A VISUAL FACTOR IN RAPID VISUAL WORD IDENTIFICATION

THE EFFECTS OF SPECIFIC VISUAL EXPERIENCE ON RAPID VISUAL WORD IDENTIFICATION

by

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ABSTRACT

Four experiments were run to determine the role of specific visual experience in fluent visual word identification. The basic paradigm consisted of training Ss to rapidly provide the assigned English meanings of each of 20 pseudowords (e.g., PARTRAP - fire). Throughout training, half the pseudowords were consistently presented visually (Visual condition) and half were consistently presented auditorily (Auditory condition), with the assigned meanings presented auditorily for both conditions. In the Test Phase, which immediately followed training, the subject was required to judge whether a given training word's meaning fit appropriately into a sentence, with response time (RT) per word being the dependent variable. In this Test Phase all words were presented visually, which made it possible to observe any facilitation in meaning-access time due to prior visual experience.

Experiments #1 and #2, utilizing this procedure, demonstrated a facilitation due to specific visual experience on later rapid visual word identification.

Experiments #3 and #4 addressed the issue of whether the facilitation due to visual experience reflected (a) more efficient derivation of phonic-linguistic cues or (b) direct meaning-access from the visual presentation (a non-phonic process). Experiment #3 was interpreted as supporting the non-phonic processing alternative with the finding that auditory confusibility among the pseudowords had little or no effect on the RTs for Visual condition words while significantly lengthening Auditory

condition words' RTs. Experiment #4 provided further support for the non-phonic interpretation by demonstrating no alteration of the basic effect even when Ss were given added trials in training requiring them to rapidly read aloud some of the Visual and Auditory condition words. These latter results argue against the effect being due to either novelty on the initial visual presentation of Auditory condition words or to their lack of training in the derivation of phonic-linguistic cues from the visual stimulus.

It was concluded that specific visual experience is required to achieve the most rapid rates of visual word identification with strong evidence for such experience facilitating the development of a meaning-access process dependent on graphic-letter I.D. cues alone. No clear evidence for the operation of a phonic-linguistic recoding mechanism at these rapid rates of visual word identification was found. The implications of these findings concerning efficient reading in general were also discussed.

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INTRODUCTION

The purpose of this thesis is to determine whether visual experience with a meaningful word is essential to reach the most efficient level of visual identification of that word, and further to determine the way in which this word-specific visual experience might exert its effect.

In reading one is faced with the task of accessing the meaning of a word from the visual cues present on paper. But it is not clear how those visual cues are used. Since one learns to speak before one learns to read and write, words must be addressed in memory at least according to their acoustic or articulatory characteristics. Given that such a speech-based addressing system is already well-practiced by the time the individual learns to read, it is plausible that reading involves recoding symbols to the various sounds and then using the sound patterns to access meaning. This would have to be a complex process since in English the mapping from symbol to sound is not 1-to-1; but, such a process would allow the new reader to use his past knowledge, an advantage particularly important when meeting words he has not seen before.

This argument may be true for the beginning or poor reader, but for the efficient reader there could be a number of ultimately more efficient strategies. If words' meanings can be associated with various sound cues, then graphic cues should be able to form similar associations with meanings of words. Such a process would make the speech-based recoding process obsolete if the graphic-based meaning-access process can be performed more rapidly. However, this would require sufficient experience with each word to build up a new, visually-based address for every word in the reader's lexicon.

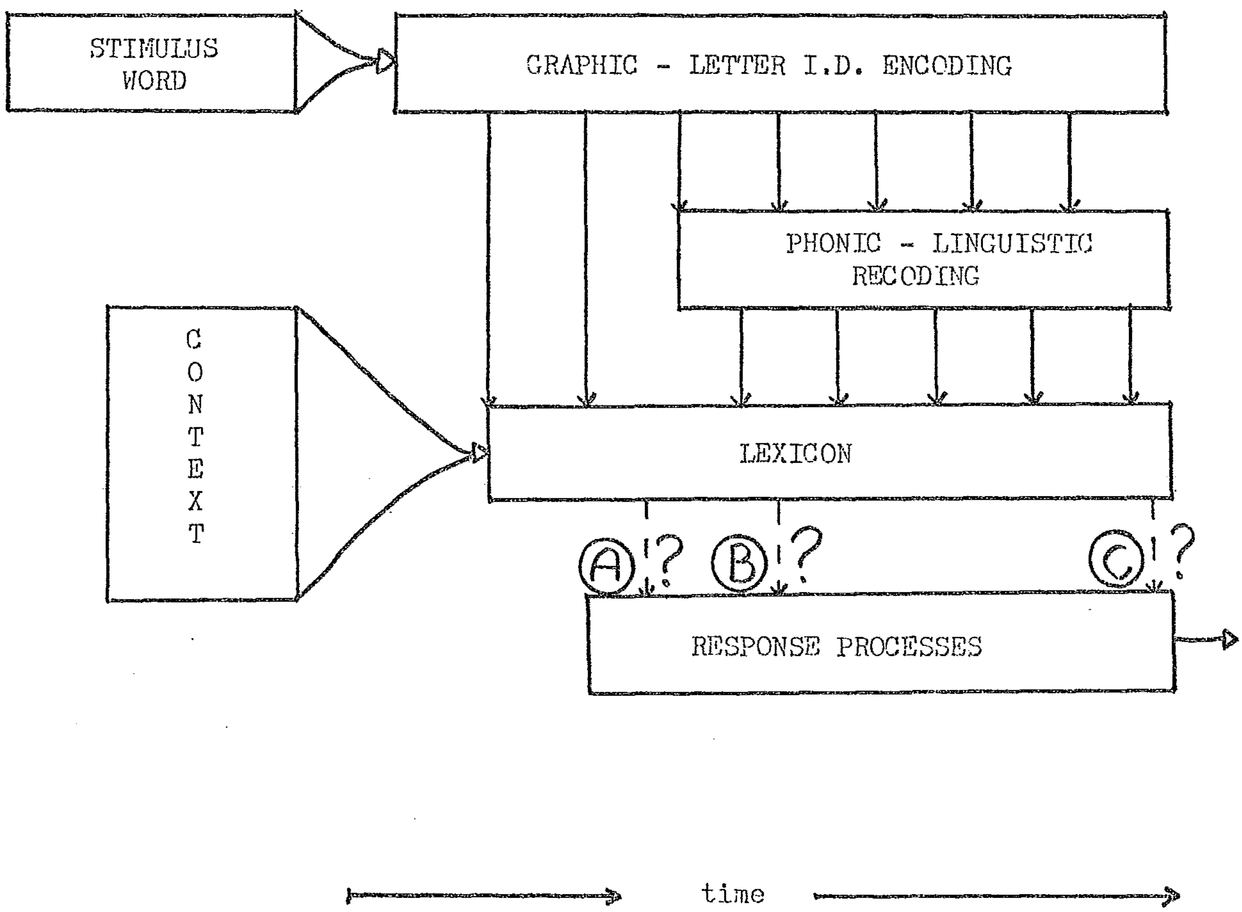
Dealing then with the nature of meaning access for well-practiced visual word identification, there are the following extreme possibilities: First, access of a lexical item could be dependent on a speech-based recoding mechanism whose efficiency is not determined by the degree of visual experience with the specific word to be identified. Of course this speech-based mechanism would still necessitate familiarity with the meaning and auditory form of the word as well as general facility with producing speech cues from the visual stimulus.

Second, access of a word's meaning could require visual experience with the specific word to attain its highest level of efficiency. This specific visual experience could operate in either of two ways: (A) By establishing a direct association between the visual word and its meaning and thus allowing meaning access from some coding of visual cues alone. (b) By facilitating the derivation of sound cues from the visual features available in the specific stimulus word. In this case visual experience is necessary for the most efficient visual word identification, though it plays no role in the actual meaning-access mechanism. Any of the above possibilities could operate in conjunction with any contextual cues used in accessing a given word's meaning.

The three word-processing possibilities in rapid visual word identification are pictured in Figure 1. The diagram represents the possible time courses of meaning-access mechanisms. The box labelled "LEXICON" represents the reader's collection of lexical items, that is

Figure 1

MODEL : Possible Processing Routes in Rapid Visual Word Identification as a Result of Specific Visual Experience



the meaning units into which written words are analysed. The lexicon collects information over time from sensory and contextual sources until there is sufficient information to specify a unique lexical item and thus initiate the response processes. This information is either gathered directly for the visual cues alone or requires additional sound pattern cues, necessarily derived from the visual presentation, before the lexical item can be accessed.

The three basic possibilities are represented by the dotted arrows in Figure 1 which occur at various points along the time scale. Path C represents the possibility that specific visual experience plays little or no part in affecting processing required for most efficient visual word identification. Paths A and B represent possibilities that show facilitation of visual word identification as a result of word-specific visual experience. Path B represents facilitation as a result of practice in the derivation of speech-based cues from the visual cues available, and path A represents facilitation based on the development of a direct meaning-access mechanism dependent on the information available from visual cues alone. The possibility that the lexicon operates on a combination of these processes will be considered later.

In this diagram, "graphic-letter I.D. encoding" is a term meant to include all analyses based on a word's graphic characteristics which do not involve any of the sound values of the words identified. Thus a word stimulus may be characterized by its overall shape or pattern, or according to certain letters or combinations of letters within the word. This includes such abstractions of the visual information as the identity of letters or letter groups considered independently of type face or case (e.g., the letter 'a' in apple or Adam). Also, the cues used for the identification of words might only involve critical parts of letters or combinations thereof.

Our term "phonic-linguisitc recoding" is meant to cover any of the following possibilities. (1) Auditory coding, involving use of a sensory modality and characterizing the word in terms of its associated acoustic properties; (a) Articulatory coding, involving use of a motor or kinesthetic-sensory modality and characterizing the word in terms of its associated articulatory properties (Hardyck & Petrinovich, 1970); and (3) use of some abstract verbal modality, which operates from the sound value information obtainable from a word stimulus (Hintzman, 1967; Wickelgren, 1969).

One important step in any program addressing these meaning-access issues is to empirically determine whether specific visual experience with a word is required to achieve the highest level of efficiency in the identification of that word. Upon finding a paradigm that demonstrates the facilitating effect of visual experience, we can then attempt to determine whether this facilitation is due to process A or process B in Figure 1.

There has been little research directly addressing this first step, the effect of visual experience on later rapid visual word identification. There has, however, been a considerable amount of research in related problems. For example, Beery (1968) in a short report provides the finding that a list of either English or nonsense words is learned to criterion in fewer practice trials when the words are seen as opposed to when they are only heard. This, however, only represents a facilitatory effect on trials to acquisition with no measure of the separate effect of visual experience on speed of performance at criterion. In addition, the faster acquisition may have been due to some mnemonic strategy induced by, for example, the longer effective presentation time of the visual stimulus rather than any specifically visual learning.

Haber (1965) found that the more often a given word was flashed in a tachistoscope, the more of the word's letters were clearly and correctly perceived by S according to Ss' reports. This suggests that prior visual experience with a word in some way facilitates the perception of that word. But, it does not address the issue of the effective cues in meaning access.

Postman and Rosenzweig (1956) gave Ss preliminary training of a set of nonsense syllables which involved a fixed number of repetitions of the syllables in either the visual or auditory modality. Following training Ss were required to recognize the stimuli either from a visual presentation in a tachistoscope or from an auditory presentation through masking noise. It was found that the transfer effects from visual training to auditory discrimination were more pronounced than vice versa. This could suggest that visual experience provides for an easier access or storage for a given word than a word which has only received auditory experience. In this case, however, it is difficult to effect a valid comparison across the two recognition measures, nor is there any meaning access required by the experiment.

Let us now consider what evidence would be relevant. Everyday experience with words in reading on the surface suggests a need for visual experience with a novel word before it can be efficiently identified. People often report stumbling over novel words the first few times they see them. However, such observations may be due to unfamiliarity with the word's meaning, or its spelling if it doesn't follow the simplest orthographic rules, or due to its inappropriateness in the context of a given situation (e.g., obscene words).

To adequately address the question of a possible facilitatory effect of specific visual experience one would have to ensure that the word's meaning was known, that the word's appearance in the visual form was not contextually inappropriate, and that the orthography of the word was thoroughly familiar. The basic paradigm used in this thesis was designed to guarantee these conditions.

In this paradigm, subjects are taught English meanings for 20 pseudowords. These are words that Ss have never experienced before but which conform to simple rules of pronouncing on the basis of spelling. This ensures that the subjects have had neither previous visual nor auditory experience with the word-stimuli and that no confusion should arise concerning their pronounciation. During this Training Phase Ss learn the pseudowords and their assigned meanings to the point at which they can provide the word's meaning within about 1.5 seconds. Throughout this Training Phase S is shown half the words printed on index cards with E providing the meaning vocally, and half are presented only vocally by E with the meanings again given vocally. Thus there are two conditions, one Visual and one Auditory, both of which receive the same number of training trials and vocal renditions of the stimulus words. The intent is to distinguish the two conditions only by the added visual experience in the Visual condition.

The Test Phase, which immediately follows, consists of a word identification task which requires S in some way to use a given word's meaning when the word is presented visually, with response time (RT) being the dependent variable. Here S sees the Auditory condition words for the first time. If the visual experience is in some way necessary to attain the most efficient level of visual word identification, then there should be overall shorter average RTs to Visual condition words over Auditory condition words. No difference in RTs would argue against a facilitatory effect due to visual experience. All four experiments to be reported here in fact demonstrated faster RTs to Visual condition words than to Auditory condition words on their first Test Phase presentations.

With this finding we were next interested in determining whether this visual experience helped by facilitating the derivation of phonic-linguistic features from the visual information available in a word, or by allowing direct access of a word's meaning from graphic-letter I.D. cues alone (see possibilities A and B in Figure 1). The question became one of whether any form of phonic-linguistic recoding is sufficient for efficient visual word identification.

Several previous studies have addressed this issue. Rubenstein, Lewis, and Rubenstein (1971) found that in a task where S had to judge a string of letters as being an English word or not, "NO" responses were slowest for nonwords (e.g., BRUME) that were homophonic with English words (e.g., BROOM); "YES" responses were slowest for homophonic English words (e.g., MAID - MADE), and fastest with ordinary English words. The authors concluded that the phonic similarity of certain pairs of words was responsible for the longer response latencies, thus implying the operation of a phonic-linguistic recoding process in addressing the lexicon to determine the correct response. However, Meyer, Schvaneveldt, and Ruddy (1973) point out that homophones have a greater degree of graphic similarity than random word pairings, and so one may also interpret Rubenstein _et al_'s findings on the basis of visual similarity producing confusions affecting graphic-letter I.D. based encoding. It can also be argued that the word-nonword judgement required by Rubenstein _et al_. is only remotely relevant to the task in normal rapid word identification. We rarely experience or expect nonwords in our everyday reading and thus have little obvious need for a word-nonword decision process.

