task. Thus, dissociations expose the specific qualities of long-term memory, which can then be studied empirically. Tulving (1983) equates dissociations with fruit flies in genetic research: a convenient medium through which phenomena can be examined.

Tulving (1972) proposed that long-term memory can be divided structurally into episodic (i.e., stored knowledge of events experienced at a specific point in time) and semantic (i.e., stored general knowledge of the world) systems. Episodic memory tasks such as recognition and free and cued recall are assumed to tap the episodic system because their completion is dependent upon explicit information encoded from a previous episode. In contrast, memory tasks such as word stem completion (e.g., fal___; for the word falcon), word fragment completion (e.g., f_l__n; for falcon), and perceptual identification (tachistoscopic presentation of a word) are assumed to tap the semantic system because their completion is dependent on general knowledge, rather than specific episodic information (Tulving, 1985; Tulving & Schacter, 1990).

The storage system distinction has received support from studies on amnesics (Warrington & Weiskrantz, 1970) and mood congruity (Weaver & McNeill, 1992). Amnesic and normal controls displayed equal memory performance when tested on semantic memory tasks such as word stem completion, but not episodic tasks such as recognition (Warrington & Weiskrantz, 1970, Experiment 2). Shimamura (1986) also lists additional semantic memory tasks that demonstrate preserved priming in amnesics. In addition, Weaver and McNeill (1992) reported mood did not prime semantic memory, whereas others (e.g., Teasdale & Fogarty, 1979) have consistently obtained a priming effect of mood for episodic memory.

One alternative to the structural theory of long-term memory is basing retention upon the "levels of processing" such that "deeply" encoded information produces better long-term retention than "shallowly" encoded information (Craik & Lockhart, 1972). Deep semantic processing occurs when the meaning of an item is elaborately encoded, whereas shallow phonological processing relies on an item's perceptual features including sounds, shapes, angles, letters, or numbers of syllables. Craik and Tulving (1975) further explored this distinction by comparing recognition of words processed deeply (deciding if a word meaningfully fits into a sentence) or shallowly (determining whether words either rhyme with other words or are typed in upper- or lower-case font). Recognition of deeply, relative to shallowly, processed words was greater. Thus, Craik and Tulving concluded that long-term memory is enhanced only by deep semantic, rather than nonsemantic (or shallow phonological) processing.

In contrast, Morris, Bransford, and Franks (1977) modified Craik and Lockhart's (1972) conceptualization of long-term retention to indicate that memory is dependent on the mental operations performed during both encoding and retrieval, regardless of whether the processing is semantic or phonemic in origin. Furthermore, the best ways to encode are dependent on the criteria necessary for retrieval (Rabinowitz & Craik, 1986). Thus, semantic encoding enhances the retrieval of semantic information, whereas phonemic encoding enhances phonemic retrieval. This result suggests replacing the concept of "levels of processing" with transfer-appropriate processing (Morris et al., 1977), or similar concepts such as encoding specificity (Tulving & Thomson, 1973), and a processing account (Roediger, Weldon, & Challis, 1989).

Jacoby (1983) demonstrated transfer-appropriate processing when comparing memory for stimuli encoded in varying contexts. Subjects studied cue-target pairs by generating the target word when given an antonym (e.g., hot-????); reading the target in the absence of a contextual cue (e.g., xxxx-COLD); or reading the target paired with a contextual cue (e.g., hot-COLD). Jacoby labeled the generating of targets as involving conceptually-driven processing because generating was dependent on the meaning of presented stimuli. In contrast, he labeled the reading of targets in the absence of contextual cues as data-driven processing because reading only relied primarily on the physical features rather than the contextual meaning of stimuli. Reading the targets paired with a contextual cue was assumed to involve both conceptually-driven and data-driven processing.

Jacoby (1983) reported that recognition (an episodic task according to Tulving, 1985) was increased when subjects generated targets relative to reading them without contextual cues (see also Slamecka & Graf, 1978). In contrast, perceptual identification (classified as a semantic memory task) was better when targets were read in the absence of contextual cues and not generated. These results indicate that recognition and perceptual identification memory are differentially sensitive to conceptually-driven and data-driven processing. Thus, generating a target, or reading a target without context may provide an alternative framework for dissociating memory tasks relative to the storage system tapped.

The recognition advantage of generating words in comparison to reading them without contexts (e.g., Jacoby, 1983) was initially reported by Slamecka and Graf (1978) and is described as the "generation effect." They obtained the generation effect under a variety of conditions including free and cued recall, cued and uncued recognition, timed and self-paced presentations, between- and within-subjects designs. Slamecka and Graf did not address the distinction between episodic and semantic memory or conceptually-driven and data-driven processing, although recognition and recall tasks were predominantly used to assess the generation effect.

Recent studies indicate that the conditions under which the generation effect is demonstrated have become more complex. For example, the generation effect was not observed for nonwords (McElroy & Slamecka, 1982), or for low-frequency (rare) words (Nairne, Pusen, & Widner, 1985). However, Gardiner, Gregg, and Hampton (1988) did report a reliable generation effect for rare words. The graduate students and staff Gardiner et al. used as subjects might have been more familiar with rare words than Nairne et al.'s (1985) younger subjects.

