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PICTURE-WORD INTERACTION: IMPLICATIONS FOR SPEEDED ON-LINE PROCESSING AND DELAYED MEMORY RETRIEVAL

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Concrete and abstract words were processed similarly, in a lexical decision task, suggesting that concrete and abstract words are not represented in a different form. In sequential presentation of pictures and words at 8 items per second, a target specified by category was equally rapid for pictures and words. In a masking study, scenes presented for 110 msec showed only a small level of interference from a following picture, when the masking picture was always the same.

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Report Summary

Objectives. The goal of the research program is to investigate speeded reading, speeded picture-recognition and the interaction between pictures and words, both in on-line tasks and in delayed use of the information.

Methods and Results. Part I reports three experiments that extend previous work on the automaticity of speeded decisions to include abstract as well as concrete words. Since words that name pictures are necessarily concrete, our previous findings might have been valid only for concrete words. Concrete and abstract words were rated in Experiment 1 and presented in a word-nonword decision task (so-called lexical decision) in Experiments 2 and 3. Although concrete words were somewhat more rapidly identified than were abstract words, there was no difference in incidental recall. The results imply that abstract and concrete words are processed similarly.

Part II A reports three experiments that extend previous detection experiments, continuing the study of the readiness with which a picture or word target can be detected in a stream of pictures, words, or both. The experiments also vary both the target specification (e.g., "respond if you see a car" versus "a vehicle" versus "something that moves fast") and the rate of presentation of the sequence (12 items/second versus 8 items/second). The main result of the present experiments was that the speed and accuracy of response is approximately equal for picture and word targets, as would be expected if words and pictures share a common conceptual representation in memory.

Part II B makes a preliminary report of an experiment on RSVP reading (at 12 words a second) designed to test whether on-line processing of meaning occurs at that rate. Preliminary results confirm that hypothesis.

Part III reports an experiment on the perception of scenes presented briefly and followed by another picture or a plain grey field. With a presentation of 110 msec, there was only a small difference between the two conditions in later

recognition accuracy, suggesting that when a viewer attends to a briefly-presented scene, s/he can successfully ignore a following visual event.

Conclusions and Implications for Further Research. The results of the various experiments support the general thrust of the research program in demonstrating that rapid access to and storage of semantic information is possible for pictorial as well as verbal stimuli. The sort of conceptual information obtained from 83-110 msec of viewing and 500-1000 msec of processing a picture and a word appears to be similar, across a variety of stimulus conditions and tasks. Future work will extend these observations in several directions, including the study of structure in reading RSVP paragraphs, map-reading, and detection of a "negative" target in a sequence of scenes.

I. Automaticity in speeded decisions about pictures and words: Some extensions

In earlier reports we presented research which suggested that conceptual processing of pictures and words relied on similar underlying semantic representations. For example, the time to decide that an instance is a member of a category is equally fast for pictures and words (Potter & Faulconer, 1975). Likewise, items of one modality can influence the semantic processing of items of the other modality even when one of the items is not directly attended (Kroll & Potter, 1977). Even in contexts which present a strong linguistic bias (e.g., the comprehension of a sentence), pictures can replace words without a marked decrement in performance.

Although the studies mentioned and others have claimed to show that pictures and words are represented in similar form at conceptual levels of processing, the exact nature of the pictures and words that form this comparison may also present a number of potential problems for this conclusion. The words employed in picture-word studies are almost always the verbal labels of the pictures. For reasons of experimental control the use of matched pictures and words makes good sense. A picture and its verbal label represent the same concept and share the same name. The frequency of usage of the word and the object are likely to be highly correlated. Differences that are observed between such matched sets of pictures and words are thus attributable to the modality difference alone. For purposes of generalizing the observed similarities between the processing of pictures and words to the general representation of language and objects, however, the use of closely matched materials may present a critical restriction. The use of words that verbally label pictures limits the population of words to concrete nouns. The fact that the words are concrete is a problem because differences between concrete and abstract words have been found in memory tasks (e.g., Paivio, 1971), for left versus right visual field processing (Day, 1977), and in lexical access (James, 1975). The concrete words employed in picture-word comparison studies may thus represent a small portion of lexical memory which may be the only subset of words that can be represented in a conceptual format that is similar to the format used to represent pictures. Finally, the fact that all of the words are nouns is also a problem because lexical knowledge may also be organized according to syntactic function (Ehri, 1977; Healy, 1976; Ryder, 1976; Scarborough & Springer, 1975).

The present study considered differences in lexical access and subsequent memory for abstract and concrete nouns. In an earlier study (Potter & Kroll, 1977b) we found that the time to decide that a string of letters formed a real word or that a picture of an object represented a real object, was about the same when subjects knew the modality of the items in advance. When subjects were forced to make amodal "reality" decisions about pictures and words presented in mixed sequences, however, there was a distinct advantage, in processing speed, for the words. In addition, the overall decision times were longer for mixed modality conditions than for pure modality conditions. These results suggested that the overall decision times in the pure conditions do not reflect similar representations, but rather a certain degree of flexibility in processing. For example, it may be possible that lexical decisions about words can be accomplished via access to a relatively superficial lexical representation. Object decisions about pictures may require deeper semantic processing. The two tasks may have appeared to be similar in the pure conditions because capacity can be allocated in an optimally efficient manner when expectancy is controlled, or, because semantic processing for pictures may be a bit more rapid than lexical-semantic processing for words (e.g., Potter & Faulconer, 1975; Rosch, 1975).

The present study employs the method of the study just decribed (Potter & Kroll, 1977b) to examine differences in lexical access for concrete and abstract words. If decisions about the lexical status of a word require only superficial consultation of a mental dictionary, then abstract and concrete words of the same frequency should be accessed in equal time. If, however, lexical decisions require contact with semantic or conceptual memory, then the speed of access may well differ for the two classes of words.