Meyer _et al_. tried to avoid confounding graphic and phonic variables as occurred with Rubenstein _et al_. They had Ss judge whether graphemically or phonically similar pairs of strings of letters were English words. Graphemically similar words that didn't rhyme (e.g., (COUCH - TOUCH) provided longer positive RTs than such words that did rhyme (e.g., BLAME - FLAME). This was claimed to support the phonic-linguistic recoding hypothesis as the difference in latencies was accredited to differences in the auditory or articulatory redundancy between the two conditions. The behaviour of the graphic encoding variable was assumed to be constant across the two conditions. However, here again we have the problem of comparing the word-nonword judgement to the word identificiation situation, there being no assurance in Meyer _et al_'s task that various words' semantic stores are being accessed. In making a word-nonword judgement S may use the strategy of determining whether or not he had seen or heard a particular word before to make his response, since it is doubtful that he would have experienced any of the nonwords before.

Meyer *et al.* discuss and reject two additional pieces of evidence alleged to support a graphic-letter I.D. encoding interpretation of visual word identification processing. First, the fact that speed-readers can read with comprehension at rates of up to 1000 words per minute (Carver, 1972), implies the presence of word-processing at speeds that wouldn't be possible if phonic-linguistic analyses were occurring at normal speech rate. But Meyer *et al.* point out that other strategies may produce such rates which involve either not having to read every word on a page, or the presence of higher-order phonological processes that use phonic cues over and above covert pronounciation of the words.

Second, Bower (1970) found with Greek bilinguals translating prose passages into English that Ss took longer to translate modified passages which involved homophonic pseudowords (e.g., like FONOGRAF for PHONOGRAPH in English) than for normal passages. The argument here was that the time difference reflected the presence of a graphic-letter I.D. dependent meaning-access process in word identification since the altered words only differed along a visual dimension and not along a phonic-linguistic dimension. However such a result does not establish whether the words are identified directly from visual cues or indirectly from the phonic-linguistic information derived from those visual cues. This latter derivation process would also be adversely affected by alterations in visual pattern.

Eichelman (1970) experienced the same interpretive dilemma. His task required Ss to judge whether two strings of letters or two words were 'SAME' or 'DIFFERENT'. He found that if each of a pair of stimuli are printed in different type-cases that this judgement requires a longer RT than if both are in the same type-case. Since only the physical characteristics of the words involved were altered it was suggested that the result can only represent the isolated operation of a graphic-letter I.D. processing stage since the phonic aspects are assumed unaltered across conditions. Aside from the lack of clear relevance of his task to word identification, the results could still be interpreted as representing the operation of a phonic-linguistic recoding process.

The studies outlined thus far fail to differentiate between possibilities A and B in Figure 1. However, one study that is more successful in isolating the word-processing occurring in reading is Baron's (1973). He found that Ss judging whether a given phrase made sense or not had as quick negative RTs for phrases which sounded sensible (e.g., tie the not) as for phrases that didn't (e.g., our no car). Further, when required to judge whether phrases sound sensible, Ss were fastest and had fewer errors on phrases that both looked and sounded sensible. These results are only possible if certain of the visual cues present in the stimulus were used to arrive at a decision which requires some form of meaning-access. This is the basis of Baron's claim that a phonic stage is not required for reading and that the lexicon may be accessed by visual cues alone either prior to or in parallel with ongoing phonic processing.

Baron's study is the clearest of those discussed concerning its treatment of the processing possibilities. However, Meyer _et al_. have raised questions regarding details of his procedure. Specifically, they point out that the number of errors differed among the conditions, which allows an explanation in terms of a speed-accuracy trade-off in phonic processing. Further, the phrases used in his different conditions certainly differed in frequency of normal occurrence, which again would allow an alternate explanation that wouldn't clearly eliminate phonic processing. These objections can probably be met within Baron's paradigm. However, the approach adopted in this thesis was to produce evidence from an independent paradigm which would converge upon the same conclusion. Experiments #3 and #4 were designed to accomplish this.

Experiment #3 followed the basic design in use throughout the thesis with the added manipulation of introducing auditory confusibility among the stimulus words. This alteration was intended to selectively affect any ongoing phonic-linguistic processing across the two conditions in the word identification task, thus giving some indication of the degree of such processing within the task as reflected by RTs. The lack of any effect of auditory confusibility for the Visual condition words could be taken to suggest the absence of essential phonic-linguistic processing in that condition. This would support the choice of possibility A in Figure 1 as representative of part of the processing occurring in efficient visual word identification.

Experiment #4 was an attempt to both corroborate the interpretation of Experiment #3 and remove the possibility of a 'novelty-interrupt' explanation of the basic effect. Such an explanation would deal with slower visual RTs to previously auditory stimuli by saying that a preliminary judgement of unfamiliarity of the visual stimulus would cue the S to slow down. Thus one could get slower RTs to the previously auditory stimuli even though all stimuli were ultimately dealt with in a phonic manner. To eliminate this explanation Ss were provided visual experience with both auditory and visual stimulus words in a task that did not require meaning access.

EXPERIMENT #1

The purpose of Experiment #1 is to establish whether visual experience with a specific word is required for the highest speed of visual identification of that word. The method used involved giving Ss extensive practice in accessing the assigned meaning of pronounceable pseudowords from a vocal presentation of the words (Auditory condition) or from a visual presentation of the words (Visual condition). Following the training, the Test situation required rapid semantic categorization from a visual presentation of both Auditory condition words and Visual condition words. The general purpose of this procedure was to produce a situation in which any difference in categorization response latency in the Test Phase between the Visual and Auditory conditions could only be due to the presence or absence of *visual* experience with the words.

METHOD

Subjects. Subjects were 10 McMaster undergraduates, 1 male and 9 female, who were paid for their participation. Each subject ran in a single session which took approximately 1 hour.

Stimuli. There were 20 pronounceable pseudowords, each 7 letters long and spelled the same forwards as backwards (i.e., palindromes) in order to maximize the possibility that visual pattern would be important to their learning and perception. The words were chosen, from pilot experiments run with the same words, in order to ensure a single common pronounciation per word upon first seeing it. The English "definitions" assigned to the pseudowords were common English concrete nouns to allow for an easier association in the Training Phase. Each such pseudoword-English word pairing remained constant across Ss. The 20 English words used as 'meanings' were chosen in such a way that 3 from each of the two conditions shared the characteristic of being 'animal', 4 from each condition shared the characteristic of being 'man-made', with the 3 remaining words in each condition having no affiliation with either of these characteristics (see Table 1).

The words were divided into two groups of 10 words each, with each group being equally represented in the Visual and Auditory conditions across Ss. For the Training Phase, each Visual condition word was printed in Letraset #8 capital type on a 4" x 6" index card, with each Auditory condition word represented by a blank 4" x 6" card.

For the Test Phase, 8 lists of 10 words each were made up, with each of 4 lists comprising all 10 words of the Visual condition and likewise 4 lists for the Auditory condition. Each list provided a random vertical listing of the 10 pseudowords, each word being separated from another by a dividing line (see Appendix A). The words were printed in capital letter type.

Procedure. The experiment involved a Training Phase followed by a Test Phase. The Training Phase further consisted of an acquisition component in which S learned to respond correctly to the pseudowords with their assigned meanings, and a speed component which required S to give the response within a predetermined speed criterion.

The acquisition component of the Training Phase began with E's teaching S 10 pseudowords and their assigned meanings. The 10 words were composed of 5 chosen at random from each of the Visual and Auditory

Table # 1

Experiment # 1

Stimuli & Characteristics

	PSEUDOWORD	ASSIGNED ENGLISH MEANING	CHARACTERISTIC
List A			
	SIXAXIS	silver	*****
	LANTNAL	tree	*****
	ATARATA	hen	animal
	SPINIPS	man	animal
	RALPLAR	nail	man-made
	PRONORP	pencil	man-made
	FILPLIF	water	*****
	ORTETRO	cat	animal
	BUTATUB	car	man-made
	STARATS	door	man-made
List B			
	GRABARG	gun	man-made
	MAGSGAM	pot	man-made
	PARTRAP	fire	*****
	TIPSPIT	stick	*****
	PETATEP	baby	animal
	NINANIN	forest	*****
	POLCLOP	plane	man-made
	BALSLAB	chair	man-made
	RETSTER	bird	animal
	TENANET	lion	animal

condition lists. On the first trial E presented successively the 10 words and meanings, pronouncing the words and their meanings, showing the printed word for the Visual condition and holding up a blank card for the Auditory condition. S was given time (0.5 - 1.0 min.) at each presentation to form associations to make the word-pair easier to recall. S was also asked at this time to vocally spell the Auditory condition words to ensure that there was no discrepancy between S's anticipated spelling of a word and its actual spelling to contaminate the identification RTs in the Test Phase.

Subsequent trials on these 10 word-pairs involved E's presenting S with the pseudowords one at a time, requiring S to pronounce the word and give its English correlate. Lapses and errors were recorded. This procedure continued, with E shuffling the 10 words prior to each trial, until S achieved two consecutive error-free trials. Upon completion of this, the remaining 10 words (5 from the Visual condition and 5 from the Auditory condition) were taught in the same manner as the first 10.

The acquisition training was finished by E's presenting S with random orderings of all 20 words, again requiring S to pronounce the words and provide the English meanings; again to a criterion of 2 consecutive error-free trials.

After a 5-minute break the speed-training component was run to achieve fluency in categorizing the pseudowords for meaning. This phase consisted of 8 presentations, each involving E's presenting S with a random sequence of the 20 pseudowords in rapid succession, requiring S to respond by saying "yes" if the word flashed (Visual condition) or spoken (Auditory condition) fit a given characteristic, and by saying "no" otherwise. The characteristics, either 'animal' or 'man-made', were given S before each presentation, in ABAB fashion across presentations with each characteristic occurring equally often on the first presentation across Ss. S was required to respond as quickly as possible, with E measuring the latency from the presentation of each list to S's response to the 20th word. All Ss managed to provide at least one error-free sequence of responses at a latency shorter than 45 secs. Lapses and errors per presentation were recorded by E.

Finally, the Test Phase consisted of 8 presentations. On each presentation E provided S with a characteristic and a list of 10 pseudo-words, composed of a random sequence of all the words in one of the two conditions. S was required to respond as quickly as possible to each word in a sequential manner from the first to the tenth word without going back to a previous word by putting a check (✓) beside the word if it fit the category, and a dash (-) beside the word if it didn't. E measured the response time from the presentation of the list to S's response to the tenth word. Thus there were 10 responses per list.

Four of the presentations used randomly sequenced Auditory condition lists and 4 used randomly sequenced Visual condition lists. The two types of lists were presented in an ABAB sequence per S, with each AB pair representing a single test presentation of all 20 words. Each condition had an equal number of first presentations across Ss to balance out any practice effects due to presentation sequence. The four trials in each condition were randomly paired with the 'animal' and 'man-made' categories in such a way that each condition had two test presentations of each of the two categories, to avoid any differences in response latency due to category responded to.

Finally, E kept a record of S's errors and lapses in the Test Phase, and of Ss' comments after completion of the experiment.

RESULTS AND DISCUSSION

The results clearly demonstrate a facilitating effect of the added visual experience on rapid visual word I.D. response time, at least over the initial presentation of words in the Test Phase. This is shown in Figure 2.

We are here primarily interested in the effect of specific visual experience as it occurs on presentation #1, with discussion of how long this effect lasts over visual presentations being deferred to Experiments #3 and #4. Since Experiments #1 and #2 deal singularly with the demonstration of the effect, added Test Phase visual presentations add little more information about the effect than its duration over presentations.

The Wilcoxon Matched-Pairs Signed-Ranks test carried out between Visual and Auditory conditions across presentations yielded the following comparisons:

presentation #1, $z = 2.80$ ($p < .01$)

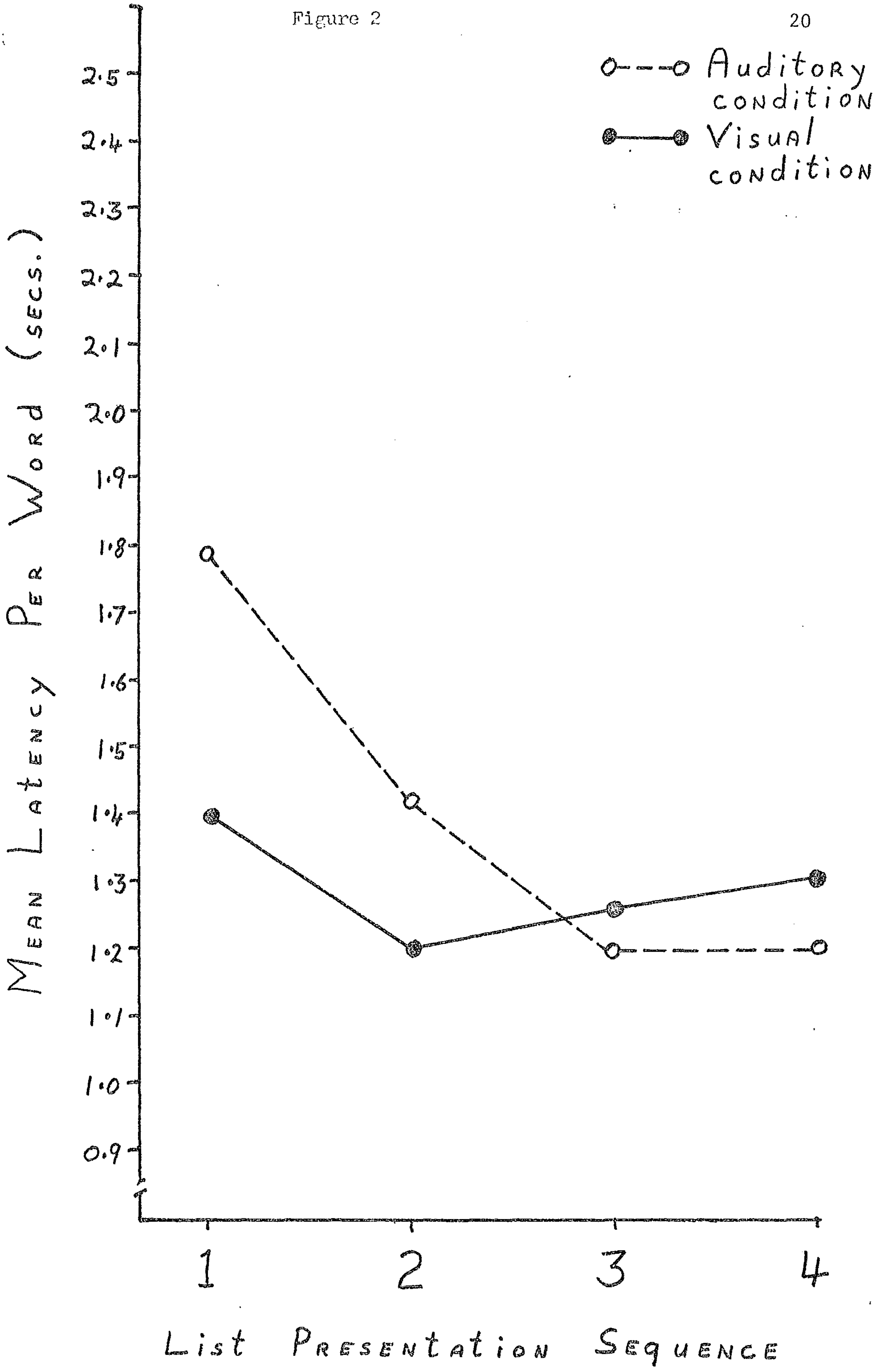
presentation #2, $z = 2.09$ ($p < .02$)

presentation #3, $z = -0.36$ (N.S.)

presentation #4, $z = -1.01$ (N.S.)

