

THE EFFECTS OF CONTEXT AND FRAGMENT SIZE UPON  
WORD FRAGMENT COMPLETION

by

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## ABSTRACT

### THE EFFECTS OF CONTEXT AND FRAGMENT SIZE UPON WORD FRAGMENT COMPLETION

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Two experiments using the fragment completion task attempted to study the influence of adding contextual information during presentation of an item. Conceptual context was varied by presenting: 1) synonyms with the fragment (a conceptual driving procedure); 2) letters adjacent to the fragment (a data driving procedure); rhyming words with the fragment. Rhyme context can be considered a data driving procedure when many of the same letters occur in both target and rhyming words (e.g., LIBRA for Z B \_ \_).

In Experiment I, exposure times of seven to fifteen seconds were used. These were long enough to enable the subject to use conceptual information to enhance fragment solution. In Experiment II, very brief presentation times (1/6 second and 1/3 second) were employed. This procedure was an attempt to force subjects to rely on the earlier data-driven processes in performing the task.

The results of Experiment I were similar to those of previous studies and showed that all context conditions enhanced fragment completion relative to the control condition. No differences between types of context were demonstrated.

Results of Experiment II showed that conceptual contexts strongly interfere with fragment completion. Under some conditions, only letter contexts (data driving)

appear to enhance fragment completion. These findings suggest that it may be impossible to experimentally separate data-driven from conceptually-driven processes using current laboratory methods. Further research using brief presentations may be necessary to evaluate the interference effects found in Experiment II.



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## INTRODUCTION

Recent memory theorists have attempted to present evidence for a number of different memory subsystems that use different codes, exhibit different retrieval or access processes and different forgetting mechanisms. Tulving (1972, 1983), for example, proposes that autographical knowledge (episodic memory), world knowledge (semantic memory) and motor skills (procedural memory) are based upon different storage processes in the human brain. Tulving employs evidence from neuropsychology (PET scan studies and brain damaged patients) and behavioral evidence (test dissociations) to justify these distinctions. Neuropsychologists have long known that some forms of brain damage may produce patients who are extremely forgetful about personal experiences yet retain world (historical) knowledge and retain motor and perceptual skills intact. Also, performance of normal subjects on different memory tests can be uncorrelated. Words or verbal symbols recently read may not be easily recalled a few days later but the perception of these words, when briefly flashed, is enhanced or primed relative to similar words not read as recently (Jacoby and Dallas, 1981).

Attempts to postulate different storage systems in human memory have been criticized on both logical and empirical grounds (McKoon, Ratcliff and Dell, 1986). McKoon, *et al.* argue that there is no logical basis for classifying various memory tasks as representing cases of semantic, episodic or procedural memory and, in fact, any



such classification is based solely upon intuition. Moreover, there appears to be no clear and generally accepted criteria that permit one to postulate the existence of new and different memory systems. Also, there may be no *a priori* basis for determining how specific independent variables will affect a specific memory system.

The standard alternative to the multiple storage system view has been developed by Roediger and his colleagues (Roediger and Blaxton, 1987; Jacoby and Dallas, 1981; Roediger, Weldon and Challis, 1989). They assume that there is a single storage system that is accessed in different ways. In fact, memory tests differ in the degree to which they are accessed by sensory data (reading the word *elephant*) as opposed to relying upon more abstract conceptual and associative processes for retrieval (i.e., the name of a very large animal with very rough skin and a large trunk is \_\_\_\_\_). Roediger, *et al.* (1987, 1989) attempt to classify different memory tasks on a continuum depending upon the degree to which access is driven by data rather than by more abstract conceptual associations. Again, Tenpenny and Shoben (1992) question the utility of this approach, suggesting that there is no *a priori* basis for determining which independent variables are perceptual and which will affect only conceptual processes. Also, if some memory tasks require or utilize both data-driven and conceptually-driven retrieval processes, there are no well established procedures to determine proportion or weight of each of the component processes affecting the test performance.

Rather than attempting to speak to the theoretical debate, the present study attempts to broaden the research data base related to data-driven or implicit memory

tests. The experiments described below attempt to study the completion of very degraded words under a number of different test conditions. The particular memory task employed in the present research is called word fragment completion. The test requires the subject to construct a word from a letter string with missing letters - for example CZ\_\_ for CZAR or \_W\_P for SWAP. The fragments are typically presented for eight to sixteen seconds so that the subject may try different letters, sounds or syllables until the correct word occurs to him or her. The fragments generally have only one possible completion and the test is considered to be an implicit or data-driven test (Roediger, 1990). Also, completions are more frequent for words recently seen (primed) even though the subject may not be aware of having read the words recently.

In summary, the present research will study variations of the fragment completion task which has been taken as an implicit memory task and/or a task that is primarily data-driven. The task requires the completion of words with missing elements with the first word that "comes to mind". The subject is given a degraded string like \_L\_P\_A\_T for ELEPHANT or Z\_B\_A for ZEBRA and attempts to identify the word represented. Performance is said to be data-driven or perceptual because the test stimulus is severely degraded and the subject must try to resolve the test stimulus into a meaningful word.