Experiment 1: Ratings of Abstract and Concrete Words

In the initial stages of designing an abstract-concrete word comparison we attempted to match a set of abstract words to the already existing corpus of concrete nouns that we used in our studies of picture-word processing. We found that with the published ratings available (e.g., Paivio, Yuille, & Madigan, 1968) we were unable to match a sufficiently large number of words and that most of our concrete words had not been included in the rating study. To remedy this situation we decided to work in the other direction, starting with a set of abstract words, and matching concrete words to them on the basis of tabled word frequency (Kucera & Francis, 1967) and word length. We then submitted the resulting population of items to be rated for degree of concreteness.

Method

Stimulus materials. The rating scale consisted of 212 nouns. Items were categorized as concrete or abstract according to the following criteria:

(1) Words with concreteness ratings (Paivio et al., 1968) less than or equal to 3.77 on a scale of one to seven, where one represented highly abstract and 7 represented highly concrete, were considered to be abstract.

(2) Concrete words were taken from the Kucera & Francis (1967) word frequency count. For some of these nouns concreteness ratings were available and ranged from 5.60 to 6.87 on the one to seven scale used by Paivio et al. (1968).

(3) Words for which concreteness ratings were unavailable were judged as concrete by two observers on the basis of: (a) how easily they could be imaged, and (b) the degree to which they seemed to be available to sensory experience.

The abstract and concrete words were matched on word length and frequency. Word length ranged from three to eight letters and word frequency ranged from 1-477 per million (Kucera & Francis, 1967). As best as possible, the abstract and concrete words were matched word by word on these dimensions. In addition, an effort was made to exclude homographs, homophones, and words of different form class.

Procedure. The set of 212 abstract and concrete nouns were combined randomly and typed in a column, approximately 25 words to a page. Rating booklets were constructed and the order of pages was counterbalanced . Subjects were instructed to decide how abstract or concrete the words were and to rate them on a scale from one to seven, where one was very abstract and seven was very concrete. No attempt was made to separate rated concreteness and imageability. Subjects were encouraged to use imageability as a criterion for concreteness along with sensory experience.

Subjects. The subjects were 101 undergraduate volunteers who participated in the context of an introductory psychology class. None of the subjects was aware of the purpose of the rating scale.

Results

A complete listing of the concrete and abstract nouns, along with their rated concreteness values, word frequency, and length is included in Appendix A. The concrete and abstract words were clearly discriminable, with the mean rating for the abstract words being 2.697 and for the concrete, 6.151. A correlation was computed between the mean rating values we obtained and those rated by Paivio et al. (1968) for all overlapping items. The value of the correlation on 130 common items was .9588.

Experiment 2: Lexical Access for Abstract and Concrete Words: Pure Search

In this experiment subjects were asked to make lexical decisions about abstract words or concrete words. Each subject viewed one or the other class of words but not both. The pseudoword distractors were identical for both groups of subjects. If lexical decisions can be made on the basis of a superficial access to lexical memory, then we might expect that the time to access and retrieve either type of word will be a function of its frequency but not it concreteness. The speed of lexical access has often been shown to be a function of word frequency (e.g., Frederiksen & Kroll, 1976). If lexical access requires semantic analysis, however, then we might expect differences in the time to accept a word as a function of its availability in memory. According to dual coding approaches to memory representation (e.g., Paivio, 1971), the time to accept a concrete word may be faster than the time to accept a matched abstract word because the concrete word is thought to be represented lexically, like the abstract word, but in addition, to have a direct connection to an imagistic representation. The dual code for the concrete words would then make them more salient in memory, and thus more available for rapid access. There is some suggestion in the literature (James, 1975) that the speed of lexical access may be a function of word frequency for high frequency (i.e., familiar) words, but a function of deeper semantic processing for lower frequency, less familiar words. Thus, concreteness effects would be expected for the lower frequency class words alone.

Method

Stimulus materials. One hundred abstract and one hundred concrete words were chosen on the basis of the ratings obtained in Experiment 1. The words were divided into four roughly equal classes according to their frequency of occurrence (Kucera & Francis, 1967). Since the abstract and concrete words had been previously matched on an item-to-item basis for length and frequency, the resulting breakdown of items into frequency classes was identical for the abstract and concrete word sets.

The words were lettered in black ink on white paper with a Leroy Stencil No. 0030-290CL and pen No. 4. All words were lettered in lowercase. A five letter word was approximately 2.4 cm wide. The words were then mounted on the center of a page of program paper used to automatically adjust the tachistoscopic presentations. A separate card containing a small star was used as a fixation field.

A set of pseudoword distractors were matched to the stimulus words by length. The pseudowords were then lettered in the same manner as described for the words and mounted on program paper.

Design. The sets of 100 abstract and 100 concrete words were each randomly divided into four blocks of 25 words. For each block 25 pseudoword distractors were also randomly selected. The particular pseudowords used in the abstract and concrete conditions were identical and appeared in the same sequence in both conditions. Each block thus consisted of 50 trials, half of which were words ("yes") and half of which were pseudowords ("no"). The order of the four blocks was counterbalanced across subjects.

An additional twelve trials of practice was constructed for each condition. The practice consisted of the six remaining abstract/concrete words randomly chosen from the original ratings and six pseudowords.

Procedure. The stimuli were presented in one field of a three and one half field Scientific Prototype tachistoscope (Model N-1000). A second field contained a small star which served as the fixation point. Prior to the stimulus presentation there was a 100 msec warning tone followed by a 400 msec delay. Immediately following the delay the stimulus was presented for 200 msec. Reaction time (RT) (to the nearest millisecond) was measured from the onset of the stimulus to the subject's response by a Scientific Prototype Reaction Timer (Model N-1002). The clock was stopped by the subject's "yes" or "no" response which activated a voice key (Scientific Prototype Audio Threshold Detection Relay 761 G). The fixation point returned to view immediately following the 200 msec stimulus presentation.

One group of subjects viewed the four abstract word blocks, and a separate group of subjects viewed the four concrete word blocks. Subjects were instructed to decide whether the string of letters was a real word and to indicate their response by saying "yes" or "no" as quickly as possible. They were told to be fast but also accurate and to guess if they were unsure.

Following the lexical decision task subjects were asked to perform an incidental memory task by writing down all the words they could remember from the experiment. The entire experiment lasted approximately 50 minutes.