Nairne and Widner (1988) reported that familiar (e.g., dinosaur) relative to unfamiliar rare words (e.g., bivouac) can display a memorial benefit from generation. In contrast, unfamiliar relative to familiar rare words were better recognized if they had been previously read, but not generated. Even though Nairne and Widner did not interpret their results as dissociating conceptually-driven and data-driven processing, they did suggest that the generation effect has foundations in the match between the cognitive operations (i.e., generating or reading) performed during both encoding and retrieval (Rabinowitz & Craik, 1986). Thus, the generation effect appears useful for investigating dissociations between conceptually-driven and data-driven processing, especially if word frequency is manipulated.

Most researchers exploring episodic and semantic memory dissociations have not investigated whether episodic or semantic memory tasks may involve both conceptually-driven and data-driven processing. Rather, they appear to assume that episodic memory tasks typically rely on conceptually-driven processing, whereas semantic memory tasks are primarily associated with data-driven processing (Duchek & Neely, 1989; Roediger & Blaxton, 1987). Likewise, recognition is associated with both episodic memory and conceptually-driven processing, and is often contrasted with perceptual identification, which is identified with semantic memory and data-driven processing (e.g., Jacoby, 1983; Jacoby & Dallas, 1981).

Blaxton (1989) attempted to unconfound the type of task (episodic or semantic) from the type of processing associated with each (conceptually-driven or data-driven). She incorporated into her experiments the usual episodic, conceptually-driven (free and semantic cued recall) and semantic data-driven (word fragment completion) tasks. However, she also included semantic, conceptually-driven (answering general knowledge questions) and episodic, data-driven (graphemic cued recall) tasks. During encoding, subjects generated targets by producing synonyms to presented cues (conceptually-driven), read targets in the absence of contextual cues (data-driven), and read cue-target pairs (both types of processing assumed). The results supported transfer-appropriate processing by demonstrating a dissociation between conceptually-driven and data-driven processing manipulations, but not between tasks classified as episodic or semantic. Blaxton suggested that classifying memory tasks based on their processing type rather than the storage system tapped may be more correct. However, this interpretation seems to apply only to experiments that employ generation procedures (Tenpenny & Shoben, 1992).

Because the processing distinction assumes that some memory tasks use a combination of both types of processing (Roediger et al., 1989), it often fails to determine a priori which independent variables (other than generating or reading words without context) produce strongly conceptually- or strongly data-driven processing. For example, manipulating conceptual (e.g., meaning based study context) and perceptual (e.g., sense modality) between study and test phases should be sensitive to conceptually-driven and data-driven processing, respectively, regardless of generating or reading without context. However, Tenpenny and Shoben (1992) indicate that classifying tasks as conceptually-driven or data-driven may be limited to experimental designs using generation procedures only.

Tenpenny and Shoben (1992) tested the processing distinction without generation. In Experiment 2, subjects studied words by reading them with or without context. Reading items without context (e.g., xxxx-PIGEON) was considered data-driven. In addition, semantic (e.g., dove-PIGEON) and graphemic (e.g., pigpen-PIGEON) encoding contexts were assumed to primarily involve conceptually-driven and data-driven processing, respectively. They report that word fragment completion was unaffected by study context. Graphemic cued recall (i.e., recalling a target when given a cue that looks like it), on the other hand, was affected more by graphemic encoding context than the others. Although both of these tasks were assumed to be data-driven (e.g., Blaxton, 1989), no difference was obtained between these two tasks and semantic cued recall (classified as conceptually-driven) when items were read without context. This result poses problems for the processing distinction, which assumes better performance for data-driven relative to conceptually-driven tasks when targets are read without context. In Experiment 3, word fragment completion was greater for common relative to rare words when targets were studied in graphemic context, but the opposite was obtained for graphemic cued recall.

Tenpenny and Shoben (1992) suggest that conceptually-driven and data-driven processes should be analyzed as components within tasks, as they failed to support the processing distinction. However, their results indicated that the processing distinction may be too broad to classify all tasks, even though the distinction captures a great deal of the appropriate processes involved during retrieval.

Nairne and Widner (1988) and Tenpenny and Shoben (1992) indicate that the effects of word frequency in the context of conceptually-driven and data-driven processing needs further exploration. The frequency of an item's occurrence in the language affects its probability of recognition (Shepard, 1967) and recall (Balota & Neely, 1980). In addition, rare words have fewer associate items (Zechmeister & Nyberg, 1982), possess fewer meanings (Postman & Keppel, 1970), and may fail to produce retention advantages when generated (Nairne et al., 1985). Only a few studies have addressed word frequency as it relates to the processing distinction (e.g., Duchek & Neely, 1989; Tenpenny & Shoben, 1992). However, these studies did not incorporate generation procedures into their methods.

In order to explore further conceptually-driven and data-driven processing as a basis for classifying memory tasks, the present experiment manipulated word frequency and required subjects to generate and read targets without context. In addition, this experiment examines semantic (conceptually-driven) and graphemic (data-driven) cued recall of rare and common words after they have been generated or read without context. Both of these tasks correspond to an episodic taxonomy (due to the prior encoding episode) because the focus of this study is the type of processing for each task.

Although word frequency dissociates free recall from recognition (Shepard, 1967), its effects on semantic and graphemic cued recall when generation procedures are used during encoding are not clear. This investigation provides a clearer index for task classification by examining the role of word frequency in conceptually-driven and data-driven processing. The present study attempts to answer the following research questions:

1. Will generating or reading produce greater semantic cued recall of common and rare words?
2. Will generating or reading produce greater graphemic cued recall of common and rare words?