The present research attempts to vary the accuracy of test performance as a function of recency priming and the addition of various kinds of contextual information adjacent to the test fragment. First, a brief discussion of implicit vs. explicit memory tasks will be presented.



Explicit memory tasks are those in which subjects are asked to consciously recollect information presented during a recent learning episode. At the time of testing, the subject is aware of that specific learning situation, and the act of remembering is intentional (Schacter, Bowers & Booker, 1989). Most of the research (and theory) on human memory is based upon explicit tests (i.e., recognition or recall).

Implicit memory tasks are those in which task performance might be facilitated by or changed by information acquired during a previous learning episode. In contrast to the explicit task paradigm, instructions in the implicit testing situation do not refer to the learning phase of the experiment; participants are often merely asked to perform the task using the first information that comes to mind. Also, subjects need not intentionally perform the act of remembering or recollecting in order to perform effectively on implicit tests (Schacter, 1987).

As mentioned above, implicit memory tasks may also utilize priming to assess retention. Priming refers to prior exposure to a test item (cf. Richardson-Klavehn & Bjork, 1988) which the subject is unaware of at the time of testing. Specifically, to evaluate priming, comparisons are made of performance on tests of studied material with performance on tests of similar unstudied material. For example, priming on a word fragment completion test would be measured by the proportion of fragments of studied words successfully completed relative to successful completion of unstudied words.

# EXPERIMENT I

## Introduction

The present research was concerned with variations of the fragment completion task which is classified as an implicit memory task and/or a task that is primarily data-driven. The task requires the completion of words with missing elements with the first word that "comes to mind". The subject is given a degraded string like \_L\_P\_A\_T for ELEPHANT or Z\_B\_A for ZEBRA and attempts to identify the word represented. Performance is said to be data-driven or perceptual because the test stimulus is severely degraded or data-limited and the subject must try to resolve the test stimulus into a meaningful word. In order to strengthen the data-driven component of the test, letters may be added to any fragment in order to enhance completion (Z\_B\_A vs Z\_BRA). Also, adjacent context words may be present on the test to enable more conceptual access processes to cue completion (e.g., present the word, *horse*, adjacent to Z\_B\_A). The present study employs a number of test contexts that might be expected to induce various combinations of data-driven and conceptually-driven processes to influence the fragment completion test. Finally, in this study, subjects have thirty seconds to complete two fragments so that long term memory can be used to enhance conceptual processes.



## METHOD

### Subjects

Thirty subjects participated in the study. The subjects were undergraduate introductory psychology students whose participation was a course requirement.

### Design

The design is a 2 x 2 x 2 x 5 within-subjects factorial design. Factor A, word length, was five or six letters. Factor B was fragment size (two letters or three letters presented). Factor C was priming (primed or unprimed) and Factor D was context (dollar signs, a target letter, a rhyme of the target, a word related in meaning to the target, or both, i.e., a rhyme and a semantically related word). Examples of each context condition are presented in Table I.

Table I. Examples of Word Fragments Presented in Each of Five Context Conditions.

Fragment Context					
	1.	2.	3.	4.	5.
	NOISE	LETTER	RHYME	SYNONYM	RHYME/ SYNONYM
Context	\$ \$ \$ \$	\$ \$ N \$	ARE	SPICE	FEEL
Fragment	Q _ _ Z	J _ _ X	C Z _ _	H _ _ B	Z _ A _
	\$ \$ \$ \$	\$ \$ \$ \$	JAR	PLANT	FERVOR

## Materials

The materials were eighty unique two-letter fragments taken from the pool of 1,086 words published by Gibson and Watkins (1948). Forty were fragments of five-letter words and forty were fragments of six-letter words. For each word, the investigator found a semantically related word from a thesaurus, and a rhyming (or near rhyming) word. An attempt was made to select rhyme context words that contained few of the target letters (i.e., RACK for PLAQUE, TOUGH for BUFF, etc.), but this was not possible for most targets (LIBRA for ZEBRA, etc.) Three sets of materials were used with a different list given to every ten subjects. Appendix A shows a complete set of materials for List A. For each of the three sets of materials, a forty page booklet was made up for each subject, with two fragments (plus context) contained on each page.

## Procedure

Subjects were first given a sheet containing a list of forty words, some of which would appear later in the experiment in the form of word fragments which they would be asked to complete (Appendix C). Subjects were told that the words would be used in a spelling test for children and were asked to rate the words on a five-point scale according to perceived difficulty of its spelling.

Subjects were then given a copy of the instructions (Appendix B) and were asked to read it while it was being read aloud by the investigator. They were subsequently given ten practice fragments to complete (Appendix D). When all had



completed the practice items, they were given the solutions and asked if they had any questions about the experiment. After any questions were answered to the subjects' satisfaction, subjects were instructed as follows: "There are two items on each page of your booklet similar to those you just completed. You will have thirty seconds to complete each page. At the end of thirty seconds, I will say, 'TURN'. Please turn the page then even if you have not completed both fragments. If you are not sure about any fragment, feel free to guess."