These comparisons demonstrate a visual facilitation over presentations #1 and #2, with no demonstrable effect in presentations #3 and #4. This suggests that specific visual experience with a word

Figure 2


Auditory condition
Visual condition
Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
1
2
3
4
List Presentation Sequence

is required to attain the upper levels of fluent meaning-access, and that little specific experience may be required to attain those levels.

The apparent reversal on presentations #3 and #4 does not compare in intensity with the positive effect on presentations #1 and #2. The comparison for Visual vs. Auditory conditions for data pooled across presentations #3 and #4 yielded a $z = -1.02$ (N.S.). Compare this to a $z = 2.70$ ($p < .01$) for the same comparison for data pooled across presentations #1 and #2. The reversal trend did not appear in any of the pilot experiments run to determine the feasibility of the present paradigm, nor did it appear in Experiments #3 and #4, which had 3 test presentations each. It should be safe then to interpret the reversal trend as due to chance. On the other hand, the visual facilitation for presentations #1 and #2 occurred on the first test presentation in the pilot studies mentioned above, and in Experiments #2, #3, and #4 covered in this thesis.

The general conclusion at this point is that there is some quality of the Visual condition training that increases the speed of word identification at fluency of words experienced visually as opposed to words experienced only auditorily. This does not indicate whether the facilitatory effect of visual experience is due to direct access of the lexicon with graphic cues or to more efficient derivation of phonic-linguistic cues.

The result needs to be regarded in light of two major qualifications. The first concerns the inherent assumption that both Auditory and Visual conditions receive the same degree of training in all respects except that of specific visual experience. This may not be true in that there may be something about Visual condition training that makes these words easier to learn. For example, their length of exposure on the index card in the Training Phase may have Ss concentrate longer on visually-presented words than words they only get to hear. This possibility of differential training is made more credible by the data on errors during training. Since the Auditory and Visual condition words were mixed together in acquisition this error data is the only means of comparing the relative degree of acquisition. The mean error scores across conditions for the Training Phase before the speed criterion training were 6.5 for the Auditory condition and 4.7 for the Visual condition.[1] A $z = 2.31$ ($p < .05$) was found for this comparison across conditions. It obviously suggests the necessity of a closer look at the assumption of same degrees of training across the two conditions.

The other qualification concerns the reports of some Ss who claimed that during the speed training where they had to classify rapidly-presented words as having a certain characteristic or not, that they were often responding only to the word's characteristic without recourse to its meaning. This factor doesn't alter the reasoning behind the general conclusion, but it does limit the potential relevance to normal meaning access. Experiment #2 was designed to deal with these two qualifications.

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[1]These refer to the total number of errors per condition in training before the speed criterion training (see Appendix E).

EXPERIMENT #2

The main purpose of Experiment #2 was to address the two major qualifications on the results of Experiment #1 just mentioned.

(1) The Test Phase of Experiment #2 consisted of a word identification task which avoided having words categorized on a single semantic dimension. A separate trial was run for each of the 20 words learned in training with S being required to make an affirmative response if a presented word's meaning fit the context of a previously given sentence, and a negative response otherwise. This change, besides providing us with a distinct RT for each word, also gave us a word identification task more related to that found in reading than did the categorization task used in Experiment #1. Further, if the effect found in Experiment #1 also occurred with the change in identification task offered here, there would be cause to consider the facilitatory effect of visual experience with a word as generalizeable to a class of word identification situations.

(2) The issue of equality of experience across Visual and Auditory conditions was considered by including an auditory word identification task in the Test Phase for all 20 words. If there were no difference between the degree of training in the Auditory and Visual conditions then both conditions would give similar identification RTs on this task in the Test Phase. It should be noted that this manipulation only addresses the equivalence of training on the auditory presentations that were given in both conditions.

METHOD

Subjects. Subjects were 10 McMaster undergraduates, 7 female and 3 male, each of whom participated in a single session lasting about 1 hour, and who were paid for their participation. 2 other subjects are not included in the results due to lack of complete data.

Stimuli. Nineteen of the pronounceable pseudowords were the same as those used in Experiment #1, (see Table 2). All other details regarding the material were the same but for the following alterations to admit the new identification task.

For the Test Phase, 10 sentences were constructed, each of which made sense when its last word was one of a pair of words, (i.e., each sentence had a correct alternative in both conditions) (see Table 3). Thus the 10 sentences covered all 20 words. Also, 40 stimulus cards were made up, 20 blank ones for the auditory identification task and 20 covering the words learned in training, again printed in Letraset #8 type on cards, for the visual identification task.

The 40 Test Phase trials were arranged for presentation sequence in the following manner: There was a random sequence of 10 sets of 4 trials each, with each set assigned to one of the 10 sentences and containing one trial of each of 4 conditions [i.e., Visual training - visual I.D. task (V-V); auditory training - visual I.D. task (A-V); visual training-auditory I.D. task (V-A); auditory training-auditory I.D. task (A-A)]. The 4 trials per set were also randomly sequenced. It was further arranged that 1/2 the trials per condition required an affirmative response and 1/2 a negative response.

Table # 2

Experiment # 2

Stimuli & Meanings

	PSEUDOWORD	ASSIGNED ENGLISH MEANING
List A		
	ORTETRO	radio
	FILPLIF	cat
	TIPSPIT	pipe
	BUTATUB	rifle
	PETATEP	pencil
	PARTRAP	book
	GRABARG	cup
	BALSLAB	chair
	RALPLAR	water
	STARATS	hat
List B		
	RETSTER	cigar
	SIXAXIS	stove
	GLENELG	bottle
	POLCLOP	note
	NINANIN	cannon
	TENANET	chalk
	MAGSGAM	car
	SPINIPS	glove
	PRONORP	hen
	LANTNAL	coffee

Table # 3

Experiment # 2

Test Phase Sentences

SENTENCE	CORRECT RESPONSES
SHE FED THE ________ .	- cat , hen .
BOB WORE A ________ .	- hat , glove .
ANNE SPILLED A GLASS OF ________ .	- water , coffee .
HE SAT IN A ________ .	- chair , car .
FRED SMOKED A ________ .	- pipe , cigar .
JILL READ A ________ .	- book , note .
JANE WROTE WITH THE ________ .	- pencil , chalk .
HARRY FIRED THE ________ .	- rifle , cannon .
MARY SWITCHED ON THE ________ .	- radio , stove .
BILL DRANK FROM A ________ .	- cup , bottle .

Procedure. The Training Phase was the same as that for Experiment #1 with the exception that S had to achieve a speed criterion of under 35 secs. on each of 4 presentations, up to a maximum of 10 presentations altogether. This was instead of the flat 8 presentations used as criterion in Experiment #1. Furthermore, the speed training required S to vocalize as rapidly as possible the meanings of words presented visually (Visual condition) and words presented vocally (Auditory condition), as opposed to the categorization training in Experiment #1.

The Test Phase consisted of 40 trials, 10 for each of 4 conditions (A-V, V-V, A-A, V-A). Each trial consisted of S's oral reading of a sentence on a card which had the last word missing. When S reached the missing word, E either flashed a card with one of the 20 words learned printed on it (visual identification task), or E flashed a blank card and spoke one of the 20 words (auditory identification task). S was required to respond as quickly as possible by pressing a "yes" telegraph key if the presented word's meaning made sense in the sentence (i.e., fit the context), or by pressing a "no" telegraph key if it didn't. The placing of the keys was reversed from right to left across subjects, and S had to begin each response from a resting position half way between the "yes" and "no" keys. The response time per word was measured by E initiating a timer upon presentation of a word and S terminating the same timer by pressing either the "yes" or "no" key. E recorded latencies and errors for all 40 trials.

RESULTS AND DISCUSSION

The results of Experiment #2 support the conclusions made in

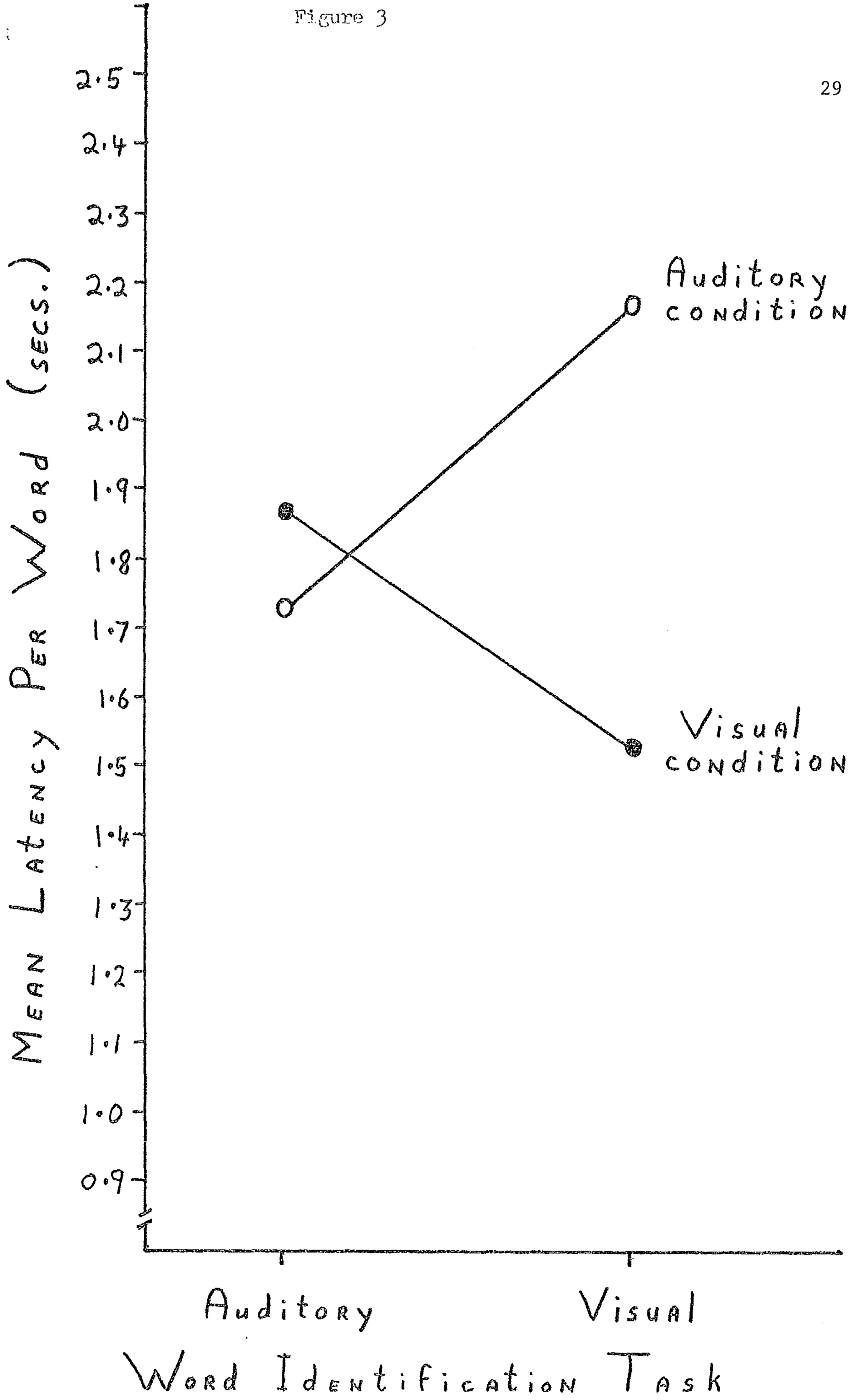
Experiment #1 by demonstrating the Visual condition superiority effect in a different visual word identification task. In addition, equivalence of training at least on the auditory dimension was supported by the finding of no difference between the performance of Visual and Auditory condition words in the auditory identification task. The means per condition are presented in Figure 3.

The results here reported replicate a previous experiment of the same design. The previous experiment was replicated because it failed by a narrow margin to show a significant treatment x test measure interaction comparison. Only 2 of the original 10 subjects failed to produce an effect in the direction of the desired interaction and all comparative analyses on the data of this experiment demonstrated strong trends favouring the training x test measure interaction. All other comparisons carried out for both the original experiment and its replication coincide favourably in supporting the same conclusions.

In the data analysis of the current experiment, Auditory condition words took longer than Visual condition words in the Visual word identification task [$z = 2.70$ ($p < .01$)][2]; no such difference occurred between the two conditions in the auditory word identification task [$z = -1.38$ (N.S.)]; and a significant interaction was obtained by comparing the difference between differences on the two word identification tasks [$z = 2.81$ ($p < .01$)]. As further evidence of the strength of this finding,

[2]All comparisons are Wilcoxon matched-pair signed-rank tests unless otherwise specified.

Figure 3


Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
Auditory condition
Visual condition
Auditory
Visual
Word Identification Task

Mann-Whitney tests for independent samples were carried out for each S's data: comparing Visual and Auditory condition RTs for the visual word I.D. task showed 6 of 10 Ss whose individual data were significant to at least the .05 level in favour of shorter word I.D. latencies for the Visual condition with the remaining 4 demonstrating trends in the same direction; comparing Visual and Auditory condition RTs for the auditory word I.D. task showed all 10 Ss data as not significant in either direction (see Appendix B).

It is made more likely then that the faster visual word I.D. RTs for the Visual condition words over the Auditory condition words are due solely to the added specific visual experience offered words in that condition. The results due to auditory training alone demonstrate that any phonic-linguistic meaning-access process and response learning that is present is practiced to roughly the same level of efficiency for both Visual and Auditory conditions. This claim, of course, is irrespective of whether these cues are derived from a visual or vocal rendition of the word. It follows then that the facilitatory effect of specific visual experience on rapid visual word I.D. must derive from certain changes in the <u>initial</u> processing of the visual information available.

There are two possible explanations for the effect of the specific visual experience. The available visual information is either used to derive phonic-linguistic information which in turn is used to access the lexicon, or it is sampled for non-phonic information which can itself be used to directly access the lexicon (possibilities B & A respectively in Figure 1). Experiments #3 and #4 attempt to distinguish these two interpretations as well as addressing and eliminating certain artifactual interpretations of our results.

Finally, it is of interest to note that the effect has now occurred under two different contextual tasks, each requiring access of different semantic aspects of the lexical store (i.e., categorization in Experiment #1 and relation to syntactic and semantic context in Experiment #2). This argues for the generality of the processes under investigation.

EXPERIMENT #3

Experiments #1 and #2 have demonstrated that a word requires some form of visual experience in order to be most efficiently identified in its printed form. The effect has occurred with two different tasks: one in which S had to categorize a word on a semantic dimension (Experiment #1); and one in which S had to judge a word's appropriateness in the context of a given sentence (Experiment #2). At this point we don't know whether the added visual experience produced its effect by facilitating the derivation of phonic cues, or by allowing direct access by graphic-letter I.D. cues alone (possibilities A and B in Figure 1). Experiment #3 is an attempt to select between these possibilities by using an auditory confusibility paradigm. [Shulman (1971) reviews the use of such paradigms.]