Subjects. Sixteen undergraduate students at Swarthmore College served as subjects. They each participated in a single session for which they received $2.50. All subjects were naive with respect to the purpose of the experiment, native English speakers, and had normal or corrected-to-normal vision.

Results and Discussion

The mean RTs for "yes" responses to words for the abstract and concrete conditions are shown in Figure 1 as a function of word frequency. Note that Frequency Class 1 is common and Frequency Class 4 is rare. The main effect of frequency was significant for both subject and item analyses, Min $F'(3, 187) = 12.302$, $p < .001$, replicating previous research on lexical decision. There was not, however, a strong effect of concreteness or an interaction between frequency and concreteness as has been claimed by others (James, 1975). The main effect of concreteness was not significant in subject analyses, $F(1, 14) > 1$, but was significant in item analyses, $F(1, 168) = 7.477$, $p < .001$. The failure to find a concreteness effect in the subject analyses may simply reflect the between subjects design that was employed.

Mean RTs, percent errors, and percent recall for the "yes" responses are shown in Table 1. The errors and RTs were positively correlated; when RTs were long there were also more errors. An analysis of variance performed on subject error rates indicated only a main effect of word frequency, $F(3, 42) = 4.851$, $p < .01$. Analyses of variance computed for mean number of words recalled in the incidental recall task showed no significant main effects or interactions.

Mean RTs, percent errors, and percent recall for the "no" responses to pseudowords are shown in Table 2. "No" responses were longer than "yes" responses, $F(1, 14) = 39.5598$, $p < .001$ (subject ANOVA) replicating previous research. The "no" data can provide an interesting comparison in this experiment since the actual pseudowords were identical in both abstract and concrete conditions, even to the point of their order of occurrence. If

Figure 1. Mean reaction times (RTs) to make lexical decisions as a function of word frequency for abstract and concrete words in pure and mixed conditions. (Word frequency class 1 is most common.)

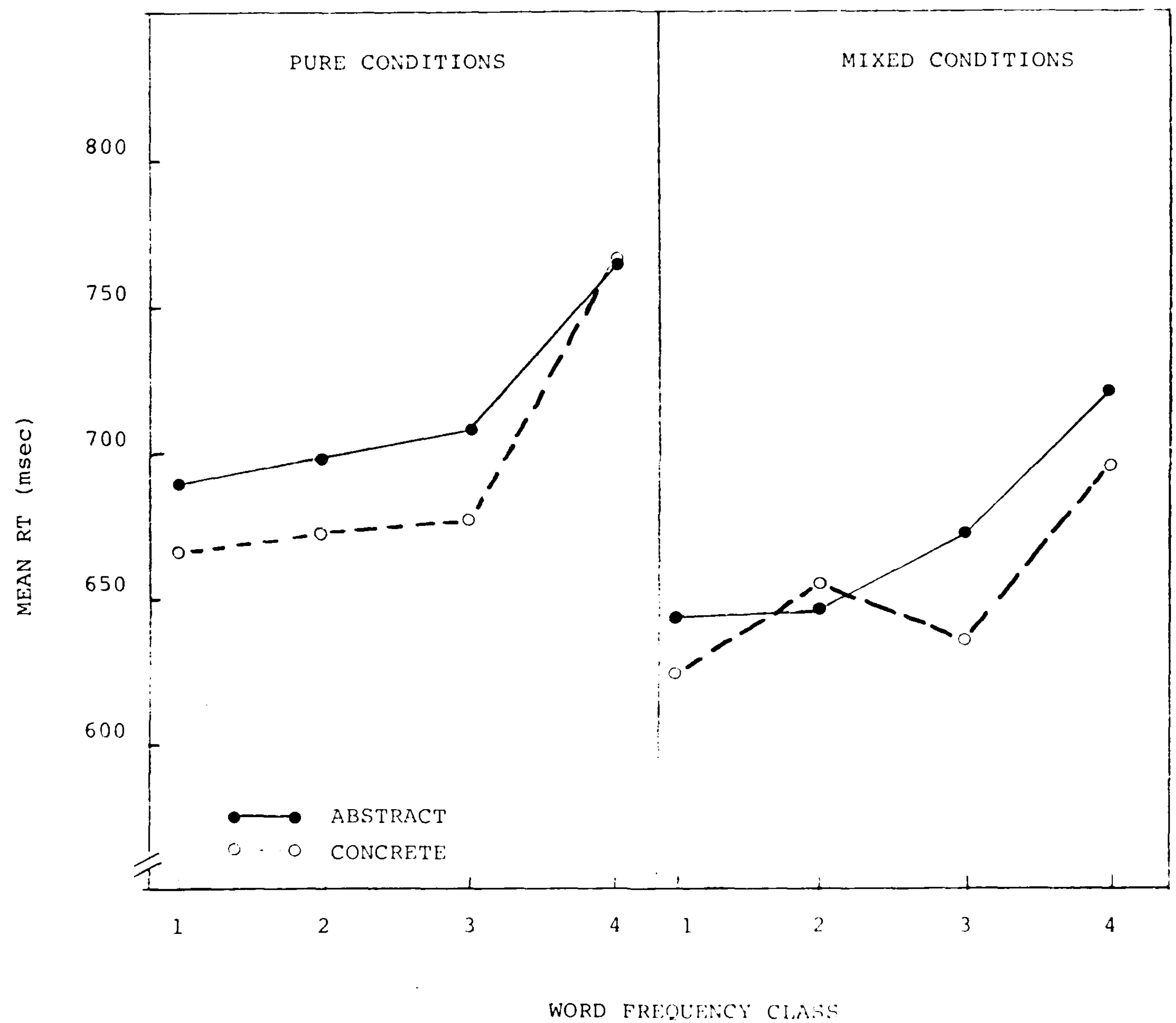

Table 1

Mean Reaction Times (RTs), Percent Errors, and Percent Recall for Positive Responses to Words as a Function of Word Frequency