Subjects had one of three possible lists. The entire experiment lasted approximately twenty minutes and consisted of eighty fragments. Subjects were then given a copy of a debriefing statement (Appendix E), thanked for their cooperation and excused.

## RESULTS

A 2 x 2 x 5 x 2 within subjects factorial analysis of variance was performed on the data. Following this analysis, Tukey (HSD) post-hoc mean comparison tests were performed on the final context means. Table 2 shows the proportion of correct fragment completions for each condition of the experiment.

Table 2. Proportions of Completions for Each Test Context - 30 S's

Word Size	Fragment Size	Priming Condition	Noise (Control)	Letter	Rhyme	Meaning	Rhyme/ Meaning
5 Letters	Two Letters	u	.32	.33	.40	.58	.72
		p	.43	.75	.70	.82	.77
	Three Letters	u	.67	.83	.83	.82	.90
		p	.68	.88	.85	.93	.93
6 Letters	Two Letters	u	.27	.30	.25	.38	.52
		p	.27	.67	.68	.57	.67
	Three Letters	u	.35	.73	.62	.73	.90
		p	.65	.87	.77	.90	.85

p = primed

u = unprimed

Visual inspection of Table 2 shows that the unprimed condition (.57 correct) resulted in lower performance than the primed condition (.74 correct completion). There was a substantial difference in performance between all context conditions and the control (\$\$\$\$) condition. Also, as expected, performance levels were higher on five letter word completion (.71) than six letter words (.60). Also, three letter

fragments were easier to solve than were two letter fragments (.79 vs .52 respectively).

The Analysis of Variance on the correct responses confirmed that all four main effects were highly significant. Specifically, for word size  $F(1,29) = 38.35$ ,  $p < .0001$ ; for fragment size  $F(1,29) = 224.82$ ,  $p < .001$ ; for context  $F(4,116) = 35.51$ ,  $p < .0001$  and finally for the priming effect  $F(1,29) = 74.23$ ,  $p < .001$ . There were only two significant two-way interactions. Specifically, fragment size interacted with priming  $F(1,29) = 12.11$ ,  $p < .002$  and the context by priming interaction was also significant  $F(4,116) = 6.70$ ,  $p < .0001$ . Finally, there was one significant three-way interaction. fragment size by test context by priming  $F(4,116) = 4.28$ ,  $p < .003$ . No other interactions were significant.

The Tukey (HSD) comparison among the context means indicated that the baseline noise context performance was inferior to all other text contexts. Apparently, all contexts produced superior fragment completion relative to the no context baseline. The Tukey comparisons also showed that the meaning (synonym) context and the synonym plus rhyme context did not differ from each other. Finally, there was no difference in overall performance among the letter, rhyme and meaning contexts.



## DISCUSSION

The present study showed that, as expected, ability to recognize and reconstruct words from fragments was more difficult with longer words (six letters) than shorter words (five letters). It also showed, as expected, that any help or information in the testing context which subjects were given (rhyming or near rhyming words, synonyms or near synonyms, one of the missing letters) resulted in better performance than the control condition in which no potential information of any kind was given on the test. Again, as expected, when the fragment size is increased, (i.e., \_Y\_ \_ P vs \_Y\_UP for SYRUP) fragment completion is greatly improved. Finally, fragments of the words that were read 30 minutes earlier (primed) on the spelling difficulty rating portion of the study, were completed more easily than the unprimed items.

Adding letters (by increasing the fragment size) may be viewed as data driving the recognition process, whereas adding rhymes, close synonyms or both to the test may be viewed as attempts to trigger recognition by slower, conceptually driven processes that are also part of the memory retrieval process. Thus, word recognition is viewed as a pattern recognition or pattern matching process that uses orthographic, phonological (rhyme) and semantic information to constrain the solution to the fragment. In general, when long (10-15 seconds) fragment exposure times are used, one may view the fragment completion task as analogous in many ways to the

process required in crossword puzzle solving where letters and meanings are combined to isolate the correct word.

Perhaps the more interesting aspects of this experiment were the significant interactions. The three-way interaction - priming by fragment size by context - was broken down into two fragment size by context interactions, one for the unprimed words and one for the primed items. For the primed words, all contexts are about equally helpful and well above the baseline noise context. Performance on the easier three letter fragments is at least 15% higher than for two letter fragments (Figure 1).

The picture for unprimed words appears to be quite different (Figure 2). For the three letter fragments, the best performance (.90) is for the meaning plus rhyme context; the worst for the base noise (.51), and the letter, rhyme and synonym contexts are very similar to one another (.78, .73 and .77, respectively). For the most difficult two letter fragments, the base noise condition, the letter context, and the rhyme condition are equal. There is better completion performance for close synonyms (.48) and the best performance (.62) is for the synonym plus rhyme context.

The above is relevant to the two-way context by priming interaction which appears to be mainly due to the unprimed items. Finally, the fragment size by priming interaction indicates a larger fragment size effect for the unprimed words in comparison to primed items. The primed items are closer to the ceiling performance and adding more letters (data driving) does not increase performance as much as for the unprimed items. Overall, the effects of test context in this presumably implicit

memory task depend upon whether the items were primed or not and whether the fragment size is two or three letters. For primed items, all test contexts may be superior to the base condition and equal to each other in efficiency.