If a group of words in our Auditory condition were made auditorily confusible yet retained their visual distinctiveness, then one might expect an increase in latency of visual word identification due to the presence of a phonic-linguistic mechanism in processing. Further, the size of any increase in latency of word identification may give us some indication of the importance of the role of phonic-linguistic recoding in the given processing situation. Given that this confusibility effect occurs, the question is whether a comparable effect can be seen after specific visual experience. To investigate this, the Visual and Auditory conditions in this experiment were each composed of ten pseudowords, five of which in each condition were auditorily confusible yet visually distinguishable (see Table 4).

Another control was also built into Experiment #3. This was an attempt to counteract the argument of list membership as being responsible for our effect. It is possible that, as a result of the Training Phase, when a word is presented visually the set of responses for the Visual condition words is cued as a group and selected among on the basis of further processing of the stimulus word. When a word is presented auditorily, the same thing happens for the responses to the Auditory condition group of words. If so, then in the Test Phase, when a word from the Auditory condition is first presented visually, the wrong group of responses is cued. This could delay processing relative to the Visual condition group of words even though no specific visual cue was used in the access of the Visual condition words' meanings.

An attempt was made in Experiment #2 to minimize this possibility by presenting the Visual and Auditory condition words to S in a mixed list in the Test Phase. This meshing may inhibit the generation of a different strategy for each Test Phase trial. The fact that the words are also learned in a mixed list fashion is not conducive to the development of a list membership strategy. Such a manipulation may discourage selective processing of the stimulus words by conditions in the Test Phase, though it need not necessarily prevent it. To determine whether the slower response to Auditory condition words is due to some inappropriate strategy such as list-membership or to the singular lack of word specific visual learning, a staggered introduction of the stimulus words was employed in the Test Phase. Specifically, some words from all four conditions were not presented for identification until S had had

Table # 4

Experiment # 3

Stimuli & Meanings

PSEUDOWORD	ASSIGNED ENGLISH MEANING
List A	
Not Auditorily Confusible (NAC)	
DOKE	radio
BARM	cannon
GOLP	note
LART	bottle
SPAG	pencil
Auditorily Confusible (AC)	
JIGHT	cat
PITE	pipe
PAWPH	car
JAWF	glove
NOFF	milk
List B	
Not Auditorily Confusible (NAC)	
TESH	coffee
OLAR	chair
VIPS	cigar
STOD	hen
RAST	hat
Auditorily Confusible (AC)	
HEIGN	chalk
FAIN	book
NANE	rifle
HUX	stove
NUCKS	cup

various degrees of experience in the Test Phase. In this way if the facilitatory effect of visual experience is maintained no matter how late in the Test Phase sequence the stimulus words are first introduced, then there would be reason to believe that the list-membership strategy interpretation, if present, is at least not sufficient to explain the effect. One holding the list-membership view would be hard put to explain the lack of some degree of learning of the inappropriateness of that strategy across delayed test presentations.

Finally, it should be noted that one-syllable pseudowords were employed in the present experiment. This was to discount any supposed dependence of the effect on a particular word length or type of visual pattern, in that Experiments #1 and #2 used pseudowords of seven letters and two to three syllables with a stress on visual patterning through the use of palindromes.

METHOD

Subjects. Subjects were 10 McMaster undergraduates, 5 male and 5 female, whose first language was English and who were paid for their participation.

Stimuli. Two groups of 10 one-syllable pseudowords each were used with each such group being further split into two 5 word groups of which one was composed of 5 visually and auditorily distinct pseudowords and the other had 5 visually distinct and auditorily confusible pseudowords (see Table 4).

There were thus 4 conditions

Visual training - not auditorily confusible [V-NAC]

Visual training - auditorily confusible [V-AC]
Auditory training - not auditorily confusible [A-NAC]
Auditory training - Auditorily confusible [A-AC]

Each word was assigned a common English word. These assignments were constant across Ss.

For purposes of the Test Phase, which required judgement of appropriateness of a word in the context of a sentence, 10 basic sentence frames were formulated in such a way that each sentence could reasonably be completed by one correct alternative from each of the two groups of 10 words. Four variations of each sentence were constructed to allow enough variety so no sentence-word pair would occur more than once for any given S in the Test Phase.

Since the Test Phase further required 3 presentations of each of the 20 stimulus words, 60 index cards (4" x 6") were used with 3 cards per word having that word printed on them in Letraset #8 lettering, this being the same size of type and card used in the acquisition training of the 20 words. Each 10 word group had an equal number of assignments in both the Visual and Auditory conditions across Ss.

Procedure. The Training Phase was the same as in Experiment #2 but for the following manipulations.

Upon reaching the criterion of two error-free trials on the 20 pseudowords S had to vocally give his (or her) impression of the spelling of the Auditory condition pseudowords as E spoke them. This was done in Experiment #2 on the first Training Phase presentation of each Auditory condition pseudoword. The purpose of this task was to assess any discrepancy between S's expectations and E's spelling of the words.

In the speed training task S had to undergo at least 8 twenty-word presentations. If at least 4 of these first 8 were completed in under 40 secs. the training stopped at 8 presentations, otherwise S ran in two more (maximum = 10).

The Test Phase consisted of 60 trials, each run the same as in Experiment #2 except that the sentences were not shown and E rather than S read aloud the context sentences. A different sentence was used in each successive trial.

The presentation sequence of stimuli in the Test Phase was done in the following way: The 20 words were divided up into 5 squads of 4 words each, each squad containing one word from each of the 4 conditions (V-NAC, V-AC, A-NAC, A-AC). Each squad was presented 3 times over 3 successive _presentations_ and a new squad was started on each of the first 5 _presentations_.[3] For instance, _presentation 1_ involved squad 1 alone; _presentation 2_ involved squad 1 followed by squad 2; _presentation 3_ involved squad 1 followed by squad 2 which was followed by squad 3; and so on until _presentation 7_ involved squad 5 alone. This arrangement was not made known to S (see Figure 4).

The sentences were assigned to words in such a way as to ensure that no two pairings were alike, that there were an equal number of "yes" responses across Visual and Auditory conditions, and that there were an equal number of "yes" responses for each of the four conditions across Ss.

---

[3]These _presentations_ refer to the 7 successive sets of words presented in the Test Phase which are a result of the staggered sequence of Test Phase trials by squads (see Figure 4). Where referred to these _presentations_ will be underlined.

Figure # 4

Schematic Test Phase Presentation By Squads :

SQUAD = 4 items :
one from V-NAC condition .
one from V-AC condition .
one from A-NAC condition .
one from A-AC condition .

5 squads x 4 items each = all 20 pseudowords .

PRESENTATIONS	SQUADS 1	2	3	4	5	No. trials
1	1					→ 4
2	1	2				→ 8
3	1	2	3			→ 12
4		2	3	4		→ 12
5			3	4	5	→ 12
6				4	5	→ 8
7					5	→ 4
						60 trials

Note : Each squad is in three successive presentations .
All items are exposed in one continuous presentation , with no breaks between any two of the seven presentations .
Stimulus items were randomly assigned to squads for each S .

RESULTS AND DISCUSSION

In general, the auditory confusibility significantly increased visual word I.D. RTs for the Auditory condition, with little or no effect on the RTs for the Visual condition (see Figure 5). This result was strongest over the first Test Phase presentation. In light of the reasoning outlined in the introduction to Experiment #3, it appears that the critical meaning-access process in our Visual condition is probably of a graphic-letter I.D. encoding type.

These apparent trends were verified by the following analyses (see Table 5). Considering presentation #1 alone we see first that the visual experience facilitation effect found in Experiments #1 and #2 is still present (A-NAC vs. V-NAC, $z = 1.83$, $p < .05$) and most prominent in presentation #1. Second, there is a very strong effect of increased latency due to auditory confusibility in the Auditory condition (A-NAC vs. A-AC, $z = 2.70$, $p < .01$). Third, there is no effect of auditory confusibility in the Visual condition (V-NAC vs. V-AC, $z = 0.66$, N.S.). Finally, a strong interaction was found by comparing the AC minus NAC group differences for the Auditory and Visual conditions ($z = 2.80$, $p < .01$). The trends exhibited by these comparisons are further maintained across presentations #2 and #3 (see Table 5).

Concerning the relevance of these results for choosing between the two possible sequences of meaning access facilitated by specific visual experience (possibilities A and B in Figure 1), a strong case can be made <u>against</u> the presence of a phonic-linguistic process critical to meaning-access in the Visual condition. We first have a demonstration

Figure 5

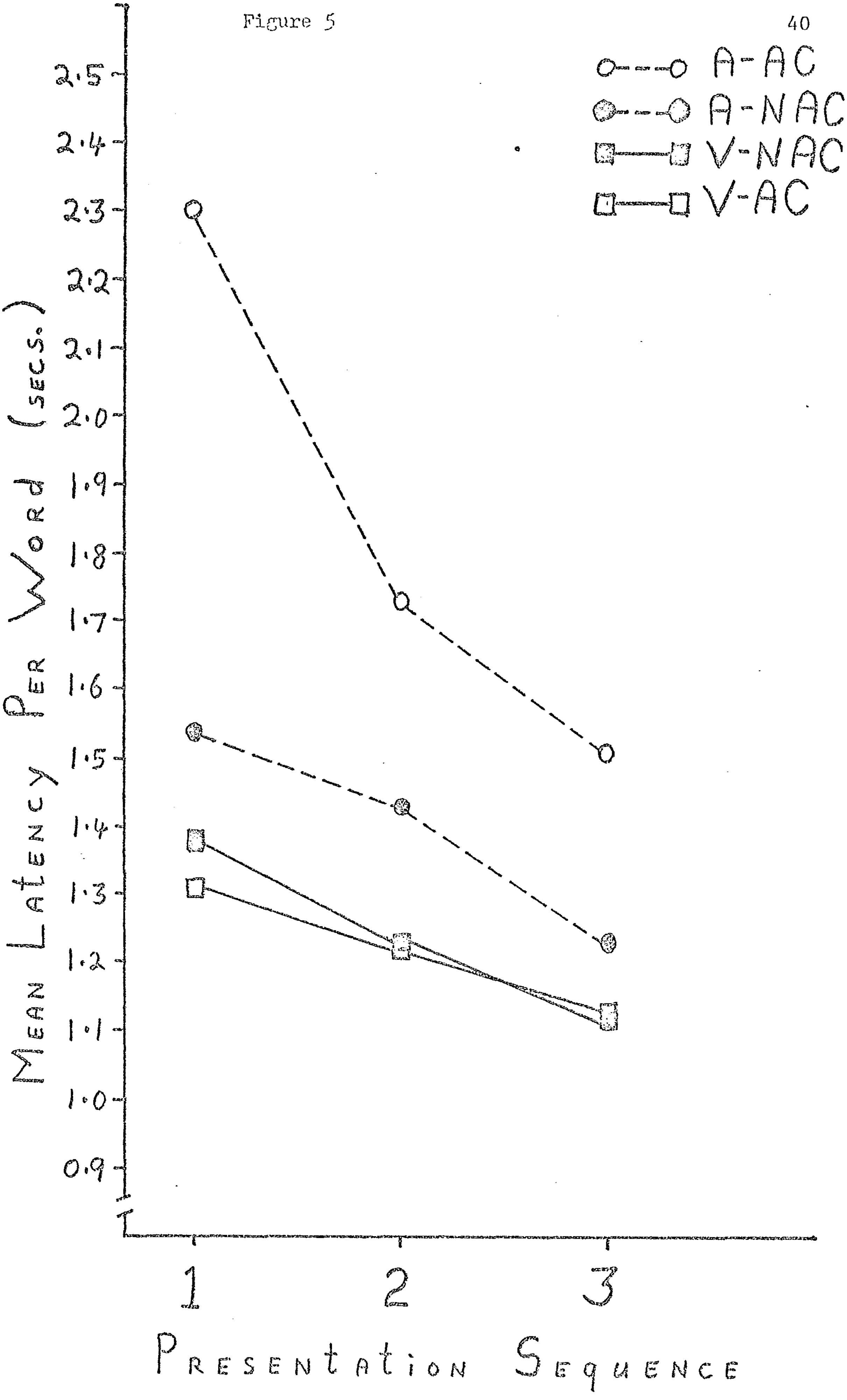

A-AC
A-NAC
V-NAC
V-AC
Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
1
2
3
Presentation Sequence

Table # 5

Experiment # 3

Wilcoxon Matched - Pair Comparisons Across Presentations

Comparison	Presentation #1	Presentation #2	Presentation #3
Auditory Groups (A-NAC) vs (A-AC)	$z = 2.70$ ($p < .01$)	$z = 1.43$ (N.S.)	$z = 1.17$ (N.S.)
Visual Groups (V-NAC) vs (V-AC)	$z = 0.66$ (N.S.)	$z = 1.38$ (N.S.)	$z = 0.36$ (N.S.)
Basic Comparison (A-NAC) vs (V-NAC)	$z = 1.83$ ($p < .05$)	$z = 1.07$ (N.S.)	$z = 1.89$ ($p < .05$)
Confusibility Groups (A-AC) vs (V-AC)	$z = 2.80$ ($p < .01$)	$z = 2.70$ ($p < .01$)	$z = 2.14$ ($p < .05$)
Interaction (A-AC) - (A-NAC) vs (V-AC) - (V-NAC)	$z = 2.80$ ($p < .01$)	$z = 1.58$ (N.S.)	$z = 1.48$ (N.S.)

of the effectiveness of the auditory confusibility manipulation in that it served to produce interference in the processing involved in visual word identification for the Auditory condition words as measured by response latency. The Visual and Auditory conditions demonstrated a differential response to the auditory confusibility even though they received equal opportunity to counter any confusion due to that manipulation in training, at least along a phonic-linguistic dimension. Interestingly enough, this leads to the implication that phonic redundancy cannot be bypassed in processing in meaning-access where it may be confusing unless it can be transferred, at least in part, to a visual mode.

Further reason for supporting a non-phonic based interpretation of processing follows from the lack of evidence for a floor effect in the Visual condition where the AC and NAC subconditions both demonstrate improvement over the 3 presentations in the Test Phase. Thus one cannot argue that there is an auditory confusibility effect in the Visual condition that is not observed because the words in that condition are already being responded to at the maximum rate possible. From this discussion one can only conclude that if a phonic-linguistic recoding mechanism is present in our Visual condition in the Test Phase, that it is not as simple as some gross form of implicit speech. If present it must involve some kind of processing interaction between the visual and phonic cues available which is dependent on specific visual experience for its most efficient operation. In any event, such a mechanism in the Visual condition must be different in degree if not in type from that found in the Auditory condition.

A simpler interpretation of the data concerns the development of a graphic-letter I.D. based meaning-access mechanism in rapid visual word I.D. involving no recourse to the phonic-linguistic properties of the words being identified. Though the existence of such a process is not directly demonstrated by the results of the present experiments, its feasibility is quite obvious in its facility of adherence to the data.