CHAPTER 2

METHOD

Subjects

Subjects were 32 volunteer students (20 males, 12 females) from introductory and upper level psychology courses at a midsized midwestern university. All subjects were native speakers of English and received extra credit for their participation in the experiment when approved by the instructors.

Design

The present study has a 2 (Word Frequency: common and rare) X 2 (Study Condition: generate and read) X 2 (Memory Test: semantic and graphemic cued recall) mixed factor design. Word frequency and study condition are within-subjects independent variables, and memory test is a between-subjects factor. All subjects studied an equal number of common and rare words in both study conditions, but they were randomly assigned to receive either a semantic or graphemic cued recall test.

Recall was assessed by using semantic and graphemic cued recall tasks. Half of the 64 words for these tasks were studied items; the other half were new items in order to compare differences in baseline performance across subjects and the degree to which prior study benefits performance (Neely, 1989).

<u>Materials</u>

A consent form and biographical questionnaire were provided for each subject (see Appendix A). In addition, two sheets of lined, 8.5" X 11" notebook paper, two pencils, and a random number table were also provided. A Commodore 128 personal computer and monitor was used for the presentation of stimuli in the experiment.

A set of 64 words of 4 to 9 letters in length were the target items (see Appendix B). They were randomly drawn from the Kucera and Francis (1967) norms, but constrained so that 32 were common and 32 were rare. The common words appear 100 or more times per million words of English text, whereas rare words appear 5 times or less per million. These words were cross-referenced with the Carroll, Davies, and Richman (1971) norms in order to ensure that they are not biased to a particular form of printed media (e.g., textbooks of various subjects, newsprint, journals, etc.), and the Paivio, Yuille, and Madigan (1968) norms to ensure that they have similar levels of familiarity. Thus, all target items have a "meaningfulness" rating between 6 and 8, which corresponds to the average number of associates produced by raters within a 30 second time frame for each word.

All 64 targets were divided into two base lists, each containing 16 common and 16 rare words. Each subject studied only one base list, whereas the other list appeared as nonstudied items on the subsequent memory test.

Each target had one semantic and one graphemic cue, each corresponding to either a semantic or graphemic cued recall task. Semantic cues (see Appendix B) are synonyms for the target items. A semantic cue cannot possess similar physical features as the target and cannot be five letters greater or less than the target. In contrast, graphemic cues possess the same physical features as target words (see Appendix B) such as sharing the same first letter and exceeding the target's length by no more or less than three letters. Furthermore, all but three letters of the graphemic cues are shared by the targets of seven or more letters, and all but two letters of targets with less than seven letters.

Volunteers from the same population as the subjects wrote for each target word both a synonym and a word that looks like the target. The most frequently provided word that fit the criteria for each target was selected as a cue. All items (including cues and targets) were entered into a computer program that was used for presentation.

<u>Procedure</u>

Subjects were individually tested by a 24-year-old white, male experimenter. After entering the testing room, subjects were greeted and instructed to sit in a chair facing the computer screen. They were then asked to read and sign a consent form and complete a set of demographic questions. After the consent form was signed and the questionnaire completed, the experimenter described the specific functions of the computer that was used in the experiment (see Appendix C).

Instructions for each study condition (see Appendix C) were given prior to each condition. The experimenter asked for questions before beginning each study condition, in order to make sure that the directions were fully understood. Subjects were given the opportunity to practice using two high- and two low-frequency words for each condition. This controlled for any primacy effect.

All subjects studied targets in both generate and read conditions, and both common and rare words were equally represented in both conditions. Each study condition was administered in a blocked fashion. Half of the subjects generated 16 and then read 16 targets, whereas the other half read 16 and then generated 16 targets. Furthermore, the ordering of the study conditions was counterbalanced across subjects.

The beginning of the study phase was initiated once the experimenter pressed the space bar on the computer keyboard. There were a total of 32 trials during the entire study phase with a one second interval between trials.

Subjects required to initially generate targets during study were first presented with the synonym cue on the computer monitor for four seconds. After a one second blank screen, subjects saw the first letter and corresponding blanks of the correct response for five seconds (the target) followed by a five second blank screen. They were always required to verbally produce the target response, which was always a synonym of the cue word (e.g., photograph: P------). If the subject failed to generate the target correctly within the ten second time frame, the experimenter read aloud the correct answer, and the subject repeated it back. Subjects required to initially read the targets always saw a string of x's for four seconds followed by a one second blank screen. The target word was then presented in upper-case letters by the computer for a five second interval, during which the subject read the word aloud (e.g., xxxx: PICTURE). The target word was then followed by a blank screen for an additional five seconds before the next trial commenced.

After all 32 targets were generated and read, the experimenter distributed a random number table (see Appendix D). Subjects were asked to circle as many three's as they could in a two-minute period. This is designed to erase the experimental stimuli from short-term memory.

After 2 minutes, the experimenter said stop, collected the random number table, and verbally gave the instructions for the memory test (see Appendix C). All subjects were given two practice trials before testing. The memory test was initiated by the experimenter by pressing a key on the computer keyboard one time. During the test phase, cues were presented one at a time on the computer monitor for 5 seconds followed by a 5-second interval during which the screen is blank. This gave subjects a total of 10 seconds to record responses on their paper before the next trial commenced.