	Word Frequency Class			
Condition	1	2	3	4
Pure Abstract				
RT	689	699	709	765
%Error	5.5	4.0	4.0	12.0
%Recall	9.8	13.6	7.3	12.0
Pure Concrete				
RT	666	672	677	765
%Error	2.0	4.5	2.5	5.5
%Recall	9.4	11.9	7.8	10.1
Mixed Abstract				
RT	642	645	671	720
%Error	1.3	1.0	2.3	4.3
%Recall	9.4	10.8	7.3	12.5
Mixed Concrete				
RT	625	654	637	695
%Error	1.3	1.5	1.0	6.0
%Recall	11.1	6.3	9.9	8.7

Table 2

Mean Reaction Time (RT), Percent Errors, and Percent Recall for Negative Responses to Pseudowords

Condition	RT (msec)	%Errors	%Recall
Pure Abstract	789	4.1	2.5
Pure Concrete	802	7.9	3.1
Mixed Abstract-Concrete	750	4.9	2.5

abstract and concrete words were processed to different levels (e.g., if abstract words were accessed via a superificial dictionary look-up and concrete words were accessed semanticially), then we might expect the time to respond "no" to reflect a change in the criteria used to make a "yes" response. Since the relative difficulty of the "no" decision is known to influence the time to respond "yes" (e.g., lexical decisions are faster with nonword distractors that do not conform to English orthography than with pseudowords that do conform), it is reasonable to imagine that the "no" responses would reflect differences in processing the positive stimuli as well. The fact that there was not a significant interaction between concreteness and the "yes" - "no" response suggests that the level of processing was similar for abstract and concrete conditions.

Experiment 3: Lexical Access for Abstract and Concrete Words: Mixed Search

The experiment just described showed that lexical decisions for abstract and concrete words were equally rapid when subjects knew which class of words to expect. Like the picture-word comparisons, it is difficult to know whether the failure to find between-subject differences in the pure search conditions represents subject variability, true similarity in access and representational format, or different representational formats which, by chance, happen to be equally accessable when subjects are allowed to develop accurate expectations in the consistent pure conditions. One way to differentiate these possibilities is to present subjects with mixed blocks of abstract and concrete words. If abstract and concrete words are stored in separate lexical locations, then the overall time to make lexical decisions should increase because a larger area of memory will be accessed. If concrete words are represented both lexically and imagistically, as the dual code model claims, then the time to make lexical decisions should be faster for concrete words than for abstract words because a switch in lexical location would only have possible detrimental consequences for the abstract words, which presumably are only represented lexically. Experiment 3 was designed to test these possibilities by presenting mixed blocks of concrete and abstract words to subjects to make lexical decisions.

Method

The general method and procedure for Experiment 3 was identical to that described for Experiment 2. The changes were as follows. Half of the words from each abstract block were replaced with words that appeared in the same position on the corresponding concrete block. Similarly, the abstract words that were deleted from the abstract block were replaced in the same positions in the concrete block. Thus, each block now consisted of half abstract and half concrete words, randomly ordered throughout the block. The pseudowords remained identical to what they had been in Experiment 2. The resulting materials included two complete sets of mixed stimuli. Each set, or version, contained four blocks of stimuli, each consisting of 50 trials. The versions differed only in which particular abstract and concrete words they contained. Different groups of subjects received each version of the materials. Again the order of blocks for each of the versions was counterbalanced across subjects.

Subjects. Sixteen undergraduates at Swarthmore College served as subjects. They each participated in a single session and received $2.50 for their services. All subjects were naive with respect to the purpose of the experiment, native English speakers, and had normal or corrected-to-normal vision.

Results and Discussion

The mean RTs for "yes" responses to words for the abstract and concrete conditions are shown in the right panel of Figure 1 as a function of word frequency. As in the pure search conditions there was a main effect of word frequency which was significant when tested against subjects as well as items, Min F' (3, 182) = 11.113, $p < .01$. The mixed conditions also produced an effect of concreteness, however, in contrast to the earlier results. Overall, lexical decisions about concrete words were approximately 17 msec faster than decisions about abstract words. This small difference was significant in ANOVAs using subjects as the random factor, F (1, 15) = 5.786, $p < .05$, and items as the random factor, F (1, 168) = 4.331, $p < .05$. but was not significant when the Min F' was computed, Min F' (1, 70) = 2.477, $p > .05$. There was also a significant interaction between frequency and concreteness in the subject analysis, F(3, 45) = 3.8749, $p < .05$ but not in the item analysis, F(3, 168)> 1. A series of post hoc Newman-Keuls tests on the subject interaction replicated James (1975) in that lexical decisions about concrete words were faster than decisions about abstract words for the lower frequency classes only, $q_{2,45} = 3.83$, $p < .01$ for the lowest frequency words, and $q_{5,45} = 4.83$, $p < .05$ for the next lowest frequency words.

Mean RTs, percent errors, and percent recall for the "yes" responses are shown in the bottom portion of Table 1. The error rates again followed the RT results, with more errors for lower frequency words in the subject analysis, F(3, 45) = 12.8445, $p < .01$. Although there were no overall error differences between abstract and concrete decisions, there was a significant interaction, in the subject analysis, between frequency and concreteness, F(3,45) = 3.363, $p < .05$. More errors were made for low frequency concrete words (6.0%) than for low frequency abstract words (3.8%) suggesting a slight speed-accuracy trade between the two conditions.

As in the pure conditions, there were no significant main effects or interactions in the analysis of incidental recall. Although more words were recalled than pseudoword distractors, in both experiments, there was no influence of word frequency or concreteness. Upon first examination this result seemed at odds with most of the previous research on the role of concreteness and imagery in memory (cf. Klatzky, 1975). In general, it has been claimed that concrete words are better remembered than abstract words in both tests of recognition and recall. A closer examination of the memory literature, however, revealed an interesting lack of concreteness effects in <u>incidental</u> recall (Paivio, 1971). One might attribute this failure to find concreteness effects in incidental recall to the lack of an intentional imagery strategy during initial exposure to the concrete words. A study by Baddelely, Grant, Wight, and Thomson (1975), however, suggests that an active imagery strategy cannot account for the concreteness effect in paired associate learning. When Baddeley etal. tested for visual interference with a concurrent visual suppression task, they found no differential interference for concrete and abstract words, but a substantial effect of concreteness, suggesting that an active imagery strategy was not producing the concrete word advantage in memory.