The issue of list-membership as a factor in the production of the difference in RTs across conditions has been further deemed unsupportable in the present experiment. This is evidenced first by the recurrence of the effect in spite of mixed-list presentations of the 4 conditions' words in all phases of the experiment, a factor which would at least make a list-membership strategy difficult to employ if not futile. Secondly, there is no evidence that the intensity of the basic effect (A-NAC vs. V-NAC) grows lesser the later in the Test Phase trial sequence the pseudowords are first presented. If a list-membership strategy were being used one would expect its inappropriateness to be noticed early in the Test Phase trial sequence, bringing about its subsequent abandonment. Such a development would be reflected in a weakening of the effect over initial Test Phase presentations of the pseudowords if the appropriate use of a list-membership strategy were responsible for the effect. This was not the case (see Figure 6 & Appendix C).

This last piece of evidence can eliminate another interpretation. The difference in RTs on the first visual presentation of a particular word in the Test Phase may in some way be due to some general strategy or novelty effect rather than an effect specific to particular words. If so, the Visual-Auditory condition difference might be smaller for words first introduced late in the test sequence. The data for individual squads of words, each squad representing a different position of first

Figure 6a

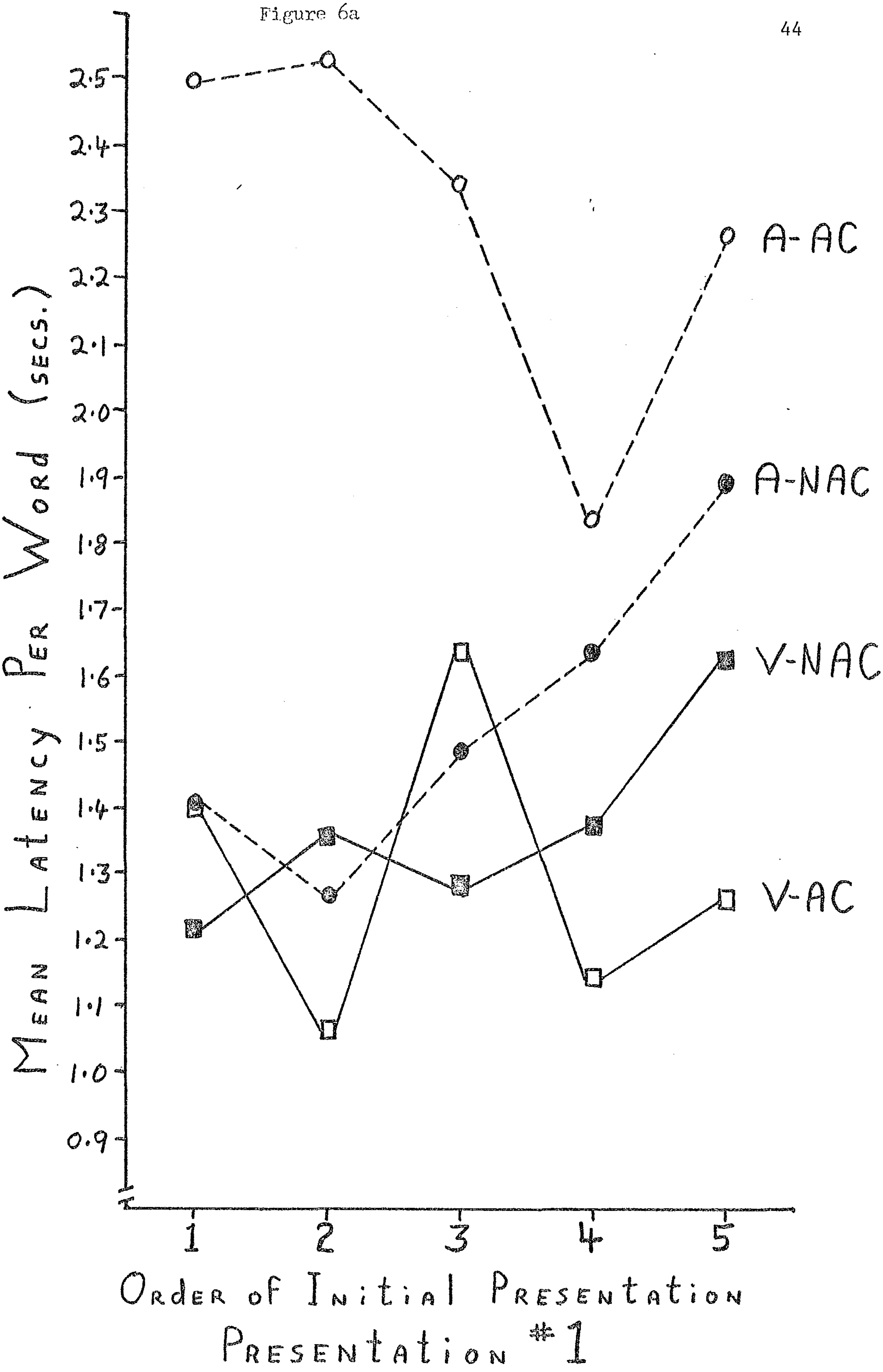

Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
A-AC
A-NAC
V-NAC
V-AC
1
2
3
4
5
Order of Initial Presentation
Presentation #1

Figure 6b

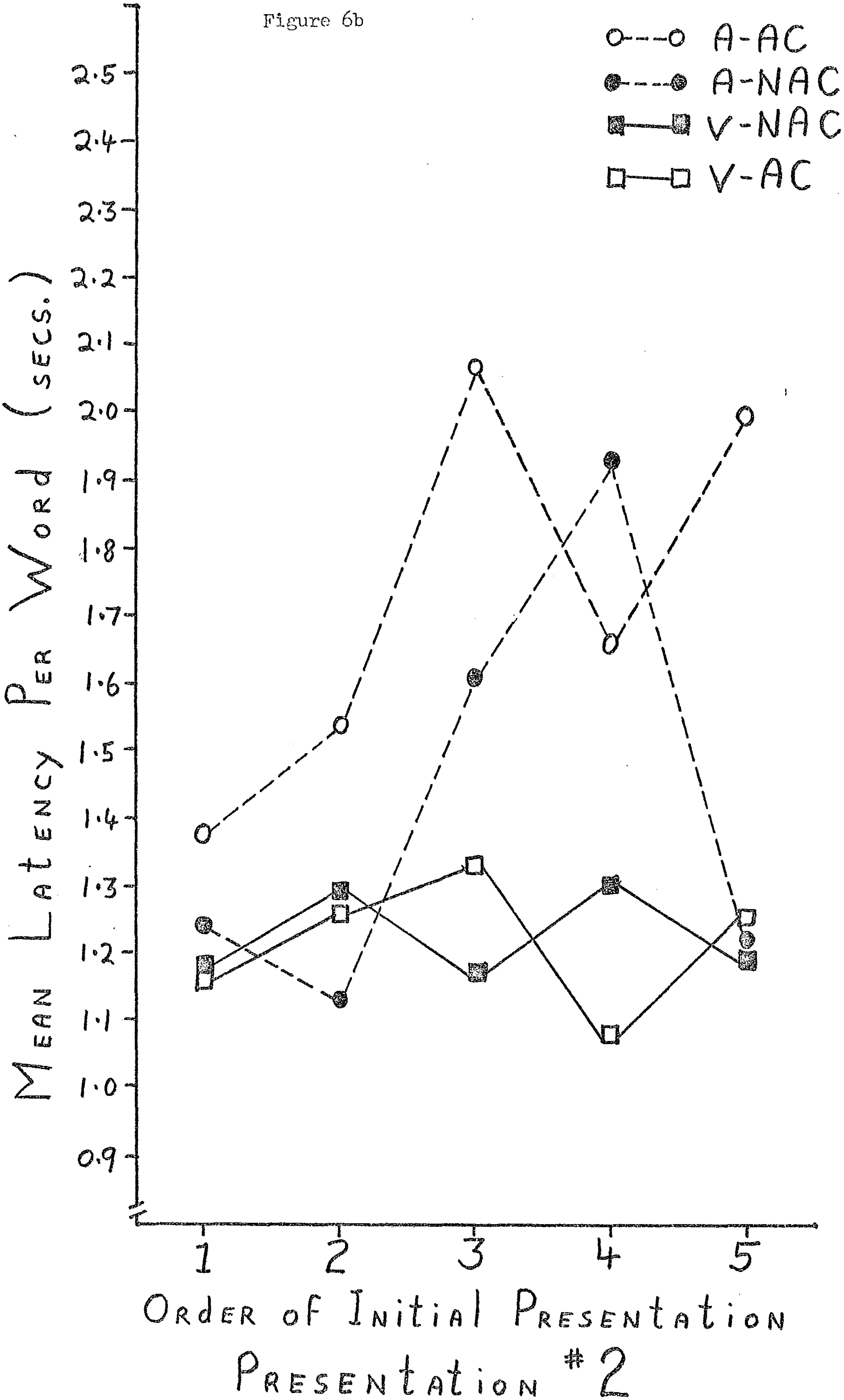
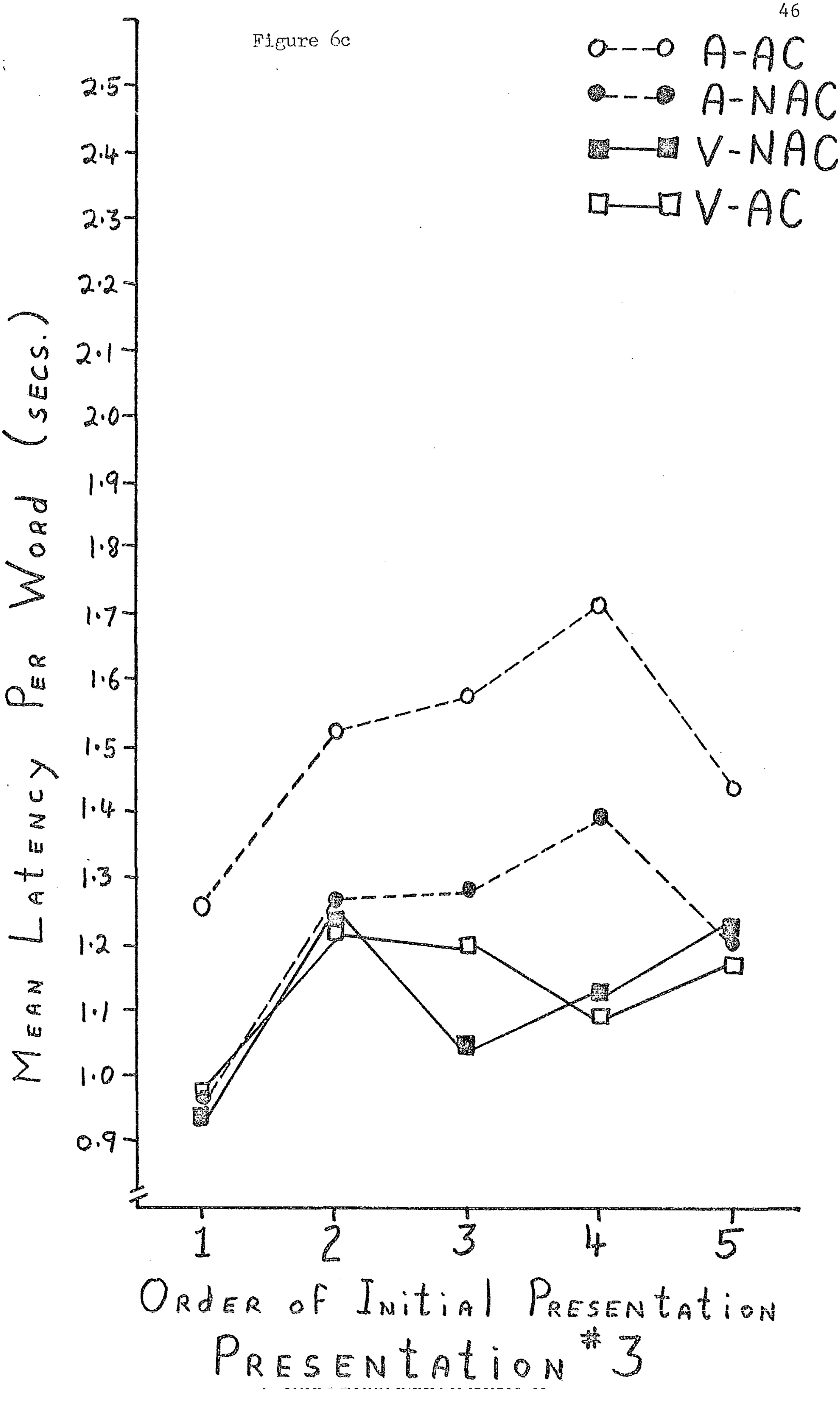

A-AC
A-NAC
V-NAC
V-AC
Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
1
2
3
4
5
Order of Initial Presentation
Presentation #2

Figure 6c


A-AC
A-NAC
V-NAC
V-AC
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
Mean Latency Per Word (secs.)
1
2
3
4
5
Order of Initial Presentation
Presentation #3

introduction in the seqence of test trials, are shown in Figure 6. Our principle interest here is the degree to which the general results outlined before are maintained across the 5 squads. Wilcoxon matched-pair comparisons for all squads on First Test Phase presentation are shown in Appendix C.

One consistent change is a lessening of the latency of response gap between the A-NAC and A-AC groups from squads 1 to 5. (n.b. We are speaking here primarily of the effects as they occur on the first presentation trial for words in the Test Phase). This may lead one to infer that some general strategy is acquired over trials which serves to somehow lessen the interfering effect of the auditory confusibility. A reasonable explanation of this may be that practice on any of the auditory confusible words allows S to develop more efficient strategies for bypassing the auditory confusibility present in the group (A-AC) as S proceeds through the Test Phase. In any event, it appears that visual experience in the context of meaning-access is here required to provide an alternate means for word identification to replace one that is upset by phonic-linguistic similarities among words.

This result confuses the issue for we don't know whether the interpretation above is correct <u>or</u> is the weakening of the confusibility effect over squads due to some general overall practice. Our basic interpretation is, however, supported by the fact that none of the other inter-condition comparisons display any consistent changes across squads. This finding adds further to the evidence that specific visual experience with a particular word is required to attain its most efficient level of identification irregardless of any specific auditory or articulatory experience with the word, or experience with visual word identification in general.

Finally, we come to an analysis of Ss' expectations of the spelling of Auditory condition words before the Test Phase. There are on the average about 2.5 spelling errors per S for the A-AC condition and .5 errors for the A-NAC condition. This discrepancy occurs even though Ss are given the spelling of the words by E when they are first presented. These data address the issue of another factor possibly responsible for our results in that they may not represent a difference in processing as much as they reflect an initial confusion in the Auditory condition on the first visual presentation of a word. This confusion may result from Ss' impressions of certain graphic features of a word not being supported on the first visual presentation of that word, or from some factor of surprise at having to identify a word they have never seen before. These confusion delays can obviously affect RTs, almost singularly affecting the Auditory condition. This question will be dealt with in Experiment #4.

As a final point to this discussion we would add that again here in Experiment #3 the effect measured was greatest on the first visual presentation in the Test Phase, decreasing rapidly over subsequent presentations. This suggests the critical nature of visual experience with a word in developing a process to allow later rapid visual identification, if just one visual presentation has such profound effects on later identification latencies for Auditory condition words.