Subjects in both recall groups used words presented on the monitor as cues to help them remember previously studied targets. Subjects randomly assigned to receive a semantic cued recall test were informed that the cues share the same meaning as previously spoken items, while those assigned to the graphemic cued recall group were told that cues share the same physical appearance as previously spoken items. In addition, some of the cues presented did not correspond to previously studied targets (nonstudied), but subjects were encouraged to write a probable word even if they were not sure of the correct response. If subjects did not write down a response within the 10-second time frame, the next cue was automatically presented.

Subjects were not allowed to go back and correct mistakes or fill in missed responses. This was visually monitored by the experimenter and all deviations were noted for each subject. After all 64 cues have been presented (including cues corresponding to nonstudied items), subjects were debriefed and thanked for their participation. The entire procedure lasted approximately 30 minutes for each subject.

Scoring and Statistics

Correctly recalled targets were scored one point each. No points were given for words that did not correspond to the list of possible responses. There was no penalty for words with minor misspellings or plurals. Each subject received four scores ranging from 0 to 8 for each level of word frequency (common and rare) crossed with study condition manipulation (generate and read).

Cell means were analyzed with a 2 (Word Frequency: common and rare) X 2 (Study Condition: generate and read) X 2 (Memory Test: semantic or graphemic cued recall) mixed factor analysis of variance. Post hoc analyses were done using Fisher's Least Significant Difference (LSD) test set at the .05 level for significant interactions. In addition, a *t*-test was done to compare memory performance between studied and nonstudied items.

CHAPTER 3

RESULTS

The present study examined the effects of word frequency on semantic and graphemic cued recall when words were either read without context or generated. The purpose was to assess the degree to which generating (i.e., a conceptually-driven encoding condition) and reading without context (i.e., most likely a data-driven study condition) had on semantic (conceptually-driven) or graphemic (data-driven) cued recall tasks when both common and rare words were used as experimental stimuli. The effect of word frequency on these memory tasks using such encoding contexts is unclear. The following research questions were investigated: 1) Will generating or reading produce greater semantic cued recall of common and rare words? 2) Will generating or reading produce greater graphemic cued recall of common and rare words?

Data were analyzed with a 2 (Word Frequency: common and rare) X 2 (Study Condition: generate and read) X 2 (Memory Test: semantic or graphemic cued recall) mixed factor analysis of variance. Word frequency and study condition were within-subjects independent variables, and memory test was a between-subjects independent variable. The dependent variable was the number of correctly recalled stimulus words. The results of the analysis of variance are summarized in Table 1, and the means and standard deviations for all cells appear in Table 2.

Main Effects

The main effects of study condition $F(1, 30) = 35.95$, $p < .001$, and memory test, $F(1, 30) = 8.88$, $p < .01$ were statistically significant. More generated ($M = 5.00$) than read ($M = 3.86$) words were recalled. Subjects receiving a semantic ($M = 4.85$) relative to a graphemic cued recall task ($M = 4.15$) recalled more items.

Interactions

The ANOVA revealed three significant interactions: study condition X memory test, $F(1, 30) = 267.17$, $p < .001$; word frequency X memory test, $F(1, 30) = 48.55$, $p < .001$; word frequency X study condition X memory test, $F(1, 30) = 8.75$, $p < .01$. A Fisher's test of Least Significant Difference (LSD) set at the .05 level was performed on each of these interactions. The results of these analyses for each respective interaction appear in Tables 3, 4, and 5.

For the study condition x memory test interaction, generating words produced significantly greater semantic cued recall ($M = 6.97$) than only reading followed by graphemic cued recall when words were read without context ($M = 5.00$). In addition, graphemic and semantic cued recall when words were generated ($M = 3.03$) or read ($M = 2.72$), respectively, did not differ, but produced significantly

Table 1

Analysis of Variance for Word Frequency, Study Condition, and Memory Test on Recall

Source	df	SS	MS	F
Between-Subjects				
Memory Test	1	21.95	21.95	8.88*
Error	30	74.17	2.47	
Within-Subjects				
Word Frequency	1	2.82	2.82	2.96
WF X MT	1	46.32	46.32	48.55**
Error	30	28.61	.95	
Study Condition	1	41.63	41.63	35.95**
SC X MT	1	309.38	309.38	267.17**
Error	30	34.73	1.16	
WF X SC	1	.38	.38	.31
WF X SC X MT	1	10.70	10.70	8.75*
Error	30	36.67	1.22	

Note. WF = Word Frequency; SC = Study Condition; MT = Memory Test.

*$p < .01$

**$p < .001$

Table 2

Means and Standard Deviations for Recall by Word Frequency, Study Condition, and Memory Test

	Memory Test		
	Semantic	Graphemic	Total
Generate			
Common	7.38 (0.50)	2.81 (1.22)	5.10 (0.93)
Rare	6.56 (1.03)	3.25 (1.06)	4.91 (1.05)
Total	6.97 (0.81)	3.03 (1.14)	5.00 (0.99)
Read			
Common	3.81 (1.56)	4.31 (1.40)	4.06 (1.48)
Rare	1.63 (0.62)	5.69 (1.70)	3.66 (1.28)
Total	2.72 (1.19)	5.00 (1.56)	3.86 (1.39)
Overall	4.85 (1.02)	4.02 (1.37)	4.43 (1.21)

Note. Numbers in parentheses represent standard deviations.