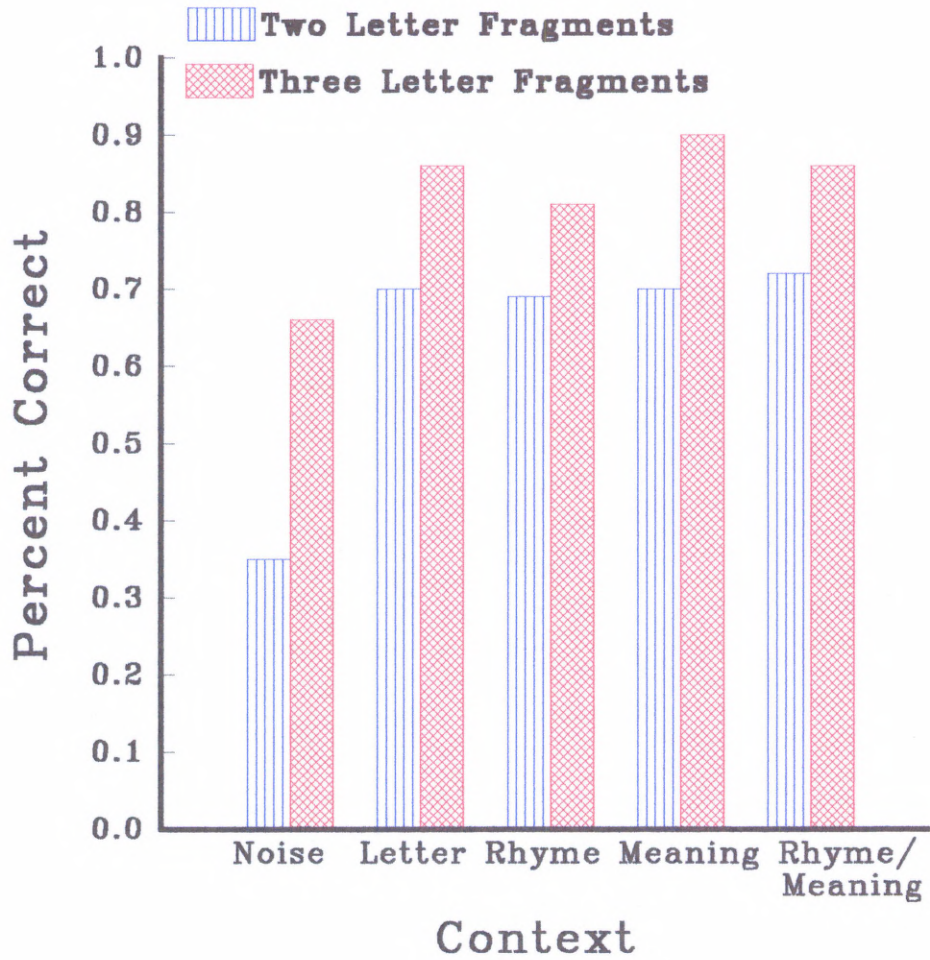


Fig. 1. Graphic Representation of Fragment Size x Context Interaction for Primed Words