EXPERIMENT #4

In this experiment three alternative interpretations of our results will be addressed. The first of these, also considered in Experiment #3, holds that specific visual experience with a word is a prerequisite to the rapid visual identification of that word, but this only aids eventual phonic-based access of the lexicon. To test this interpretation we need to equalize the training on derivation of the phonic-linguistic cues from a word's visual representation across Visual and Auditory conditions, without producing two equivalent conditions. The above interpretation would be supported if the manipulation resulted in no difference in RT across the Visual and Auditory conditions.

The second alternative interpretation concerns the "novelty interrupt" notion that the reason Auditory condition words produce such long identification RTs on their first visual presentations is that the first time S is shown a word he had only heard before, factors of surprise at seeing the word may add to his RT. This added latency is not representative of any specific process in word identification. Its presence in the present paradigm may be sufficient to explain our RT differences and their rapid disappearance after the initial Test Phase presentation. If such is indeed the case then there is no reason to support our past claims of different accessing mechanisms for the Auditory and Visual conditions.

The third interpretation holds that Ss' internal representations of the Auditory condition words (e.g., visual imagery or inferred spelling) does not match the actual physical characteristics of the stimulus words used in the experiment. This would cause an initial delay in assigning a word's visual configuration to its internal representation on its first visual presentation which would be a factor not present for Visual condition words in the visual word I.D. task. Support for this possibility is provided by first, research strongly suggesting the possibility of a visual anticipation of certain linguistic stimuli (Posner, Boies, Eichelman, & Taylor, 1969, for letters), and second, by the volunteered reports of approximately 20% of the Ss in these four experiments that they were able to "visualize" the Auditory condition words. These Ss' data, it should be noted, did not vary with any unidirectional consistency from the general pattern obtained for each experiment. About half of these Ss further claimed that this "visualizing" resulted in no differentiation for them between the Visual and Auditory conditions.

If true, these interpretations would converge to eliminate any evidence for direct meaning-access from graphic-letter I.D. cues alone.

In order to test the 3 notions mentioned, we ran Experiment #4 in the following way: 5 of the 10 words in each of the Visual and Auditory conditions were given an extra training task which involved having to read aloud the 5 words as fast as possible. The rationale for this manipulation was: (1) to provide visual experience with a word in the Auditory condition so S can neither be surprised by the word's first visual presentation in the Test Phase, nor confused in any way if his impression of the word's graphic features and spelling doesn't match that of the word's actual graphic features and spelling in the Test Phase.

(2) To provide visual experience with a word in the Auditory condition without any relation to accessing that word's meaning, so as not to produce a minor form of the Visual condition in the Auditory condition. (3) To provide some form of training for the Auditory condition which can represent the kind of graphic-to-phonic recoding training which is claimed to occur in the Visual condition and not in the Auditory. This control is simply an attempt to equate the level of efficiency for gleaning a word's phonic-linguistic cues from its visual representation across conditions, and it can be argued that the graphic-to-phonic training afforded by our manipulation is not of the kind that occurs in the basic Visual condition training where access to a word's meaning is involved. Our control for the phonic-linguistic recoding training interpretation would be of most interest if it produced no effect between the Visual and Auditory conditions, in which case it could be considered in some way representative of the training this view claims differentiates our two conditions. If the effect maintains its size and direction here, this outcome would suggest that either there is little effect of phonic-linguistic recoding training on our results, or there is a different type of phonic-linguistic mechanism in operation in the Visual condition. (4) To provide a comparison of oral naming speed before and after the basic Training Phase to see if the training of the Visual and Auditory conditions had any differential effects on this variable. It was reasoned that if there were no difference in performances on oral naming speed across conditions, that this would argue against a pronounced phonic-linguistic recoding training effect for our results, assuming of course that we are here measuring an aspect of Ss' graphic-to-phonic recoding

speed. A difference favouring quicker naming times for the Visual condition after training would seem to support the graphic-to-phonic training interpretation.

METHOD

Subjects. Subjects were 10 McMaster undergraduates, 3 male and 7 female, who were paid for their participation.

Stimuli. There were 20, three and four-letter one-syllable nonsense words (Table 6) divided into two groups of 10 words each. Each such group was further subdivided into two 5-word groups. For each of the four 5-word groups, 8 slips of paper, each having a different linear arrangement of the 5 words typed in upper-case print were made for the speed-naming practice. Each of the two 10-word groups received the same number of presentations in both the Visual and Auditory conditions across Ss, and each 5-word group received the same number of speed-naming exposures across Ss. The two 5-word lists assigned to each S for the speed-naming task were chosen from the 4 possible combinations across 10-word lists to avoid any artifactual effect due to the words themselves.

Since the Test Phase involved 60 trials, involving 3 visual exposures for each of the 20 words learned, 60 cards were made up with the words printed on them in Letraset #8 capital letters. Also, for the Test Phase context task, 20 sentences were constructed with 3 variations each, each sentence having one correct alternative in each of the two 10-word conditions. Thus there was a constant list of sentence-word associations for each S, with an equal number of "yes" responses per 5-word group across all Ss.

Table # 6

Experiment # 4

Stimuli & Meanings

	PSEUDOWORD	ASSIGNED ENGLISH MEANING
List A		
	(1)	
	SPAG	hen
	DOKE	glove
	STOD	coffee
	TESH	car
	FAIN	cigar
	(2)	
	PITE	note
	ZELT	chalk
	CLAT	cannon
	THUN	stove
	PLAR	bottle
List B		
	(1)	
	BARM	cat
	LART	hat
	RAST	milk
	VIPS	chair
	HUX	pipe
	(2)	
	NOFF	book
	MUND	pencil
	JINT	rifle
	FREP	radio
	GLIP	cup

Procedure. The experimental session began with 8 speed-naming trials, four for the 5-word group drawn from each of the Visual and Auditory conditions. The speed-naming trials were conducted in an ABBA sequence with the first trial being an Auditory or Visual condition group an equivalent number of times across Ss. Each trial consisted of S's reading aloud the line of 5 spaced words as quickly as possible while E timed the latency from stimulus presentation to the end of the voicing of S's last response. The Training Phase which followed employed the same procedure as that used in Experiment #3.

Between the completion of the speed-training task and the commencement of the Test Phase task S was once more given the speed-naming task. Again there were 8 trials, four for each condition, in the same ABBA sequence S had been given before with the same words. No two 5-word sequences were alike across the two speed-naming sessions. RTs were recorded in the same manner as before.

The Test Phase consisted of 60 trials, each presented in the same manner with the same response restrictions as was done in Experiment #3. The 60 trials were composed of 3 successive presentation sets, each set including all 20 words S had learned. The cards that the stimulus words were on were shuffled to determine the word presentation sequence per set. E used six prepared lists having 10 sentence-word pairs each, 3 lists per condition, to help structure the presentation sequence. Each presentation set was assigned one list from each of the two conditions with a random sequence of pairs of lists being offered each S. S was thus given 3 successive random sequence exposures of the 20 words.

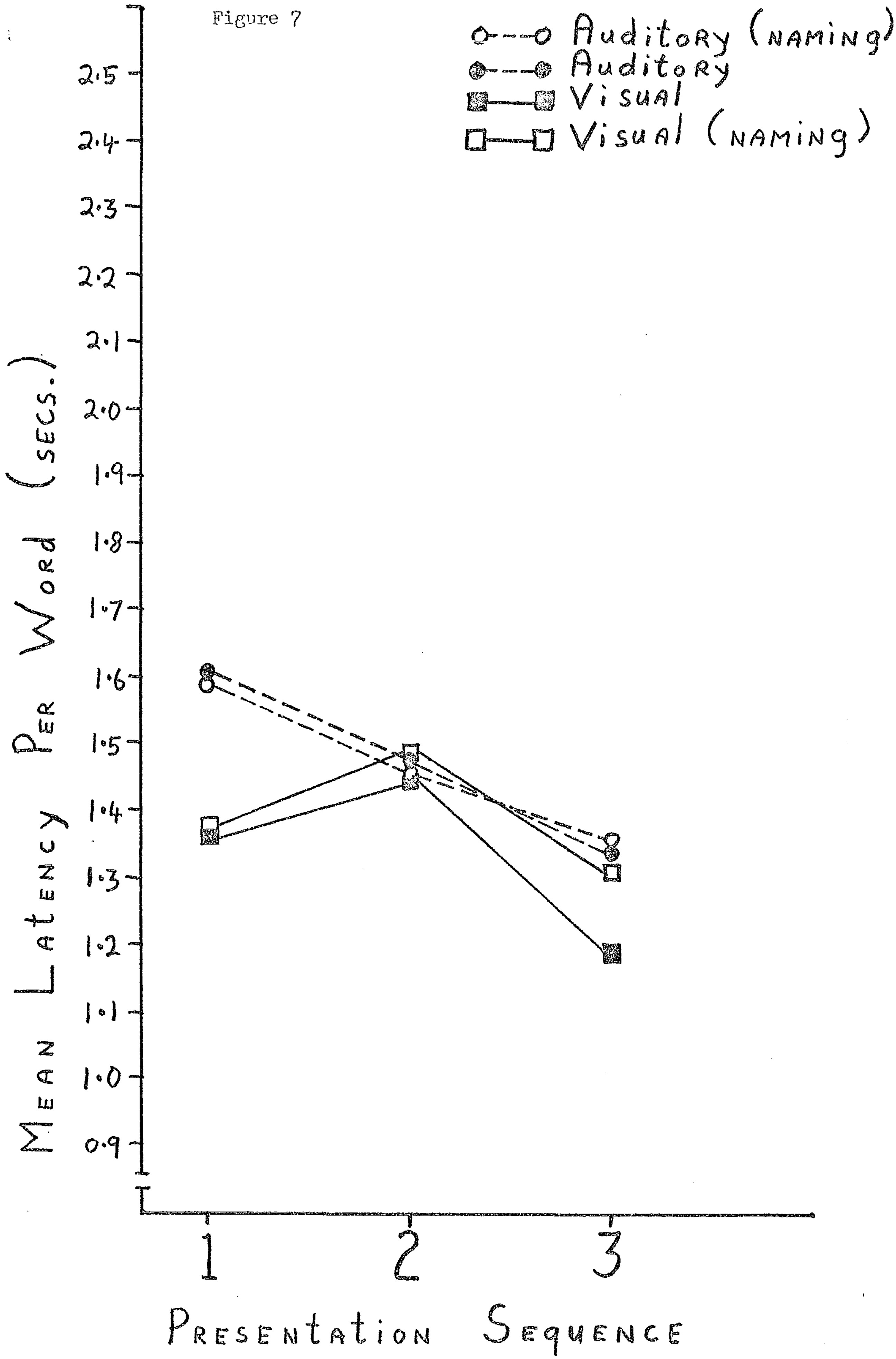
RESULTS AND DISCUSSION

In general the data exhibit no pronounced effect of the added speed-naming training on the Visual vs. Auditory condition difference. The RT data is presented per condition and per presentation by means in Figure 7. Individual mean comparisons are tabulated in Table 7.

The apparent weakening of the basic Visual vs. Auditory condition comparison ($z = 1.53$, N.S.) is apparently a chance result since it hasn't occurred in any of the previous experiments and still demonstrates a strong trend towards the anticipated effect. Further, the effect was found in the comparison of the Visual and Auditory speed-naming conditions ($z = 2.13$, $p < .05$), which result would not be expected if the speed-naming training had any beneficial effect on the visual identification of Auditory condition words. It is clear from the evidence that the added speed-naming training does not account for the RT difference between the Visual and Auditory conditions.

What this result means in terms of the possible processing differences accounting for the basic effect is that there is no support for the presence of a phonic-linguistic recoding mechanism in the Visual condition during rapid visual word I.D. If the degree of training with such a mechanism was the critical factor in differentiating the performances of the Auditory and Visual conditions then one would expect a marked weakening, if not disappearance of the effect for words which had received the naming training. That the effect is drastically reduced after just one Test Phase presentation but not after 8 rapid naming trials suggests that specific visual experience with a word requires the context of meaning-access to achieve fluent rates of visual word I.D. The

Figure 7



Auditory (NAMING)
Auditory
Visual
Visual (NAMING)
Mean Latency Per Word (secs.)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
1
2
3
Presentation Sequence

Table # 7

Experiment # 4

Wilcoxon Matched - Pair Comparisons Across Presentations

Comparison	Presentation #1	Presentation #2	Presentation #3
Auditory Groups (naming) vs (*****)	z = -0.05 (N.S.)	z = 0.41 (N.S.)	z = 0.89 (N.S.)
Visual Groups (naming) vs (*****)	z = -0.41 (N.S.)	z = -0.15 (N.S.)	z = 1.27 (N.S.)
Naming Groups Auditory (naming) vs Visual (naming)	z = 2.13 ($p < .05$)	z = 0.41 (N.S.)	z = 0.10 (N.S.)
Non-Naming Groups Auditory (*****) vs Visual (*****)	z = 1.53 (N.S.)	z = 0.15 (N.S.)	z = 0.61 (N.S.)
Interaction Auditory (naming) - (*****) vs Visual (naming) - (*****)	z = 0.30 (N.S.)	z = -1.13 (N.S.)	z = -0.51 (N.S.)

implication follows that the Visual condition training effects a direct association between the graphic-letter I.D. information in the visual representation of the word and its lexical correlate, whereas the speed-naming training practices mechanisms whose development plays no critical part in producing rapid rates of visual word I.D.

Returning to our two processing possibilities (A and B in Figure 1), the above restrictions are easily handled by the direct meaning-access from graphic-letter I.D. cues interpretation of the effect. Employing no phonic-linguistic cues in its operation, this process can gain nothing from selective practice on the abstraction of phonic-linguistic cues from visual representations; and this visual process could be interrupted or delayed by any tendency to produce phonic-linguistic information as may result from the added speed-naming task.[4]

However, the possibility remains that the phonic-linguistic recoding mechanism practiced in the speed-naming training is not of the same type as that possible for rapid visual word I.D. Such a phonic-linguistic recoding mechanism must involve a complex abstraction of phonic-linguistic information and not a simple articulatory or auditory representation of the visual stimulus (e.g., covert speech) as would be expected to result from the speed-naming task. This possibility will be further discussed in the Conclusions and Discussion section.

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[4]This refers to deviational trends in the data almost singularly occurring for the Visual condition responses: (a) longer RTs for the Visual speed-naming condition over the basic Visual condition for presentations #1 - #3, and (b) sudden rise in RT for both Visual conditions on presentation #2 (see Figure 7). Neither of these trends approaches statistical significance, nor did they reappear in a following experiment which involved a replication of the present experiment.

Analysis of the speed-naming data revealed the following results (see Appendix D for graph). Wilcoxon matched-pair comparisons showed a Pre- vs. Post-training effect, favouring shorter latencies for the Post-training measures for both the Auditory ($z = 2.80$, $p < .01$) and Visual ($z = 2.80$, $p < .01$) conditions. The Pre-training Auditory vs. Visual condition comparison showed no difference between the two conditions ($z = 0.77$, N.S.), but the Post-training comparison showed a significant difference ($z = 1.78$, $p < .05$). This last finding represents a mean difference between naming speeds of Auditory and Visual condition words of .03 secs. per word favouring faster times for the Visual condition words (see Appendix D). This difference is hardly enough to account for the basic effect which ranges in size from a difference of .16 secs. per word to .64 secs. per word (see Appendix E). Thus if the speed-naming task is in any way valid as a measure across conditions of the speed of derivation of phonic-linguistic cues, then specific training on such a derivation process is not sufficient to attain the speed of visual word I.D. we obtain for the Visual condition words.