The mixed condition did not produce longer latencies than the pure condition, contrary to our initial expectation. Although the comparison between the mixed and pure conditions is between different groups of subjects, it was striking that the mixed conditions produced, if anything, faster responses and fewer errors. The possibility this result raises is that the mixed conditions were easier because a wider area of memory was probed. In the pure conditions, the repeated access to the same relative memory locations may have increased the total level of activation and increased the level of residual noise. Some models of lexical access (e.g., Coltheart, Davelaar, Jonasson, & Besner, 1977) have proposed that deadlines for searching through lexical memory are extended when high levels of noise are present. Thus, the influence of additional noise is to force the subject to collect additional information beyond some threshold. A weak prediction that such an extended deadine model might make would be that the magnitude of the frequency effect should be greater in pure search conditions than in mixed search conditions. An examination of Table 1 shows only slight support for this prediction in the mixed-concrete condition.

Further analysis of these results will continue during the present quarter.

II. RSVP/REBUS experiments

A. Target detection: Further studies

A full report of the rationale and method for the first three target detection experiments was given in Technical Report No. 6 (January, 1978) and will not be repeated. Three more experiments, Experiments 4-6, were carried out. Experiment 4 was identical to Experiment 3 in that only the category of the target, rather than its exact identity, was specified. In Experiment 4, however, the rate of presentation of the sequence to be searched was 8 items per second instead of 12 items per second. In Experiments 5 and 6, the target to be detected was defined by an attribute of the target object, e.g., swan: can swim, football: made of leather. It was assumed that the target would be more difficult to prime in advance on the basis of an attribute than on the basis of a superordinate category (cf. Freedman & Loftus, 1971). In Experiment 5, the rate was 12 items per second, and in Experiment 6, 8 items per second.

Experiment 4: Category detection (8 items/sec)

The purpose of Experiment 4 was to determine whether the difference between pictures and words observed under the difficult detection conditions of Experiment 3 would be changed under the reduced difficulty of Experiment 4, in which the rate of the sequence was 8 items a second rather than 12 items a second.

Method. The method was identical to that of Experiment 3, except that the rate of presentation was 8 items a second. There were 32 subjects, 16 in the uniform and 16 in the mixed groups.

Results: Experiment 4

Accuracy. Responses that took longer than 2 seconds were counted as errors; they occurred on only % of the trials. The overall percentage of correct detections was 65%, compared with 43% in Experiment 3. A breakdown is shown in Table 3. An analysis of variance showed no significant differences between picture and word targets, or between uniform and mixed sequences, and no interaction. A comparison

Table 3. Percentage of detection errors in each condition.

Target Modality	Category 8/second (Experiment 4)	Attribute 12/second (Experiment 5)	Attribute 8/second (Experiment 6)
	Target Specification and Rate of Presentation		
Uniform			
Word	34	59	57
Picture	38	71	51
Mixed			
Word	31	47	51
Picture	36	66	46
Totals			
Word	32	53	54
Picture	37	69	49

with Experiment 3 showed an overall decrease in errors, in Experiment 4 ($p < .01$), but no other significant differences.

Response time. The overall mean RT was 702 msec, compared with 714 msec in Experiment 3. A breakdown is shown in Table 4. Analyses of variance by subjects and by items showed a significant difference between the uniform and mixed conditions, for the items analysis only ($p < .05$), with the uniform conditions 43 msec faster. This result was similar to that observed in Experiment 3. As in Experiment 3, there was a slight increase in errors in the uniform condition, consistent with a speed-accuracy tradeoff.

Discussion: Experiment 4

The main result confirms that of the earlier detection experiments: response to pictures is about as fast as to words. There were somewhat more detection errors when the target was a picture, but unlike Experiment 3 the difference was not significant. Although mixing pictures and words in the same sequence slowed responses slightly, there was no differential effect for pictures and words as had appeared in Experiment 3.

Judging by the error rates, the category detection task at 8 items per second was approximately as difficult as the name detection task of Experiment 2 at 12 items per second. Yet the category RT was 196 msec longer demonstrating clearly that comparison to superordinate category name involves a lengthier computation than comparison to the generic or basic-level name. It is of some interest that in both cases the picture targets were slightly faster. Contrary to what might have been expected, matching a spoken word to the same word in written form is not necessarily faster than matching the spoken word to a picture seen for the first time. As already suggested, this supports the hypothesis that the match is conceptual rather than "physical".

Table 4. Mean response time in msec for correct detections in each condition.

Target Modality	Category 8/second (Experiment 4)	Attribute 12/second (Experiment 5)	Attribute 8/second (Experiment 6)
	Target Specification and Rate of Presentation		
Uniform			
Word	689	730	981
Picture	671	719	841
Mixed			
Word	739	920	872
Picture	707	965	887
Totals			
Word	714	825	926
Picture	689	842	864

Experiments 5 and 6: Attribute detection

In the category detection experiments, it is possible that specification of the category primes a set of category members, thus facilitating detection. A task that would be more likely to require a post-identification comparison with the target specification, we reasoned, was to specify some attribute of the target such as yellow, can hop, or moves slowly. There is some evidence that memory is not organized for easy retrieval of all yellow objects or all hopping objects; it is better organized for retrieving members of categories (Freedman & Loftus, 1971). If a subject has to check each item after it has been identified, detection accuracy and speed will be a very stringent measure of the relative ease of identifying pictures and words, under uniform and mixed conditions.

Method. The stimulus sequences were identical to those used in Experiments 1-4 except that only half of the 64 different target items were used as targets, because of the difficulty of selecting attributes that would pick out only one target in a sequence. The attributes to be used were selected in part by asking a group of subjects to produce attributes of a large number of objects, and in part by the judgment of the investigators and their co-workers. In order not to bias the task in favor of pictures, the attributes were not ones that appeared in the pictures (e.g., yellow was acceptable because the pictures were black and white line drawings). Further, an effort was made to avoid the use of an attribute that made the target easy to guess. It was also important that the attribute fit only one item of the 12 items in each sequence. Partly in consequence of these many requirements, we used some attribute-target combinations (like unstable-canoe) that subjects frequently missed.