Table 3

Fisher's Test of Least Significant Difference for Study Condition X Memory Test Interaction

GEN-SEM	READ-GRAPH	GEN-GRAPH	READ-SEM
6.97	5.00	3.03	2.72

Note. GEN = Generate Study Condition; READ = Read Study Condition; SEM = Semantic Cued Recall; GRAPH = Graphemic Cued Recall. Underlined means are not significantly different.

Table 4

Fisher's Test of Least Significant Difference for Word Frequency X Memory Test Interaction

COM-SEM	RARE-GRAPH	RARE-SEM	COM-GRAPH
5.60	4.47	4.10	3.56

Note. COM = Common Words; RARE = Rare Words; SEM = Semantic Cued Recall; GRAPH = Graphemic Cued Recall. Underlined means are not significantly different.

Table 5

Fisher's Test of Least Significant Difference for Word Frequency X Study Condition X Memory Test Interaction

C-GN-S	R-GN-S	R-RD-G	C-RD-G	C-RD-S	R-GN-G	C-GN-G	R-RD-S
7.38	6.56	5.69	4.31	3.81	3.25	2.81	1.63

Note. C = Common Words; R = Rare Words; GN = Generate Study Condition; RD = Read Study Condition; S = Semantic Cued Recall; G = Graphemic Cued Recall. Underlined means are not significantly different.

less recall than the other two means (see Table 3).

In the word frequency X memory test interaction, common words had the highest semantic cued recall ($\underline{M}$ = 5.60). However, no significant difference was obtained between graphemic ($\underline{M}$ = 4.47) and semantic ($\underline{M}$ = 4.10) cued recall for rare words, and the latter mean did not significantly differ from graphemic cued recall for common words ($\underline{M}$ = 3.56; see Table 4).

For the three-way interaction in Table 5, semantic cued recall was higher for common ($\underline{M}$ = 7.38) than rare ($\underline{M}$ = 6.56) words generated during study. In contrast, graphemic cued recall was better for rare ($\underline{M}$ = 5.69) than common ($\underline{M}$ = 4.31) words when subjects read targets without context. Semantic cued recall for common ($\underline{M}$ = 3.81) relative to rare ($\underline{M}$ = 1.68) words read at study was significantly higher. However, the former was higher than graphemic cued recall for common words that were generated ($\underline{M}$ = 2.81), but not for common words that were read ($\underline{M}$ = 4.31). The data for the word frequency X study condition X memory test interaction are graphically presented in Figure 1.

A $\underline{t}$-test was conducted to assess the degree of benefit prior exposure the stimulus words had in both cued recall tasks. As expected, superior semantic, $\underline{t}(30) = 11.4$, $\underline{p} < .001$, and graphemic, $\underline{t}(30) = 13.2$, $\underline{p} < .001$ cued recall for studied relative to nonstudied items was obtained. Thus, reading and generating had its intended effect.