The "novelty interrupt" argument is readily dispensed with here. The effect occurs even when S has seen and pronounced the words 8 times before, which argues strongly against S's initially not being able to recognize them on the first Test Phase presentation as the factor responsible for the Visual vs. Auditory condition difference. For the same reason one can safely conclude that the effect is not a result of delay in assigning a word's visual configuration to its internal representation in the Auditory condition, where a higher probability of mismatches exists. This claim is further supported by there being little difference between the number of spelling errors by Ss between the Auditory condition with the speed-naming training and that without, an average of 0.2 and 0.4 errors per 5-word condition respectively.

CONCLUSIONS AND DISCUSSION

The experiments reported here in general support the presence of a direct meaning-access process in reading based on an analysis of a given word's graphic or letter identity features. Experiment #1 provided the information that specific visual experience with a word in some way produces a beneficial effect in later visual identification of that word at fluency. Experiment #2 confirmed the general findings of Experiment #1 by demonstrating that neither gross differences in the auditory aspects of the Training Phase nor the specific nature of the identification task employed were responsible for the effect.

Experiment #3 showed that added auditory confusibility significantly increased visual word I.D. latencies for the Auditory condition and had little or no effect on the latencies for the Visual condition, as well as providing another replication of faster performance on the Visual condition words. The most tenable interpretation that we can draw from Experiment #3 is that the Visual condition fosters a graphic-letter I.D. direct meaning-access process which is faster than a phonic-linguistic recoding meaning-access process, the only one allowed in the Auditory condition.

Experiment #4 had the added feature of the opportunity for some words in each of the two conditions to be experienced visually outside the context of accessing the words' meanings. The positive results of the experiment helped argue against the interpretation that the superior performance on the Visual condition words is due to the opportunity afforded in training for developing a faster phonic-linguistic recoding analysis not possible in the Auditory condition. This result was also contrary to the interpretations that either the discrepancy between Ss' preconceptions of a word's appearance and its actual physical characteristics or simply the novelty of seeing the word for the first time would generate enough of a delay to account for the effect.

The above is a summary of our results and the reasoning involved in reaching our conclusions. It is of interest then to discuss more extensively the main alternative interpretation, which is that our data demonstrate a word-specific phonic-linguistic recoding training effect. Such a claim, however, is greatly strained by our findings in Experiments #3 and #4. Whatever process is responsible for the faster word identification RTs for the Visual condition words is not aided by overt practice in naming the words, nor is it influenced in any detectable way by acoustic confusibility among the words even though the Auditory condition words are. Thus any form of covert vocalization of the visually presented words is almost completely ruled out as a mechanism involved in the rapid word I.D. processing occurring in the Visual condition. This forces the phonic-linguistic recoding interpretation of the effect to require more conceptually complex abstractions of phonic-linguistic cues from a word's visual representation. This modified possibility necessitates a highly selective derivation of phonic-linguistic cues from a printed word to be able to bypass any auditory confusibility among words and which is very rapidly acquired since the effect is drastically reduced after just one Test Phase presentation. Even from the point of view of simplicity the graphic-letter I.D. encoding interpretation is preferred.

We turn now to some limitations that make our paradigm less than representative of the general reading experience. The effect isolated here may only occur this strongly in these particular experimental situations. The following is an appraisal of such possible limitations.

First, the fact that we teach Ss only 20 words, 10 per condition, can be considered a limit on the generality of the results. Such a small population, it can be argued, is most conducive to the functioning of a graphic-letter I.D. meaning-access process since a larger population would raise the problem of visual confusions in discriminating the various items. We don't claim that a graphic-letter I.D. meaning-access process pervades reading behaviour, rather our study simply demonstrates that some potential for such a process exists for reading in general. Longer lists would more closely approximate the range of vocabulary available at a given time. However, the fact that the present effect disappears rapidly after just one visual presentation suggests that whatever type or degree of mechanism is acquired it is applied very quickly, an event not expected if one were dealing with an infrequent strategy specific to a small population of words.

Second, it can be argued that our use of nonsense words presents S with an artificial situation in that he (or she) knows that the words aren't "real" and bear no legitimate semantic relation to their assigned meanings. It may be argued that our words might undergo a special processing sequence since in normal circumstances novel words are placed into a functional, contextual structure that in most cases represents a new concept for S whereas our words represent already known concepts. The rationale for this aspect of our paradigm has been presented earlier, in the Introduction. On the other hand, many words in English are found to have the same or at least highly similar meanings (e.g., synonyms), so it should not be unusual to attach a new visual "label" to a meaning that already has one. Further, it is unreasonable that Ss should treat our words any differently than they would treat a novel word in reading, as the efficiency in the operation of such an acquisition process developed over years of reading would surely be most beneficial to them in the acquisition situation required by the present paradigm.

Third, the "visual word I.D. in context" task used throughout Experiments #2, #3, and #4 may restrict the generality of our interpretation by having the words to be identified placed at the ends of test sentences (syntactically - objects), thus providing no measure of the effect of type of sentence context cues on the meaning-access mechanism. This task was meant to be nondiscriminatory in its effect across the Auditory and Visual conditions, and to allow a measure of visual identification RT of the words shown in a reading-like situation. The fact that the effect occurred in both Experiments #1 and #2 which used different visual word I.D. tasks suggests that the occurrence of the effect may be independent of the given word's context. Such a claim would be greatly strengthened if the same effect were found to occur across a wider variety of contextual and syntactic situations.

Fourth, there is the complaint that our paradigm uses the same typeface in both Training and Test Phases, whereas the general reading experience involves seeing words in many varied graphic forms including the upper-case lower-case distinction. This argues essentially that our effect may be typeface-specific allowing little transfer to the processing of other graphic forms of the words. This boils down to the question of whether specific or general graphic qualities of a word are associated with its meaning in the present specific visual learning situation. Though the use of various typefaces across the Training and Test Phases of the present paradigm may not be successful in isolating the specific visual cues used in rapid visual word I.D., this manipulation might shed some light on the issue of whether specific graphic cues are used to access meaning in the present case or is an intermediate letter I.D. phase involved. For one would expect no effect of typeface differences if only a well-practiced letter I.D. mechanism were in operation here, and some effect of typeface differences if graphic features not specific to letters were used in the identification of a given word. We didn't directly address this question but our Experiment #1 had a different typeface presentation of words in the Test Phase (typewritten capitals) than in the Training Phase (Letraset print capitals), and still demonstrated the effect.

Fifth, the duration and extent of the Training Phase may be questioned as to its relation to the normal acquisition of a novel word in general experience. We used extensive training of the words to ensure the production of the most efficient word I.D. process possible under the conditions, so it is definitely of interest to methodically alter the type and degree of experience with the words and their assigned meanings to determine the minimal training conditions required to produce the effect. Such manipulation is interesting particularly in light of the fact that the size of the effect is so quickly dissipated after just one visual Test Phase presentation. Thus if simple degree of visual experience is not the critical factor in the production of the effect (Experiment #4) then one can probe various points in the Training Phase to determine at what point the specific visual experience is first most beneficial to eventual rapid visual word I.D. This technique would enable us to determine whether for instance the critical point for visual experience occurs initially when the word is first experienced or after the specific word has been phonetically catalogued. This would help distinguish certain possibilities in the development of the rapid visual word I.D. response in that it either requires reference to a well-practiced phonetic-lexical association in its initial stages of development or it can develop independently of the presence of any phonetic associate of the lexical item in question, meaning direct graphic-letter I.D. based meaning-access is practiced from the very first visual exposure of a word.

This discussion has covered questions that follow from the research presented and suggests ways in which the paradigm used here can be employed in their investigation. Our claim that the results reported here provide grounds for disposing of the possibility that some form of phonic-linguistic recoding exclusively mediates rapid visual word I.D. is neither novel nor unique. Huey (1908) very early proposed that, "Purely visual reading is quite possible, theoretically;..." (Huey, 1908, p. 117), and Smith (1971) has lately provided a feature-analytic model of reading that includes the option for meaning-access from graphic-letter I.D. information alone in efficient reading. It is hoped that the present paradigm proves beneficial towards adding more new information concerning the nature of the efficient reading process.

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APPENDIX A

(Experiment # 1)

Sample Test Phase List for Subjects' Responses . Experiment # 1

O R T E T R O

A T A R A T A

S P I N I P S

R A L P L A R

P R O N O R P

B U T A T U B

S I X A X I S

L A N T N A L

S T A R A T S

F I L P L I F

Test Phase Data

Response Times per Ten Item Lists (secs.)

Subject	Sex	Visual Condition List Latencies in Order of Presentation 1	2	3	4	Auditory Condition List Latencies in Order of Presentation 1	2	3	4
P.S.	M	16.8	16.1	22.8	15.9	19.2	13.0	15.7	14.1
B.P.	F	12.4	10.4	8.7	13.6	21.0	15.9	12.9	9.3
K.F.	F	14.4	8.2	15.2	15.2	17.2	9.5	11.8	9.1
J.S.	F	13.8	9.8	13.5	12.1	17.2	18.7	10.6	11.2
D.H.	F	16.1	15.8	9.7	10.2	18.2	16.3	14.7	10.3
G.S.	F	12.8	13.5	11.4	12.7	17.8	16.4	12.5	14.3
P.S.	F	14.0	11.3	7.7	9.4	17.8	12.2	8.5	10.2
B.R.	F	11.0	8.5	9.0	8.5	11.5	9.3	8.1	8.5
B.J.	F	16.2	15.1	12.2	21.0	18.6	18.6	13.3	19.7
S.L.	F	12.6	10.8	15.8	12.1	20.1	12.4	11.5	13.7
	Sum	140.1	119.5	126.0	130.7	178.6	142.3	119.6	120.4
	$\bar{X}$	14.01	11.95	12.60	13.07	17.86	14.23	11.96	12.04
Lat. per word		1.40	1.20	1.26	1.31	1.79	1.42	1.20	1.20

(Auditory List Latency) - (Visual List Latency)
Differences : (secs .)

Subject		Presentation #1	Presentation #2	Presentation #3	Presentation #4
P.S.		2.4	-3.1	-7.1	-1.8
B.P.		8.6	5.5	4.2	-4.3
K.F.		2.8	1.3	-3.4	-6.1
J.S.		3.4	8.9	-2.9	-0.9
D.H.		2.1	0.5	5.0	0.1
G.S.		5.0	2.9	1.1	1.6
P.S.		3.8	0.9	0.8	0.8
B.R.		0.5	0.8	-0.9	0.0
B.J.		2.4	3.5	1.1	-1.3
S.L.		7.5	1.6	-4.3	1.6
	Sum	38.5	22.8	-6.4	-10.3
	$\bar{X}$	3.85	2.28	-0.64	-1.03
Diff. per word		.39	.23	-.06	-.10

APPENDIX B

(Experiment # 2)

EXPERIMENT # 2

Test Phase Data

Response Times per Groups of Ten Words (secs.)

Subject	Sex	(A-V) Auditory Training - Visual ID	(V-V) Visual Training - Visual ID	(A-A) Auditory Training - Auditory ID	(V-A) Visual Training - Auditory ID
S.L.	F	19.5	14.4	19.9	20.8
A.C.	M	10.5	10.6	8.4	10.4
M.G.	F	21.5	16.0	14.2	23.3
C.A.	F	16.3	14.5	13.0	12.9
C.K.	M	35.3	16.3	23.4	23.2
B.S.	M	26.5	16.0	19.1	20.8
S.F.	F	21.1	15.9	18.7	22.4
P.B.	F	24.8	15.1	20.4	17.2
L.P.	F	21.6	18.0	19.0	18.4
S.C.	F	19.8	16.2	16.6	17.8
	Sum	216.9	153.0	172.7	187.2
	$\bar{X}$	21.69	15.30	17.27	18.72
Lat. per word		2.17	1.53	1.73	1.87

Experiment # 2

Mann - Whitney U Comparisons per Subject :

Subject	(A-V) vs (V-V)	(A-A) vs (V-A)
S.L.	z = 1.965 (p .05)	z = -0.832 (N.S.)
A.C.	z = 0.113 (N.S.)	z = -1.020 (N.S.)
M.G.	z = 1.398 (N.S.)	z = -1.550 (N.S.)
C.A.	z = 1.852 (p .05)	z = -0.340 (N.S.)
C.K.	z = 3.137 (p .01)	z = 0.151 (N.S.)
B.S.	z = 1.890 (p .05)	z = -1.361 (N.S.)
S.F.	z = 2.079 (p .05)	z = -0.794 (N.S.)
P.B.	z = 2.457 (p .01)	z = 1.020 (N.S.)
L.P.	z = 1.625 (N.S.)	z = 0.227 (N.S.)
S.C.	z = 1.361 (N.S.)	z = -0.983 (N.S.)

APPENDIX C

(Experiment # 3)

EXPERIMENT # 3

Test Phase Data

Response Times per Groups of Five Words (secs.)

		PRESENTATION # 1			
		Auditory Condition		Visual Condition	
Subject	Sex	AC	NAC	NAC	AC
J.S.	F	10.3	7.2	6.5	9.5
J.H.	M	9.3	6.7	5.4	7.5
B.M.	F	7.4	5.9	6.0	5.8
L.L.	F	8.7	4.7	4.2	5.1
R.H.	M	15.7	9.1	8.0	6.3
G.F.	M	7.5	8.2	6.8	5.8
D.H.	F	8.3	6.1	7.2	6.0
G.B.	M	13.4	10.1	10.7	7.8
J.S.	F	17.8	8.1	6.2	5.5
R.M.	M	16.5	11.0	7.8	6.0
	Sum	114.9	77.1	68.8	65.3
	$\bar{X}$	11.49	7.71	6.88	6.53
Lat. per word		2.30	1.54	1.38	1.31

EXPERIMENT # 3

Test Phase Data

Response Times per Groups of Five Words (secs.)

PRESENTATION # 2

Subject	Sex	Auditory Condition AC	Auditory Condition NAC	Visual Condition NAC	Visual Condition AC
J.S.	F	7.2	6.5	6.3	6.2
J.H.	M	6.5	10.1	5.2	6.0
B.M.	F	5.9	7.4	6.3	4.4
L.L.	F	3.8	5.7	3.3	4.2
R.H.	M	10.1	5.4	6.3	5.6
G.F.	M	10.2	4.7	6.8	6.6
D.H.	F	8.8	6.7	8.1	4.9
G.B.	M	12.8	11.3	6.2	7.3
J.S.	F	10.7	6.5	4.8	5.7
R.M.	M	10.5	7.0	8.0	9.9
	Sum	86.5	71.3	61.3	60.8
	$\bar{X}$	8.65	7.13	6.13	6.08
Lat. per word		1.73	1.43	1.23	1.22

EXPERIMENT # 3

Test Phase Data

Response Times per Groups of Five Words (secs.)