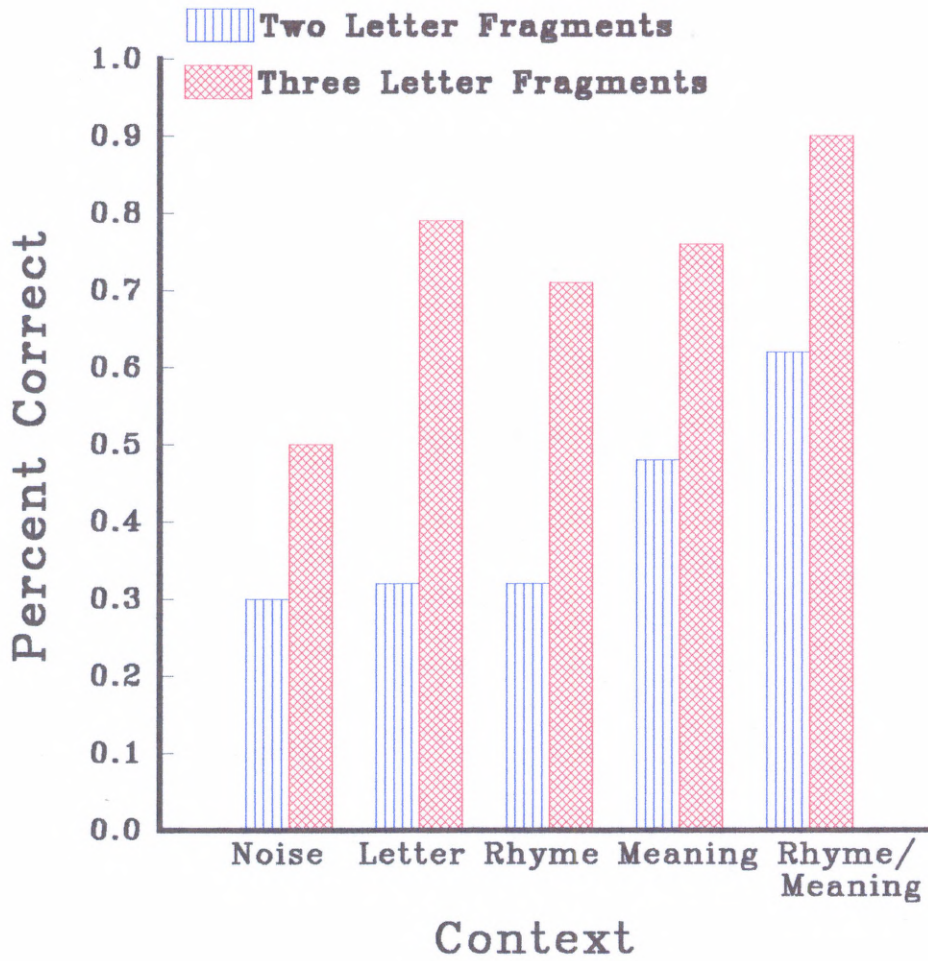


Fig. 2. Graphic Representation of Fragment Size x Context Interaction for Unprimed Words

## EXPERIMENT II

### Introduction

Most theories of memory have been constructed on the basis of data from explicit memory tests in which the subject is directly questioned about a previous experience and consciously attempts to reconstruct the time and context of that experience. Recall (free and cued) and recognition tests are presumed to represent explicit memory processes. Schacter (1987) and Warrington and Weiskrantz (1970) have reviewed experiments showing that subjects with amnesia exhibit impaired performance on explicit tests but show normal priming and performance on fragment completion and word stem completion. These results, which show a dissociation between explicit and implicit memory performance, are said to have important implications for memory theories. The major debate is whether dissociations are best interpreted as the result of different memory systems (Schacter, 1987) or whether explicit and implicit tests involve different retrieval modes that occur within a single memory system (Roediger, 1990).

The majority of studies using the fragment completion task (an implicit test) have given subjects a considerable amount of time to complete the fragment. Almost all studies (Massaro *et al.*, 1991); Roediger and Challis, 1992) present fragments for 15, 20, or 30 seconds and this permits the subject to try out different strategies to complete the fragment. Subjects may try different letters; think of a "new" word or sound, then try another vowel sound and, through such reiterative retrieval cycles,



may ultimately solve the fragment. Thus, the long test fragment exposures permit subjects to easily combine bottom-up (letter and vowel additions) and top-down (word associations and sounds) in order to complete the fragment. It might be instructive to reduce the solution time in order to constrain the subject to use fewer or quicker strategies.

Consequently, the major purpose of Experiment II was to provide a broader and enriched data base for interpreting the effects of retrieval cues in the fragment completion task. This study presented four-letter word fragments for either 1/3 second or 1/6 second with various contextual cues. Such brief presentations were expected to force subjects to employ more perceptual or very early retrieval processes (bottom-up) and to reduce the reiterative top-down strategies that might be most dominant when subjects have seconds or minutes to complete a word fragment.

## METHOD

### Subjects

The subjects were thirty undergraduate introductory psychology students who participated in the study in order to fulfill a course requirement.

### Design

The design is a 2 x 2 x 2 x 5 mixed factorial design. Factor A was fragment exposure duration (166 m/sec vs. 333 m/sec) and was the between subjects factor. The remaining factors were within subjects. Factor B was fragment size (two letter fragments vs. three letter fragments). Factor C was priming (primed vs. unprimed target word) and Factor D was test context (noise, noise plus a target letter, a rhyme of the target, a close synonym of the target, or rhyme plus synonym).

### Materials

The materials were 40 unique two-letter fragments taken from the pool of 1,086 word fragments published by Gibson and Watkins (1988). For 20 of the fragments, another letter was added (letter position was chosen at random) in order to produce a three-letter fragment. Results of pilot experiments showed that only the four letter word fragments could be "solved" with brief flashes of 1/6 or 1/3 second. The five and six letter words produced extremely poor performance. As in Experiment I, a rhyme and close synonym was found for each fragment (*with* for *myth* and *fable* for *myth*, etc.). Three sets of materials (Lists A, B, or C) were used, one list for each

ten subjects. In each list, individual word fragments were randomly assigned to one of the five context conditions. The fragments, with their respective contexts, were each typed on a white 4" X 8" card with the context typed above each fragment (e.g., COOK was typed above the fragment \_HEF for CHEF). Appendix H shows examples from List A.

### Procedure

Upon arrival, subjects received a printed list of 20 four-letter words (see Appendix G). They were told that a future spelling experiment was planned and before the present study was initiated, we would like them to rate the spelling difficulty of each word on the list on a five-point scale. The very easy words should be rated 1, quite easy = 2, 3 for medium difficulty, 4 for quite hard and a 5 for very difficult. A poster with the rating scale was preset on the T-scope table during the rating procedure. Following this, subjects were given typed instructions which the subject viewed while the experimenter read them aloud. The instructions are presented in Appendix F. Subjects were then flashed ten practice cards which contained examples of each type of context-fragment condition and were asked to complete the word fragment. The practice fragments were presented for 500 m/sec. (i.e., 1/2 second) so that subjects could "warm up" for briefer presentations. Subjects were then told that 40 more fragments would be flashed to them and that these would be briefer flashes. They were instructed to name the word represented by each fragment and to guess if necessary. Subjects were also told that the word or symbols above the fragment might sometimes be helpful or contain clues to the word fragment.