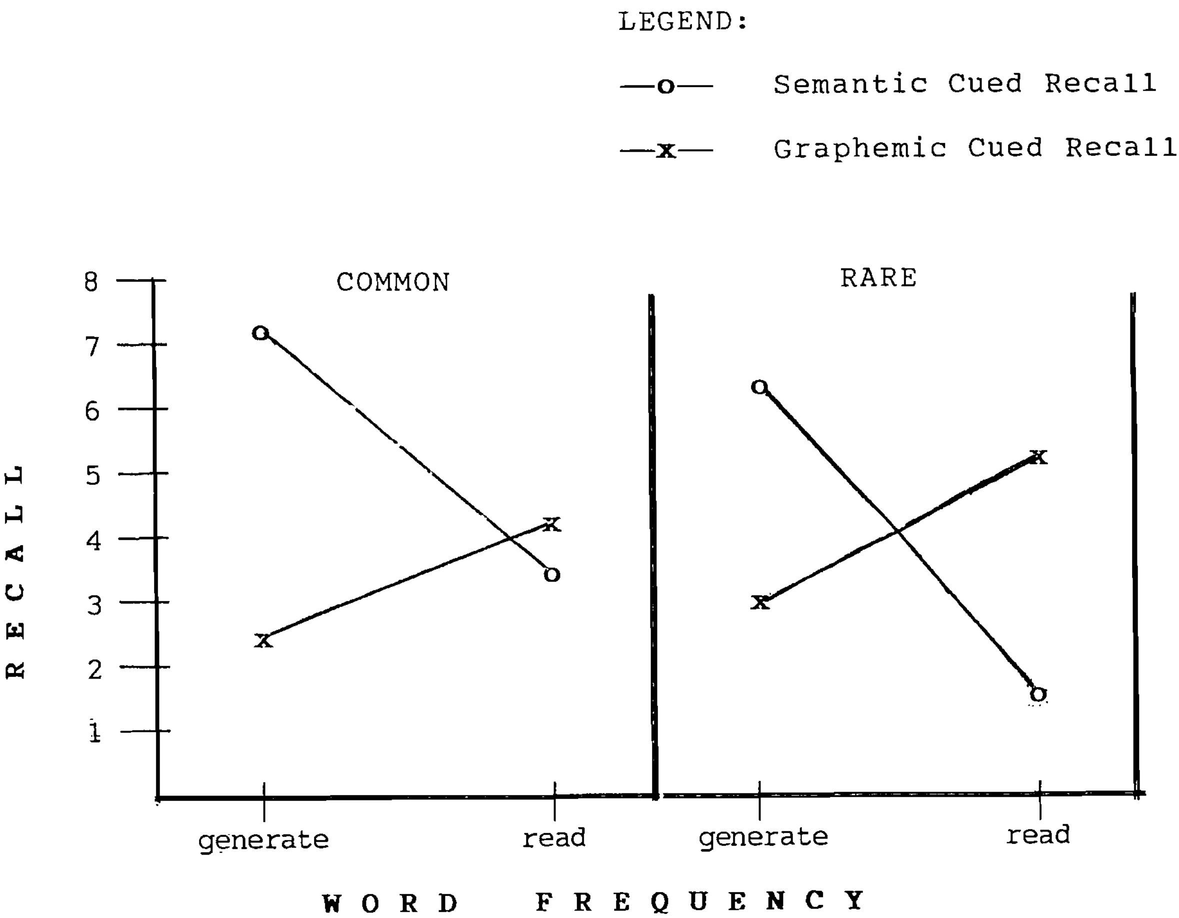

Figure 1. Word Frequency X Study Condition X Memory Test Interaction.

CHAPTER 4

DISCUSSION

This study was designed to observe the effects of word frequency on two types of cued recall (semantic or graphemic cued recall) when words were encoded in two contexts (generate or read without context). Semantic cued recall is considered a conceptually-driven memory task because performance requires processing the meaning of the stimuli. Generating stimulus words relative to reading them without context produces higher semantic cued recall (Blaxton, 1989). Conversely, reading words without context during encoding increases graphemic cued recall performance. The present results from this experiment support this distinction. However, factoring in word frequency produced different effects for semantic and graphemic cued recall.

The frequency of a word's occurrence in the language differentially affects free recall and recognition (Balota & Neely, 1980; Shepard, 1967). Common relative to rare words are better recalled, whereas rare relative to common words are better recognized. The present experiment revealed that the effect of word frequency also differentiates semantic from graphemic cued recall.

The present experiment provided a clearer answer to whether generating or reading would produce greater semantic cued recall of common and rare words. As may be seen in Figure 1, generating relative to reading produced better semantic cued recall for common than rare words. In addition, semantic cued recall was significantly decreased when common words were read, but poorest when rare words were read during encoding. For rare words, generating relative to reading produced significantly better semantic cued recall. This result is consistent with the conceptually-driven processing distinction, as semantic cued recall (a conceptually-driven task) benefitted most from generating. However, the present data indicate that semantic cued recall is significantly diminished when generated rare words are used as stimuli.

Does generating or reading produce greater graphemic cued recall for common and rare words? The current results indicate that reading rare words during encoding produces greater graphemic cued recall than reading common words. Furthermore, recall after generating both common and rare words did not differ, but were significantly less than after reading. These results support the data-driven distinction, as reading relative to generating increased graphemic cued recall (a data-driven task; Blaxton, 1989).

Word frequency appears to be a crucial factor for both semantic and graphemic cued recall. That is, rare words are more likely to be remembered (compared to common words) when read during study and recalled with graphemic cues rather than generated and recalled using semantic cues. The dissociation observed between the two cued recall tasks indicates that generating common relative to rare words more likely produces conceptual processing. Conversely, rare words are more likely than common ones to benefit from the data-driven processing of reading.

The present results can best be explained by the transfer-appropriate processing approach (Jacoby, 1983; Morris et al., 1977). The transfer-appropriate processing distinction assumes that memory is increased when the mental operations performed during encoding and retrieval overlap. Generating common relative to rare words during encoding is better transferred to the retrieval operations that occur in semantic cued recall, which predicts better performance for conceptually-driven compared to data-driven tasks when subjects generate words during encoding (Roediger et al., 1989). Common words benefit to a greater extent when processed conceptually, but rare words benefit most when the processing is data-driven. Because common words have a greater number of semantic associates when compared to rare words (Postman & Keppel, 1970), the semantic similarities between common words increases their transfer to conceptually-driven memory tasks. This effect has been demonstrated to be greater in semantic cued recall than in other measures of retention such as free recall (Burns, 1992).

Reading rare relative to common words during encoding increased graphemic cued recall because retrieval in this condition is guided more by the physical and perceptual rather than semantic similarities between cue and target. Jacoby and Dallas (1981) indicate that the retention of rare words in another data-driven task (i.e., perceptual identification) is partially due to physical and graphemic information, but the effect is less likely to be observed for common words. The current findings extend this interpretation to graphemic cued recall; when semantic information is not available to guide the recall of rare items, the perceptual or surface features will.

Because the memorial benefit of generating is differentially influenced by the frequency of words (Nairne et al., 1985), the present results may have been affected by the inability of rare words to benefit from generation. Nairne et al. discovered that unfamiliar rare words often fail to benefit from generation. The present experiment controlled for the rated level of word familiarity, which diminishes the generation failure of rare words (Nairne & Widner, 1988), and subjects generated both rare and common words equally well. However, recall of rare and common words was different.

Slamecka and Katsaiti (1987) report that the advantage of generating in within-subjects designs may be due to selective rehearsal of generated relative to read items. Generated items are more distinct than read items in mixed lists, and the more distinctive stimuli result in an artifactually inflated generation effect.