PRESENTATION # 3

Subject	Sex	Auditory Condition AC	Auditory Condition NAC	Visual Condition NAC	Visual Condition AC
J.S.	F	9.6	6.2	5.9	6.5
J.H.	M	4.9	6.5	4.6	5.7
B.M.	F	4.2	4.4	5.6	5.3
L.L.	F	5.0	4.2	3.8	3.9
R.H.	M	7.7	6.9	6.2	5.0
G.F.	M	8.8	5.4	5.2	5.5
D.H.	F	11.0	5.6	5.5	6.3
G.B.	M	7.8	9.3	7.0	6.5
J.S.	F	9.4	4.9	4.8	4.8
R.M.	M	6.9	8.0	7.3	7.1
	Sum	75.3	61.4	55.9	56.6
	$\bar{X}$	7.53	6.14	5.59	5.66
Lat. per word		1.51	1.23	1.12	1.13

Experiment # 3

PRESENTATION # 1

Wilcoxon Matched - Pair Comparisons Across Squads

Comparison	Squad # 1	Squad # 2	Squad # 3	Squad # 4	Squad # 5
Auditory Groups (A-AC) vs (A-NAC)	$z = 2.49$ ($p < .01$)	$z = 2.19$ ($p < .05$)	$z = 2.09$ ($p < .05$)	$z = 0.77$ (N.S.)	$z = 0.97$ (N.S.)
Visual Groups (V-AC) vs (V-NAC)	$z = 1.07$ (N.S.)	$z = -1.48$ (N.S.)	$z = 1.13$ (N.S.)	$z = -1.48$ (N.S.)	$z = -1.68$ ($p < .05$)
Basic Comparison (A-NAC) vs (V-NAC)	$z = 1.01$ (N.S.)	$z = -0.41$ (N.S.)	$z = 0.46$ (N.S.)	$z = 1.24$ (N.S.)	$z = 0.41$ (N.S.)
Confusibility Groups (A-AC) vs (V-AC)	$z = 2.31$ ($p < .05$)	$z = 2.80$ ($p < .01$)	$z = 1.38$ (N.S.)	$z = 2.70$ ($p < .01$)	$z = 2.55$ ($p < .01$)
Interaction (A-AC) - (A-NAC) vs (V-AC) - (V-NAC)	$z = 2.01$ ($p < .05$)	$z = 2.31$ ($p < .05$)	$z = 0.82$ (N.S.)	$z = 1.78$ ($p < .05$)	$z = 2.55$ ($p < .01$)

Experiment # 3

PRESENTATION # 2

Wilcoxon Matched - Pair Comparisons Across Squads

Comparison	Squad # 1	Squad # 2	Squad # 3	Squad # 4	Squad # 5
Auditory Groups (A-AC) vs (A-NAC)	z = 0.26 (N.S.)	z = 1.30 (N.S.)	z = 1.78 ($p < .05$)	z = -0.36 (N.S.)	z = 1.94 ($p < .05$)
Visual Groups (V-AC) vs (V-NAC)	z = -0.24 (N.S.)	z = -0.36 (N.S.)	z = 0.87 (N.S.)	z = -0.53 (N.S.)	z = 0.51 (N.S.)
Basic Comparison (A-NAC) vs (V-NAC)	z = 0.36 (N.S.)	z = -0.36 (N.S.)	z = 0.65 (N.S.)	z = 1.48 (N.S.)	z = 0.15 (N.S.)
Confusibility Groups (A-AC) vs (V-AC)	z = 0.89 (N.S.)	z = 1.27 (N.S.)	z = 1.58 (N.S.)	z = 2.04 ($p < .05$)	z = 1.94 ($p < .05$)
Interaction (A-AC) - (A-NAC) vs (V-AC) - (V-NAC)	z = 0.36 (N.S.)	z = 1.38 (N.S.)	z = 0.97 (N.S.)	z = -0.05 (N.S.)	z = 1.60 (N.S.)

Experiment # 3

PRESENTATION # 3

Wilcoxon Matched - Pair Comparisons Across Squads

Comparison	Squad # 1	Squad # 2	Squad # 3	Squad # 4	Squad # 5
Auditory Groups (A-AC) vs (A-NAC)	z = 2.55 ($p < .01$)	z = 0.89 (N.S.)	z = 1.01 (N.S.)	z = 1.13 (N.S.)	z = 0.47 (N.S.)
Visual Groups (V-AC) vs (V-NAC)	z = 0.47 (N.S.)	z = -0.12 (N.S.)	z = 1.48 (N.S.)	z = -0.15 (N.S.)	z = -0.12 (N.S.)
Basic Comparison (A-NAC) vs (V-NAC)	z = 0.30 (N.S.)	z = 0.15 (N.S.)	z = 1.24 (N.S.)	z = 1.33 (N.S.)	z = -0.12 (N.S.)
Confusibility Groups (A-AC) vs (V-AC)	z = 1.48 (N.S.)	z = 0.53 (N.S.)	z = 1.22 (N.S.)	z = 1.99 ($p < .05$)	z = 1.78 ($p < .05$)
Interaction (A-AC) - (A-NAC) vs (V-AC) - (V-NAC)	z = 1.07 (N.S.)	z = 0.71 (N.S.)	z = 0.71 (N.S.)	z = 1.13 (N.S.)	z = 1.48 (N.S.)

APPENDIX D

(Experiment # 4)

EXPERIMENT # 4

Test Phase Data

Response Times per Groups of Five Words (secs.)

PRESENTATION # 1

Subject	Sex	Auditory Condition (naming)	Auditory Condition (*****)	Visual Condition (*****)	Visual Condition (naming)
D.P.	M	9.8	8.3	8.7	7.7
W.K.	F	6.7	7.6	6.0	4.7
B.C.	M	6.2	7.0	7.7	7.1
R.B.	F	8.3	9.0	6.9	6.2
S.L.	F	9.5	14.7	7.9	9.4
M.B.	F	5.0	4.7	3.5	4.5
B.G.	F	9.3	6.7	7.5	8.4
R.B.	F	6.9	7.3	5.3	6.9
P.J.	M	7.1	7.0	9.0	6.5
D.G.	F	10.8	8.4	5.7	7.5
	Sum	79.6	80.7	68.2	68.9
	$\bar{X}$	7.96	8.07	6.82	6.89
Lat. per word		1.59	1.61	1.36	1.38

EXPERIMENT # 4

Test Phase Data

Response Times per Groups of Five Words (secs.)

PRESENTATION # 2

Subject	Sex	Auditory Condition (naming)	(*****)	Visual Condition (*****)	(naming)
D.P.	M	7.3	7.6	7.1	6.8
W.K.	F	8.0	9.1	7.4	6.9
B.C.	M	5.6	6.6	5.8	6.2
R.B.	F	7.4	7.4	6.4	6.2
S.L.	F	11.1	14.4	8.4	11.1
M.B.	F	4.3	3.7	4.3	5.6
B.G.	F	5.0	5.9	8.8	8.0
R.B.	F	7.2	7.4	7.8	7.4
P.J.	M	8.9	5.3	8.8	6.5
D.G.	F	8.1	6.6	7.5	9.8
	Sum	72.9	74.0	72.3	74.5
	$\bar{X}$	7.29	7.40	7.23	7.45
Lat. per word		1.46	1.48	1.45	1.49

EXPERIMENT # 4

Test Phase Data

Response Times per Groups of Five Words (secs.)

PRESENTATION # 3

Subject	Sex	Auditory Condition (naming)	Auditory Condition (*****)	Visual Condition (*****)	Visual Condition (naming)
D.P.	M	5.1	7.3	4.8	5.7
W.K.	F	6.4	6.4	5.9	6.8
B.C.	M	5.7	5.5	5.8	5.6
R.B.	F	6.8	6.4	6.6	7.4
S.L.	F	7.9	13.8	7.1	7.4
M.B.	F	7.1	3.5	3.2	3.9
B.G.	F	6.8	5.6	6.8	8.8
R.B.	F	7.0	6.6	7.5	6.6
P.J.	M	8.6	5.6	7.4	6.3
D.G.	F	6.8	6.4	4.3	7.1
	Sum	68.2	67.1	59.4	65.6
	$\bar{X}$	6.82	6.71	5.94	6.56
Lat. per word		1.36	1.34	1.19	1.31

EXPERIMENT # 4

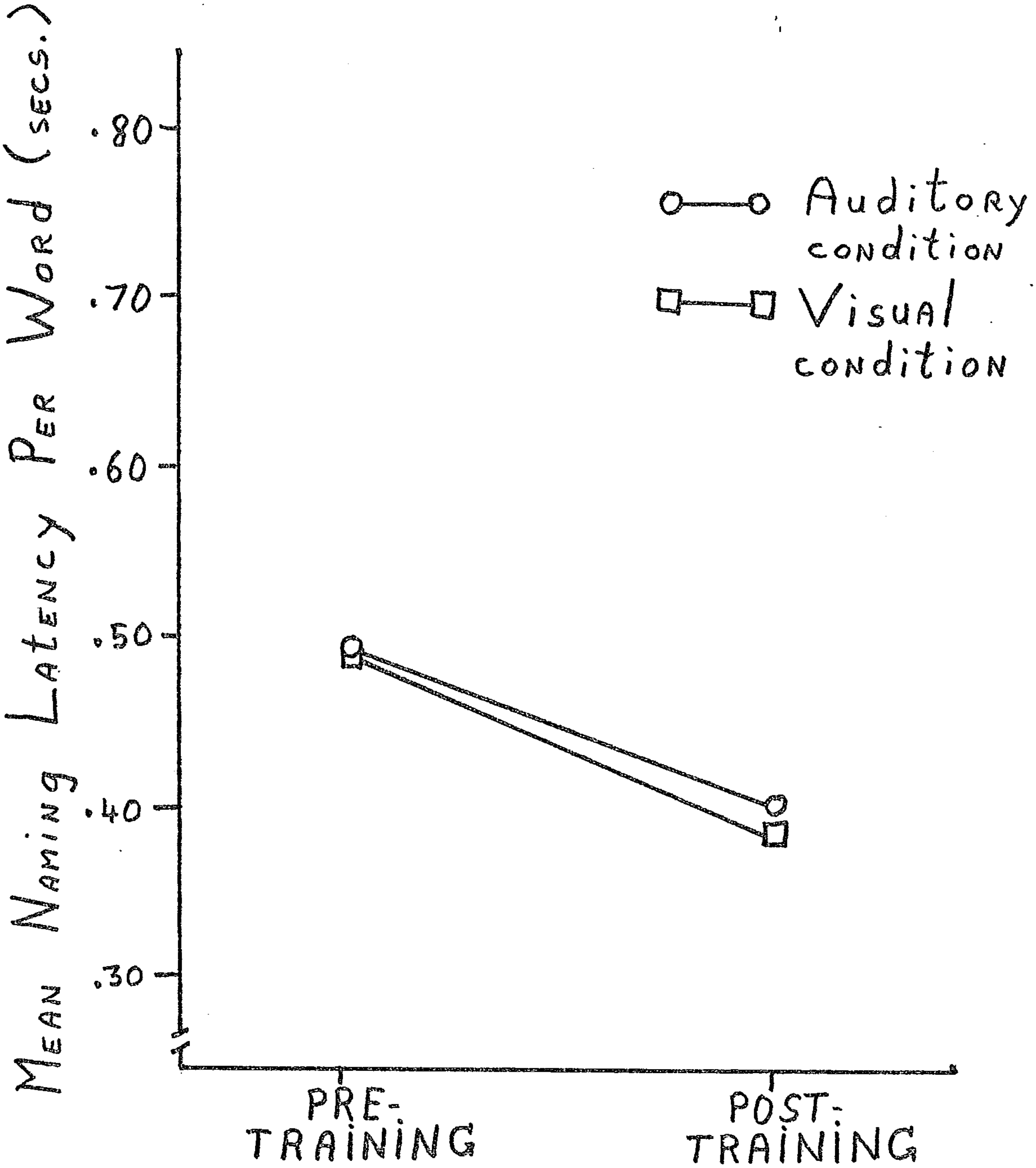
Response Times for Rapid Naming Trials

Scores are sums of four 5-word lists (secs.)

Subject	Sex	PRE - TRAINING Auditory Condition	PRE - TRAINING Visual Condition	POST - TRAINING Auditory Condition	POST - TRAINING Visual Condition
D.P.	M	9.3	7.8	7.8	6.8
W.K.	F	11.7	14.9	10.0	10.6
B.C.	M	9.0	8.1	7.6	7.8
R.B.	F	8.9	8.7	7.7	7.5
S.L.	F	9.1	8.0	6.4	5.9
M.B.	F	12.8	12.3	12.4	9.5
B.G.	F	7.8	8.0	7.7	7.5
R.B.	F	11.4	10.7	8.1	7.6
P.J.	M	8.7	9.4	7.0	6.9
D.G.	F	8.3	8.7	7.9	6.8
	Sum	97.0	96.6	82.6	76.9
	X	9.70	9.66	8.26	7.69
Lat. per 5 words		2.43	2.42	2.07	1.92
Lat. per word		0.49	0.48	0.41	0.38

Mean Speed-Naming RTs per Condition

Experiment #4



APPENDIX E

(Miscellaneous)

Test Phase Error Data Across Experiments

Each score represents mean no. of errors per condition .

Experiment	Total no. Words per Condition	AUDITORY CONDITION (errors)	VISUAL CONDITION (errors)	OTHER CONDITIONS AS PER EXPERIMENT (errors)	
# 1	40	1.2	1.1	*****	
# 2	10	0.9	0.2	(A-A) 0.9	(V-A) 1.2
# 3	15	1.4	0.8	(A-AC) 1.9	(V-AC) 1.2
# 4	15	1.1	0.6	Auditory (naming) 0.9	Visual (naming) 0.8

Miscellaneous Data

Experiments #1 - #4

All scores are means across 10 subjects .

Dimension	Experiment #1	Experiment #2	Experiment #3	Experiment #4
TRIALS TO CRITERION IN TRAINING :				
First 10 words :	3.9	4.4	3.7	3.7
Next 10 words :	3.5	3.4	3.5	3.1
All 20 words :	2.2	2.5	2.7	2.0
ERRORS IN TRAINING :				
Visual condition words :	4.7	4.4	3.0	3.0
Auditory condition words :	6.5	7.8	6.5	3.5
SPEED CRITERION DATA :				
Average of 3 fastest speed criterion trials per subject :	34.50 (secs.)	32.77 (secs.)	32.92 (secs.)	30.68 (secs.)

Mean Response Time per Word Across Conditions :

PRESENTATION # 1

Experiment	No. of Subjects	No. Words per Condition	AUDITORY CONDITION (secs.)	VISUAL CONDITION (secs.)	OTHER CONDITIONS PER EXPERIMENT (secs.)	
# 1	10	10	1.79	1.40	**********	
# 2	10	10	2.17	1.53	(A-A) 1.73	(V-A) 1.87
# 3	10	5	1.54	1.38	(A-AC) 2.30	(V-AC) 1.31
# 4	10	5	1.61	1.36	Auditory (naming) 1.59	Visual (naming) 1.38