Each subject then received 40 fragments at one of the two brief exposure durations. The experimenter recorded the subjects' verbal response, if there was one. The session took about 20 to 25 minutes for each subject, including the practice, instructions and presentation of the 40 fragments.

## RESULTS

A 2 x 2 x 5 x 2 (exposure duration x fragment size x test context x priming condition) split plot Analysis of Variance was performed on the raw data. Following the ANOVA, Tukey (HSD) mean comparisons were done on the test context means. Table 3 shows the proportion of correct fragment completions for each experimental condition. Each proportion is based upon 30 subjects and two fragments (60 observations).

Table 3. Proportions of Correct Fragment Completion for Each Exposure, Priming Condition, Fragment Size and Test Context.

Exposure Duration	Fragment Size	Priming Condition	Noise	Letter	Rhyme	Meaning	Rhyme/ Meaning
166 m/sec	2 letter	u	.18	.53	.45	.12	.17
		p	.55	.63	.60	.43	.40
	3 letter	u	.78	.58	.53	.78	.57
		p	.80	.80	.85	.77	.65
333 m/sec	2 letter	u	.37	.55	.45	.22	.35
		p	.43	.70	.63	.62	.62
	3 letter	u	.93	.75	.57	.93	.73
		p	1.00	.90	.88	.90	.78

Visual inspection of Table 3 indicates that performance is better with a longer exposure duration (.56 for 166 m/sec vs .67 for 333 m/sec). Primed fragments are completed more often than unprimed words (.70 vs .53). Also, increasing fragment size from two to three letters greatly improves performance (.45 vs .77). Finally, there appears to be a complex pattern of differences among the test context

conditions.

The ANOVA confirmed that all main effects were significant. For exposure duration,  $F(1, 58) = 13.89, p < .004$ ; for fragment size,  $F(1,58) = 360.90, p < .0001$ . Similarly for context,  $F(4,232) = 9.26, p < .001$  and for priming,  $F(1,58) = 101.40, p < .0001$ .

There were three significant two-way interactions. First, duration and context interacted,  $F(4,232) = 2.56, p < .04$ . Also, the interaction between fragment size and context was significant  $F(4,232) = 25.13, p < .0001$  and the fragment size by priming interaction was significant  $F(1,58) = 8.47, p < .005$ .

There was a single three-way interaction between fragment size, context, and priming,  $F(4,232) = 8.46, p < .0001$ .

The Tukey (HSD) comparison of the context means indicated that the no context (noise) condition did not differ from the letter or rhyme contexts and that these three contexts produced better performance than the rhyme plus meaning context. Also, the no context, rhyme and meaning contexts were not different. Finally, the synonym or meaning context was not different from the rhyme plus meaning context.



## DISCUSSION

The use of brief exposures in fragment completion might be expected to restrict subjects to the use of early sensory and data-driven processes and consequently reduce the employment of the more time consuming conceptual processing strategies. In fact, relating to the no context (noise) baseline, contextual information appears to often interfere with fragment completion.

First, the duration by context interaction (A x C) appears to be due to the fact that increasing exposure duration from 1/6 second to 1/3 second improves performance for all contexts except the rhyme context. The reason for this result is not immediately apparent. One hypothesis is that most rhymes contain more than one of the same letters as the word represented by the fragment and this may cue the solution. Also, the letter recognition process, which is very rapid, is not helped by doubling the exposure. The problem with this view is that the letter context (which contains only one of the fragment letters mixed with dollar signs) does indeed show improved performance with an increase in exposure duration. Since the rhymes on the average contained more than one letter in common with the fragment, strong letter cuing may have occurred even with the briefest exposure time.

The fragment size by context interaction (B by C) tends to show a pattern that was expected. In general, for the larger fragments (three letters) any context presented with the fragment tends to be disruptive relative to the baseline (noise) context. The proportions for the noise, letter, rhyme, meaning and rhyme/meaning contexts are .88, .76, .71, .85, and .68, respectively. On the other hand, for two

letter fragments, adding contextual letter information (i.e., letter and rhyme) improves performance above the baseline. The proportions correct for the noise, letter, rhyme, meaning and rhyme/meaning contexts are .38, .60, .53, .35, and .39, respectively. This interpretation could be weakened by the significant Fragment Size x Priming x Test Context interaction. Thus, the Fragment Size x Context interaction was analyzed separately for each level of priming. Apparently, the pattern above is not altered since the proportions of correct completions are similar for the noise, meaning, and rhyme/meaning conditions for two letter fragments, i.e., there is a Context effect. For three letter fragments, however, the baseline noise condition is the best, i.e., there is no effect of Context. The triple interaction is due to the high performance on three letter primed fragments over all five contexts in contrast to the lower performance on unprimed three letter fragments in the letter (.67) and rhyme (.55) conditions. Priming reduces the test interference for three letter fragments. There is little interference for the meaning (synonym) context relative to the noise control.