This interpretation probably does not adequately account for the observed dissociation between both recall conditions, or the superiority of common words in semantic cued recall. If selective rehearsal was a contributing factor, one would expect to see more rehearsal effects (and a nonsignificant difference) for generated rare than common words due to the greater "distinctiveness" of rare items (e.g., Gardiner et al., 1988). In contrast, the present results indicate greatest semantic cued recall for generated common words, but there was also an observed generation effect for rare words; albeit less than that of common words. Thus, rare words did demonstrate a generation advantage when compared with both common and rare read items, which also supports the findings of Nairne and Widner (1988) and Gardiner et al. (1988).

Conclusion

While generate and read study contexts dissociate conceptually-driven from data-driven tasks (Blaxton, 1989;

Jacoby, 1983), word frequency is also a factor that needs to be considered. Generated common compared to rare words were recalled better in semantic cued recall. In contrast, graphemic cued recall was better for rare than common words when read without context during study.

The transfer-appropriate processing framework accounts for these results best in that the specific encoding operations for both common and rare words overlap to a greater extent with the retrieval operations of semantic and graphemic cued recall, respectively. Thus, common words benefit most when generated and recalled using semantic cues. Rare words, in comparison to common, benefit most when read without context, and recalled using graphemic cues; which is guided more by the overlap of perceptual (as opposed to semantic) attributes.

These results indicate that the effects of word frequency should be integrated into the processing distinction of retrieval. Word frequency not only dissociates free recall from recognition (Balota & Neely, 1980), but also contributes to the observed dissociation between semantic and graphemic cued recall.

One of the reported weaknesses of the processing distinction is its inability to predict a priori the outcomes of tasks classified as either conceptually-driven or data-driven when generate versus read manipulations are not used (Tenpenny & Shoben, 1992). For example, reading targets paired with some form of contextual cue has been implicated as involving similar levels of conceptually-driven and data-driven processing (Blaxton, 1989; Roediger et al., 1989), even though others (e.g., Burns, 1992; Tenpenny & Shoben, 1992) report a preponderance of one type of processing over another depending on the contextual relationship between cue and target.

Recommendations for Future Research

Future research should attempt to examine the current effects using encoding manipulations other than generating and reading, but keeping manipulations between the semantic and perceptual features of stimuli intact. Perhaps conceptually-driven processing could be induced by having subjects answer semantic questions or compare the semantic similarities between words during study. In addition, data-driven processing could be induced by requiring subjects to make perceptually guided rhyme or orthographic judgments during encoding. Duchek and Neely (1989) did manipulate the frequency of stimuli without using generation procedures, and their experiment failed to support the processing distinction when using other measures of retention. Therefore, the current findings might be an artifact of the generation effect, unless verified using other study manipulations. Such an endeavor remains relatively uninvestigated, and continued exploration will expand our understanding of the retrieval processes in human memory.

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Appendix A

Informed Consent Form

Please read the following statements. If you agree with them, please sign your name at the bottom.

I agree to participate in this study conducted by Matthew Johnson. The purpose of this study is to investigate the effects of word processing on memory, and will take about 30 minutes to complete. I understand that I may stop participating in this study for any reason, without penalty. I also realize that my confidentiality will be respected and neither my name nor any identifying data will be used in any report of this research.

Signed______________________________Date__________________

In addition, please provide the following biographical information:

A) Age__________________

B) Gender (circle): M F

C) Year (circle): FR SO JR SR GR

Appendix B

Targets, Semantic Cues, and Graphemic Cues

Target	Semantic Cue	Graphemic Cue
COMMON		
FRIEND	companion	fiend
CITY	town	cite
HOUSE	home	hose
STREET	road	sleet
KING	ruler	kind
PARTY	celebrate	partly
WIFE	spouse	wide
STONE	rock	store
TABLE	desk	tablet
PAPER	parchment	pauper
GOLD	nugget	golf
DOCTOR	physician	doctrine
IRON	steel	irony
MONEY	cash	monkey
DIRECTION	guide	director
GARDEN	crop	guard
DEATH	decease	deaf
EARTH	planet	early
HISTORY	past	hickory

FIRE	flame	fine
WOMAN	female	wombat
ANSWER	reply	antler
PRESENT	gift	president
BLOOD	plasma	brood
BABY	infant	babble
MOUNTAIN	hill	maintain
PICTURE	photograph	pitcher
CHILD	kid	chilled
ANIMAL	beast	animate
GRASS	lawn	glass
VALLEY	lowland	volley
TEACHER	instructor	teaser

RARE

RETAILER	merchant	retainer
PISTON	engine	pistol
BANDIT	burglar	bandaid
YACHT	boat	yack
TRUCE	peace	truck
SCORPION	spider	scorpio
FOOTWEAR	shoes	footwork
ALGEBRA	math	algae
POLLUTION	smog	population

VENOM	poison	venus
AVALANCHE	landslide	available
DAFFODIL	flower	daffy
COURTSHIP	dating	courtyard
STOREROOM	closet	stockroom
TRACTION	grip	tractor
SUDS	bubbles	spuds
MISSILE	rocket	mission
FLASK	bottle	flash
LOCKER	storage	looker
ICEBOX	freezer	iceberg
TOMAHAWK	hatchet	tomato
SHEEPSKIN	diploma	sheepish
GALAXY	universe	gallery
COWHIDE	leather	cowhand
DOORMAN	bellhop	doormat
NOOSE	rope	nose
CUISINE	food	cruise
SERF	peasant	surf
SHRIEK	scream	shrink
POSTER	sign	posture
SKILLET	pan	skilled
VOCATION	career	vacation

Appendix C

Script

(Speaking clearly at a moderate pace.)