The method was like that of the previous experiments except that an attribute was given as the target specification. There were 16 subjects in each of the two experiments, 8 in the uniform and 8 in the mixed condition. The rate of presentation was 12 items/second in Experiment 5 and 8 items/second in Experiment 6.

Results: Experiments 5 and 6

Accuracy. Overall, the target was detected accurately on only 39% of the trials, in Experiment 5 and 49% of the trials in Experiment 6. A breakdown of errors for the two experiments is given in Table 3. At the higher rate of presentation, picture targets were significantly less accurate than word targets ($p < .05$). At the lower rate, however, there was no difference - if anything, pictures were more accurate. Although in both experiments mixed sequences led to somewhat more accurate detection than uniform sequences, the differences were not statistically significant.

Response time. Overall, the mean RT in Experiment 5 was 833 msec and in Experiment 6 was 895 msec. A breakdown of the RTs is given in Table 4. The 17 msec advantage of words in Experiment 5 and the 62 msec advantage of pictures in Experiment 6 were not statistically significant. A significant 218 msec advantage of the uniform over the mixed conditions ($p < .05$) appeared in Experiment 5, but since the effect totally failed to appear in Experiment 6 it may have been a random effect: there were only 8 subjects in each of the groups being compared.

Discussion: Experiments 5 and 6

The detection of a target item with a specified semantic attribute was more difficult than detection of an item in a given superordinate category, just as we expected. That may have been because naming a category (but not an attribute) primes members of the category. It is also possible, however, that the attributes were intrinsically less closely linked with the target items than were the superordinate categories.

In any case, detection of attributes was sufficiently difficult to make a good test of the true difference between picture and word targets, our main concern. The results from the two experiments together suggest that there is no overall difference, confirming again the near-equivalence of pictures and words as representations of objects.

Recall. Analysis of the incidental recall of nontarget items is not yet complete.

B. RSVP: On-line processing of redundant and nonredundant information in a sentence

The purpose of this experiment, carried out with Susan Petrick, was to test the hypothesis that a sentence presented very rapidly in RSVP format is processed semantically on-line. Previous work with REBUS and RSVP sentences (see earlier technical reports) had suggested that unimportant adjectives are likely to be omitted, in immediate report. It seemed possible that such adjectives were "discarded" because they were not important to the semantic representation that was built up on line. If, in contrast, the words of an RSVP sentence are perceived as a list and processed only later, there would be no reason to expect that their role in the sentence would determine forgetting.

In an experiment of Ehri and Muzio (1974), 32 sentences with adjective-noun phrases were read aloud to subjects, who were then given the nouns and required to recall the sentences. There were two possible versions of each sentence: in one version, a verb was used that made the adjective relatively redundant, as in "The angry waitress yelled at the customer," in the other version, the verb (e.g., "served," in this example) was not redundant with the adjective. There was a significantly greater tendency to forget the adjective when it was redundant.

The Ehri and Muzio task was adapted to test on-line processing of redundancy, in RSVP sentences. The experiment, which will be fully reported in a later report, has been completed. A preliminary analysis of the results offers some support for the hypothesis that redundant adjectives are most likely to be omitted when they follow the verb that makes them redundant. That result is what would be expected if the sentence is processed as it is presented, even at the rate of 12 words a second.

Two follow-up studies are also under way. In one, ratings of the redundancy of the adjective are made. In the second, the memory study of Ehri and Muzio will be replicated, using the materials employed in the present experiment.

III. Detection and Memory for Rapid Scenes

Effect of a picture mask on memory for visual detail.

The following experiment is one of a series concerned with the extraction and encoding of information from brief pictorial exposures. Completed experiments in this series (Intraub, 1978) have resulted in two interesting findings. In one experiment, 150 color photographs were presented for only 110 msec each, with a 5 sec interval between stimuli. Recognition memory performance did not differ as a function of whether the 5 sec interval was unfilled (blank field) or contained a photograph (filler picture) which repeated throughout the sequence. The result runs counter to the argument that poor memory performance following rapid continuous presentation of pictures (as in Potter & Levy, 1969) may be the result of backward masking (Rosenblood & Poulton, 1975; Shaffer & Shiffrin, 1972) as well as the suggestion that pictures are processed only until the next substantial visual change (Potter & Levy, 1969). In principle, both of these positions predict not only a decrease in memory performance in the filled condition, but that performance in the filled condition should be as poor as that following a continuous sequence of pictures, each presented for a duration of 110 msec. Yet, no significant difference was obtained between the filled and unfilled conditions.

In another experiment, exposure duration was again held constant at 110 msec while the blank time between stimuli was varied. Presentation was followed by a serial recognition test in which half of the target pictures were left-right reversals of pictures in the presentation sequence. Subjects first had to indicate whether they recognized a picture, <u>regardless of its orientation</u>, and then if they recognized a picture to indicate whether it was "normal" or "reversed". Subjects did not know in advance that they would be required to detect reversals. Overall recognition accuracy decreased as the time between stimuli was diminished. When the time between stimuli was 1 sec or longer, given that a picture was recognized, the subjects' ability to report whether the picture was left-right reversed was surprisingly good (approximately 60% accuracy). As the time between stimuli was decreased, given that a picture was recognized, the probability of reversal detection dropped sharply (approximately 16% accuracy in the most rapid condition). This decrease was interpreted as indicating that the detail with which a picture is encoded depends on the total amount of uninterrrupted processing time available to the subject. As presentation rate is increased, pictorial representation is less detailed so that fewer target items can surpass a recognition threshold. In a standard recognition test in which dissimilar distractor items (pictures not previously seen) are employed, enough information may be available to distinguish a previously seen picture from a distractor, while the same information is not sufficient to detect a particular change within the picture itself. The results suggest that with a constant stimulus on-time, as the time between stimuli is diminished, items which are recognized (in a standard recognition test) are actually remembered in less detail.

While the appearance of a filler picture did not have a significant effect on recognition memory in the first experiment described above, nevertheless, it is possible that it had some effect on encoding processes. For example, appearance of the filler picture may disrupt encoding of various visual details of the stimuli which would not be necessary for accurate performance on a standard recognition test but might be necessary in a recognition test requiring a more difficult discrimination, such as detection of reversal.