Finally, the fragment size by priming (B by D) interaction was significant as it was in Experiment I where the B by D interaction indicates the priming effect is bigger for the more difficult two letter displays than for three letter fragments. In this study, the B by C by D interaction complicates this result. Examining the Fragment Size x Priming interaction for each context shows that this result mimics that of Experiment I except for the letter and rhyme (data-driven) contexts. While there is little or no priming effect for three letter fragments in the noise, meaning, and rhyme/meaning contexts, there is a large effect of priming for the letter and rhyme conditions.



## SUMMARY

In Experiment I, subjects who were shown word fragments for several seconds were able to use various types of context information (single letter, rhyme, or synonym) to enhance fragment completion. For the unprimed words, a combination of rhyme and semantic cueing appears to be most useful to the subject. For primed words, however, all cues appeared to be equally effective and more effective than for unprimed words. One can assume that the presentation time (15 seconds) allowed the subjects to use a mixture of "bottom up" and "top down" strategies to solve the word fragments.

In Experiment II, fragment presentations were very brief (1/6 sec. and 1/3 sec) in an attempt to force subjects to use fewer and quicker strategies. The results of this study showed similar effects for priming and for fragment size. In short, priming greatly enhanced fragment completion performance and increasing fragment size by adding an additional letter also greatly improved performance. In contrast to Experiment I, adding context cues (especially rhymes and synonyms) often produced performance below the baseline noise condition. A possible explanation is that with very brief presentations, any attempt to process context requires some of the time needed to process the fragment letters. By itself, this view seems unsatisfactory since interference does not occur for all contexts. It is clear that, for two-letter fragments, the presence of context letters or rhymes raises performance above the baseline noise condition. Apparently, the appropriate letters contained in most rhymes and the letter presented in the letter context are helpful to the recognition process.

These context letters could affect performance especially if the subject is unsure about letter position (i.e., does not remember which letters were context cues and which letters were contained in the fragment). Results of Experiment II suggest that different cognitive processes are occurring when brief presentations are used. Clearly, more research is needed to examine and explain the strong interference effects observed in Experiment II. Extending the data base for word fragment studies by employing brief presentations might be a rewarding endeavor.

APPENDIX A

MATERIALS (LIST A ONLY) USED IN EXPERIMENT I

RACIAL	\$A\$\$\$	\$\$W\$\$	\$\$O\$\$	REPAYS
_H_C	_M_ZE	O__G	__WD	_B_ZE
\$\$\$R\$\$	HURTS	CROUCH	POSITIONOUS	KILT
_NJ_Y	_K_T_	_QU_T	__X_C	_K_R_
\$\$\$Q\$\$	UNDERTAKING	FARTHER	MUSKET	
__UO_	_F__R	Y__D__	R_FL_	
	REPAIR			
IDENTICAL	\$U\$\$\$	LIBRA	\$\$\$\$\$\$	MORPH
_Q_L	_O_BT	Z__A	P_Z__	_W_RF
\$\$N\$\$	REPEL	NOMAD	\$\$\$\$\$\$	PLASTIC
I____X	_XC_L	_Y_S_	_N_Q_E	V__YL
		TYPSY		FINAL