Hello, please put your jacket and books over there (point as you do so) and be seated comfortably (pulling out the chair that is in front of the computer screen).

Before I tell you what I would like you to do, let me point out the computer monitor, which will be displaying words to you, and the keyboard, which I will use to occasionally start and stop the program. I will be telling you more about what I want you to do later, but for now, I would like you to read the following statements carefully (present the consent form). If you agree with them, please sign your name here (pointing to the line). Note that an ID number appears at the top of this form, and will appear at the top of all other forms in order to protect your confidentiality. (After signature.) Now I would like you to read carefully and answer the biographical questions at the bottom of the form (remove when finished).

Now let me tell you about the study. In front of you, on the computer screen, you will observe a series of words and later receive a memory test.

GENERATION INSTRUCTIONS: The computer will briefly present a word in lower-case letters followed by the initial letter of the synonym. This letter begins a word that has the same meaning as the one you just saw. I want you to state the synonym out loud once you come up with it. You will have plenty of time to do this before the computer will present the next series. If you happen to state an incorrect synonym, I will tell you the correct one, and then I want you to repeat it back. Do you have any questions? (Answer them.) Let's practice a few times...okay? (Follow procedure. If subjects have no questions after the practice session, let the program continue, and inform them of this.)

READING INSTRUCTIONS: The computer will briefly present a row of X's followed by a word typed in upper-case letters. You are to read that word out loud. You will have plenty of time to do this before the computer will present the next series. Do you have any questions? (Answer them.) Let's practice a few times...okay? (Follow procedure. If subjects have no questions after the practice session, let the program continue, and inform them of this.)

(Give directions in a predetermined order. After all items have been presented, give the subject the random number table.)

I would now like you to start at the top of the first column of numbers and working down, circle all the three's that you see. If you get to the bottom before time is called, then go to the next column. Begin when you are ready and I will tell you when to stop.

(After 2 minutes.) Stop. (Remove number table.) Now please take the sheet of notebook paper and the pencil (give it to them) and focus your attention once again to the computer screen.

SEMANTIC CUED INSTRUCTIONS: The computer will present a word briefly. Use this word to help you remember a word that you stated previously. The correct answer always means the same as the word that the computer shows you. You will have plenty of time to write down a word before the computer presents the next. If you are unsure of a word, feel free to write one down anyway. Don't worry if you should happen to miss a few. Do you have any questions? (Answer them.) Let's practice a few times...okay?

(Begin the program. If the subject has no further questions and understands the directions, let the program continue.)

GRAPHEMIC CUED INSTRUCTIONS: The computer will present a word briefly. Use this word to help you remember a word that you stated previously. The correct answer always looks the same as the word that the computer shows you. You will have plenty of time to write down a word before the computer presents the next. If you are unsure of a word, feel free to write one down anyway. Don't worry if you should happen to miss a few. Do you have any questions? (Answer them.) Let's practice a few times...okay? (Begin the program. If the subject has no further questions and understands the directions, let the program continue.)

(Removing response sheet after the end of the test phase.) This concludes the study. This study is an attempt to determine if rare and common words affect your memory when you study them in certain ways. I do ask that you please not tell others about the study for the next two weeks, as they too may be subjects. I do thank you for your participation, and I will tell your instructors that you participated.

Name____________________

Starting at the top of the first column and moving down, carefully, but rapidly search for the number three (3). Everytime you see a three (3), circle it. Continue searching until researcher says "stop."

10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
24130	48360	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
37570	39975	81837	16656	06121	91782	60468	81305	49684	60672	14110	06927	01263	54613
77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
89579	14342	63661	10281	17453	18103	57740	84378	25331	12566	58678	44947	05585	56941
85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12243	90511	33703	90322
09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
01011	54092	33362	94904	31273	04146	18594	29852	71585	85030	51132	01915	92747	64951
52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
00742	57392	39064	66432	84673	40027	32832	61362	98947	96067	64760	64584	96096	98253
05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
69011	65795	95876	55293	18988	27354	26575	08615	40801	59920	29841	80150	12777	48501
25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
91567	42595	27958	30134	04024	86385	29880	99730	55536	84855	29080	09250	79656	73211
17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
46503	18584	18845	49618	02304	51038	20655	58727	28168	15475	56942	53389	20562	87338
92157	89634	94824	78171	84610	82834	09922	25417	44137	84813	25555	21246	35509	20468
14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
98427	07523	33362	64270	01638	92477	66969	98420	04880	45585	46565	04102	46880	45709
34914	63976	88720	82765	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
70060	28277	39475	46473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
53976	54914	06990	67245	68350	82948	11398	42878	80287	88267	47363	46634	06541	97809
76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41151	14222	60697	59583
90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
08962	00358	31662	25388	61642	34072	81249	35648	56891	69352	48373	45578	78547	81788
95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
15664	10493	20492	38391	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653

I, Matthew C. Johnson, hereby submit this thesis to Emporia State University as partial fulfillments of the requirements for an advanced degree. I agree that the Library of the University may make it available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching) and research purposes of a nonprofit nature. No copying which involves potential financial gain will be allowed without written permission of the author.

Signature of Author

5-14-93

Date

Word Frequency and the Conceptually-Driven/ Data-Driven Processing Distinction of Memory Retrieval

Title of Thesis

Doug Cooper

Signature of Graduate Office Staff Member

May 25, 1993

Date Received