In the following experiment, both recognition memory and reversal detection were compared between a condition in which the time between stimuli was unfilled and a condition in which the time between stimuli contained a familiar complex picture, in order to provide a more sensitive test of the effect of a complex visual event on processing of a previously viewed picture.

Method

Subjects. Subjects were 32 undergraduates reporting normal or normal corrected vision.

Stimuli. Stimuli were 20 pictures which were asymmetrical about the vertical axis, selected from the same stimulus pool used in previous experiments in this series. The stimuli contained no alpha-numeric information.

Apparatus. Subjects were seated in an anechoic chamber approximately 60 cm from a rear projection screen. A Gerbrands model G1170 two channel projection tachistoscope was used to project the stimuli and the field which appeared during the interstimulus interval (ISI). Pictures were approximately $12^{\circ} \times 12^{\circ}$. An impulse from the stimulus shutter activated a Heath digital reaction timer which was stopped by the subject's vocal response into a microphone.

Procedure. Subjects were run individually and were randomly assigned to one of the two conditions. Subjects in both conditions viewed 20 pictures for 110 msec each with an ISI of approximately 5 sec. In the unfilled condition a homogeneous medium-gray field was presented during the ISI, and in the filled condition a picture appeared during the ISI. Two different filler pictures were employed; each was viewed by one half of the subjects in the filled condition. The same order of stimulus presentation was employed in both conditions.

Each subject was shown a practice sequence of 8 pictures. Subjects in the filled condition were shown the filler picture in advance and also during the practice sequence, so that they were familiar with the picture by the time they viewed the experimental sequence. They were told to attend to the briefly presented pictures and to simply ignore the filler. Subjects in both conditions were instructed to try to remember as many pictures as possible and were informed that a "yes-no" serial presentation recognition test would follow. No mention of reversals was made.

After presentation, the subject was informed that the recognition test would include detection of left-right reversals. The recognition test consisted of 16 stimuli from the middle portion of the presentation sequence, randomly interspersed with 16 distractor items which were also asymmetrical with respect to the vertical. The stimuli were divided into two groups of eight. One group was left-right reversed for half the subjects in each condition and the other group was reversed for the remaining subjects.

<u>Results</u>

The mean number of pictures recognized (correct "yes" responses) was 14.8 (SD = 1.3) and 13.2 (SD = 2.0) for the unfilled and filled conditions, respectively. This difference was significant ($t_{(14)} = 2.52$, $p < .025$, two-tailed). The false alarm rate (incorrect "yes" responses) was .02 for the unfilled and .05 for the filled conditions. Analysis of the proportion of pictures recognized, corrected for guessing, did not alter this result. The corrected proportion was .92 pictures recognized in the unfilled and .81 pictures recognized in the filled condition. The mean response time to correct "yes" decisions was 1012 msec in the unfilled and 1035 msec in the filled condition. This difference did not approach significance ($t < 1$). The mean number of normal and reversed pictures recognized ("yes" responses) did not differ significantly in either condition, nor did the response times to make those decisions (see Table 5).

Given that a reversed picture was recognized, the probability that the subject detected its reversed orientation was .59 in the unfilled and .52 in the filled condition. This difference did not approach significance ($t < 1$). The false alarm rate (incorrect "reversed" responses) was .11 and .02 for the unfilled and filled conditions, respectively. The proportion of reversal detections corrected for guessing was .54 and .51 for the unfilled and filled conditions, respectively.

Discussion

The results of the present experiment indicate that the appearance of a highly familiar complex visual event does in some way disrupt processing of briefly exposed pictures. The effect, however, is not a large one, and cannot by itself account for the low recognition memory performance following rapid continuous presentation of pictures (Intraub, 1978; Potter, 1976; Potter & Levy, 1969). In an experiment described earlier, using a similar rate of presentation and the same stimulus duration as the present experiment, no effect of a filled ISI on later recognition accuracy was obtained. In that case, however, 150 stimuli were employed and the recognition test included a total of 60 items. Perhaps an effect of either the long duration of the presentation and test procedure, or interference caused by the large set of items on memory, over-shadowed any small advantage that the unfilled-ISI group may have had. A small difference (approximately 4 percentage points) in favor of the unfilled group was obtained in that experiment, but did not approach significance.

Table 5

The mean number of normal and reversed pictures recognized and the mean response time (in msec) to recognition in both conditions.

Condition	Mean No.	SD	Response time	SD
Unfilled-ISI				
Normal	7.4	.89	1000	296
Reversed	7.3	.79	1024	328
Filled-ISI				
Normal	6.8	1.10	1025	210
Reversed	6.4	1.11	1045	215

It is interesting that the reversal of a stimulus (whether or not the reversal was detected by the subject) apparently did not interfere with recognition memory. This finding is also reported by Standing, Conezio, and Haber (1970) who used 1 and 2 second stimulus durations. There was also no significant difference in response latencies to recognition of normal and reversed targets. Both findings are in opposition to what would be expected if recognition was based upon a type of template match between the target and a stored memory image. Shepard and Metzler (1971), for example, argued in favor of a visual image match in a task where the subject's reaction time to make a decision concerning the orientation of a letter increased as the letter was rotated away from a vertical position. The results of the present experiment do not rule out the role of imagery in decisions about the reversal of pictures, but suggest that the image match may not be necessary for the "yes" decision in the standard recognition task.

While the filler picture decreased overall recognition memory performance, filling the ISI had no significant effect on the subject's ability to detect that a picture was mirror reversed. That is, regardless of which condition was viewed by the subject, if a picture looked familiar during the test, the likelihood that a shift in left-right orientation could be detected, was equal. In order to insure that subjects could identify all of the pictures in each condition, four subjects were required to name pictures while viewing the filled sequence, and four subjects named pictures while viewing the unfilled sequence. Identification of pictures, as measured by naming, was highly accurate in both conditions. The appearance of the filler picture, while not interfereing with information relating to reversal detection, must interfere in some way with encoding processes because even though subjects can extract enough information to immediately name the pictures, later recognition memory suffers relative to the unfilled group.