DEEPNESS

\$\$\$\$\$R

ACQUIRE

MINDS

\_EP\_H

\_\_SW\_\_

\_B\_\_N

OB\_Y\_

KEPT

REPAYS

\$H\$\$\$

TRANSPARENT

\$\$\$\$\$

MARKET

\$\$\$\$\$

K\_\_KI

\_P\_Q\_E

\_Y\_UP

B\_\_AA\_

E\_J\_Y

BLURBS

SOUP

PUNTS

UNANCHORED

V\_RB\_

D\_\_P

K\_C\_\_

A\_\_FT

SILHOUETTE

MASH

\$\$\$\$\$\$

OATH

\$\$\$\$\$\$

SH\_\_W

\_Q\_SH

R\_V\_\_W

G\_\_WT\_

CL\_\_X

POSH

PORRIDGE

\$\$\$\$\$\$

HEAP

SIGHTS

COFFIN

\_EW\_G\_

C\_G\_\_C

AS\_\_P

V\_\_W\_

OF\_\_N

EXCUSE

WASH

CONFUSION

ODD

\$\$\$\$\$\$

\_L\_\_I

\_CR\_B

\_\_AO\_

QU\_\_R

Y\_\_H\_\_

RABBI

PATHOS



\$\$\$\$\$

MIFFED

\$\$\$\$\$

\$\$\$E\$

\_X\_\_C

\_W\_F\_

T\_\_Q\_\_

\_C\_\_W

A\$\$\$\$

KNOWLEDGE

\$\$\$\$\$

CHASM

\$\$\$\$\$

\_R\_\_W\_

\_\_SD\_\_

\_W\_RM

\_P\_S\_

QU\_K\_

ATHENIAN

\$\$T\$\$

\$\$T\$\$\$

RACK

FETCH

G\_\_EK

QU\_\_A

Y\_\_\_H\_

P\_\_Q\_\_

\_K\_\_C\_

SUBMIT

\$\$\$\$\$

PLASTIC

\$B\$\$\$\$

\$\$\$\$\$

O\_\_W\_\_

\_\_I\_B

\_\_AG\_C

EM\_\_Y\_

S\_\_Z\_

DISASTEROUS

\$A\$\$\$\$

\$\$\$\$\$

\$\$\$E\$\$

ALLOCATE

\$\$\$\$\$

V\_\_U\_M

R\_\_\_W

\_H\_\_WD

\_S\_\_G\_

J\_A\_\_

REFINE

ENCLAVE

FALLACY

DISAPPEAR

BAR

B\_H\_V\_

G\_\_X\_

VA\_\_\_H

T\_V\_\_\_

ACT

UNIVERSE

NICHE

## APPENDIX B

### SUBJECTS' INSTRUCTIONS FOR EXPERIMENT I

You will be presented with a series of English words with some letters missing (for example, M\_RT\_NI for MARTINI). For each word, try to identify the word it represents and write in the missing letters. Above or above and below each word there may be other words or dollar signs and a single letter. These "hints" may help you determine what word the word fragment represents. There are two word fragments on each page of your booklet and you will be given fifteen seconds to complete them. When the experimenter says, "TURN", you are to turn the page and try to complete the next fragments. Please turn when the instruction is given. If you are not sure, guess on any fragment. Before we begin the study, you will complete a practice page and can ask any questions you may have then.

## APPENDIX C

### LIST A: PRIMING ITEMS FOR PRIMED FRAGMENTS IN EXPERIMENT I

Please study the following words:

UGLY  
EATS  
RARE  
PAYS  
URNS  
SIGN  
COZY  
JINX  
STAY  
QUIT  
BLOC  
TOYS  
STUD  
MYTH  
YARD  
ERRS  
UGLY  
WOMB  
WHIZ

## APPENDIX D

### EXPERIMENT I PRACTICE ITEMS

Next to each item, write the word that completes the fragment.

DESIRE  
U \_ G \_

\$\$\$\$  
T \_ YS

\$\$\$\$  
\_ GN

TIS  
W \_ IZ

TURF  
Y \_ RD

HEXED  
NEX \_

\$\$\$\$  
Q \_ Z

ARE  
CZ \_

SPICE  
H \_ B

MET  
\_ BT  
OWING



## APPENDIX E

### DEBRIEFING STATEMENT FOR EXPERIMENT I

This experiment is testing the relative effectiveness of different kinds of context (graphic, phonological versus semantic) cues that enable readers to reconstruct and reorganize degraded words. This task is similar in some ways to solving crossword puzzles and also similar to reading words before complete information is obtained from the print. We are trying to determine how people add together different types of information in order to narrow down the possible words that can be related to an incomplete word or word fragment. The task is to specify how bottom-up data driven recognition interacts with knowledge about words. If you want to learn more about our study, you may read the following published journal article:

Rubin, D. C., Wallace, W. T. 1989. Rhyme and reason: analysis of dual retrieval cues. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 15:698-709

## APPENDIX F

### SUBJECTS' INSTRUCTIONS FOR EXPERIMENT II

This is an experiment on how people recognize 4-letter words when some of the letters are missing. The problem is similar to that of a crossword puzzle solver.

You will see some briefly flashed 4-letter words with some of the letters replaced by dashes \_ \_ \_ \_ , these incomplete words are called word fragments. Above each fragment is another word or some letters, or noise characters like dollar signs and these characters or words may help you figure out what word the word fragment below stands for.

Note, what you should try to recognize is what the word containing the dashes ( \_ \_ \_ ) or missing letters is. The other words or letters, above or below the dashed word, may or may not help but often will help you.

Before we start, we will show you some of the completed words that are the solution to the fragments that will be flashed. Try to remember these solution words. Finally, before we begin, we will give you some practice with 4 letter fragments so that your task will be clear to you. If you have any questions, please feel free to ask the experimenter. Thank you and good luck.

APPENDIX G

PRIMED (FRAGMENT) WORDS USED IN EXPERIMENT II

URNS  
JINX  
URGE  
RARE  
COZY  
SIGN  
STAY  
EATS  
PAYS  
DISC  
MYTH  
WOMB  
RAYS  
TOYS  
ENVY  
YARD  
WHIZ  
WOMB  
RAYS  
TOYS  
ENVY  
YARD  
WHIZ  
BLOC  
STUD  
ECHO



APPENDIX H

EXAMPLES OF LIST A ITEMS USED IN EXPERIMENT II

MOLASSES	DANCER	\$\$\$N\$\$	\$\$\$\$\$\$	SLACK
_Y_UP	__SW__	V___H	_P_Q_E	P_Q_
				TROPHY
TWIST	CEASED	\$B\$\$\$\$	BURNING	\$\$\$\$\$
T_Q_	Y_ST	__H_VE	_B_ZE	Q__A
			REPHRASE	

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