Is perception of detail reduced by a picture mask? An experiment is presently underway which will hopefully provide insight into the reasons for the decrease in performance in the filled (masked) condition. The naming task, described above, indicates that subjects can extract the gist of a picture whether or not it is followed immediately by a filler picture, but it is not clear that subjects in both conditions can extract the same amount of detail concerning the appearance and meaning of a picture. For example, while subjects in a naming task might call a particular picture "woman", in a description task, subjects in the unfilled group might describe the picture as "smiling Oriental woman wearing an elaborate gold headdress", while subjects in the filled condition might describe the picture only as "woman's face". Subjects in this experiment viewed the same 20 pictures that appeared in the reversal experiment for 110 msec each followed either by a blank field or a filler picture. Subjects were allocated as much time as necessary to write a complete, detailed description of each picture. At the end of the experiment, subjects took part in a serial presentation "yes-no" recognition test. These data are currently being scored for amount of detail and number of errors in the verbal descriptions given by the subjects. Results will be reported in the next quarter.

Other experiments with rapid scenes.

An experiment (described in the previous report) concerned with the effects of context on processing of pictures presented in a rapid continuous sequence, has been completed and will be discussed in the next quarterly report. Another experiment (the "negative set" experiment, also described in the previous report), concerned with the role of expectancy in the detection of rapidly presented scenes is currently being run. This experiment should be completed by the next quarter.

References

Baddeley, A.D., Grant, S., Wight, E., and Thomson, N. Imagery and visual working memory. In P.M.A. Rabbitt and S. Dornic (Eds.), Attention and Performance V. London: Academic Press, 1975.

Coltheart, M., Davelaar, E., Jonnason, J.T., and Besner, D. Access to the internal lexicon. S. Dornic and P.M.A. Rabbitt (Eds.), Attention and Performance VI. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Day, J. Right-hemisphere language processing in normal right-handers. Journal of Experimental Psychology: Human Perception and Performance, 1977, 3, 518-528.

Ehri, L. Do adjectives and functors interfere as much as nouns in naming pictures? Child Development, 1977.

Ehri, L.C. and Muzio, I.M. The influence of verb meanings on memory for adjectives. Journal of Verbal Learning and Verbal Behavior, 1974, 3, 265-271.

Frederiksen, J.R. and Kroll, J.F. Spelling and sound: Approaches to the internal lexicon. Journal of Experimental Psychology: Human Perception and Performance, 1976, 2, 361-379.

Freedman, J.L. and Loftus, E.F. Retrieval of words from long-term memory. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 107-115.

Healy, A. Detection errors on the word the: Evidence for reading units larger than letters. Journal of Experimental Psychology: Human Perception and Performance, 1976, 2, 235-242.

Intraub, H. An information processing approach to pictorial encoding. Unpublished doctoral dissertation, Brandeis University, 1978.

James, C.T. The role of semantic information in lexical decisions. Journal of Experimental Psychology: Human Perception and Performance, 1975, 1, 130-136.

Klatzky, R. Human Memory. San Francisco: Freeman, 1975.

Kroll, J.F. and Potter, M.C. Can pictures and words prime each other? Paper presented at the eighteenth annual meeting of the Psychonomic Society, 1977.

Kucera, H. and Francis, W.N. ComputationalAnalysis of Present-Day American English. Providence: Brown University Press, 1967.

Paivio, A. Imagery and Verbal Processes. New York: Holt, Rinehart, and Winston, 1971.

Paivio, A., Yuille,J.C., and Madigan,S. Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology, Monograph Supplement, 1968, 76, 1-25.

Potter, M.C. and Levy, E.I. Recognition memory for a rapid sequence of pictures. Journal of Experimental Psychology, 1969, 81, 10-15.

Potter, M.C. and Faulconer, B.A. Time to understand pictures and words. Nature, 1975, 253, 437-438.

Potter, M.C. and Kroll, J.F. Picture-word interaction: Implication for speeded on-line processing and delayed memory retrieval. Technical Reports No. 2 and 3 prepared for the Advanced Research Projects Agency (ARPA), 1977 a, b.

Rosch, E. Cognitive representations of semantic categories. Journal of Experimental Psychology: General, 1975, 1, 192-233.

Rosenblood, L.K. and Poulton, T.W. Recognition after tachistoscopic presentations of complex pictorial stimuli. Canadian Journal of Psychology, 1975, 29, 195-200.

Ryder, J. Context contingent lexical access. Paper presented at the 48th annual meeting of the Eastern Psychological Association, 1977.

Scarborough, D., and Springer, L. Noun-verb differences in word recognition. Paper presented at the fourteenth annual meeting of the Psychonomic Society, 1973.

Shaffer, W.O. and Shiffrin, R.M. Rehearsal and storage of visual information. <u>Journal of Experimental Psychology</u>, 1972, <u>92</u>, 292-296.

Appendix A

Concreteness Ratings for 212 Nouns: P & Y = Paivio, Yuille, and Madigan (1968) ratings; New = Kroll, Potter, and Merves (1978) ratings.* The numbers in parentheses ( ) are the Kucera and Francis (1967) frequency values. When no frequency value is given for an abstract word its frequency is identical to that given for the matched concrete word. The pseudowords are nonword distractors that were matched to the pairs of concrete and abstract words by length.

*note: Both sets of concreteness ratings employed a one to seven scale with one as most abstract and seven as most concrete.

CONCRETE	P&Y	NEW	ABSTRACT	P&Y	NEW	PSEUDOWORDS
rug (13)		6.76	ego	1.93	2.27	zow
bag (42)		6.31	joy (40)	1.66	2.87	lig
cup (45)		6.77	fun (44)	2.45	3.11	rov
elm (3)		6.52	pep	2.73	3.55	jox
car (274)	6.87	6.79	law (299)	3.73	3.00	ote
bone (33)		6.63	fate	1.46	1.60	drom
body (276)		6.12	fact (447)	3.31	3.52	eyra
tuba (1)		6.85	gist	1.77	2.27	heng
road (197)		6.46	idea (195)	1.42	1.90	irch
gate (37)		6.37	mood	1.52	2.02	pase
town (212)		5.89	soul (47)	1.87	1.76	anly
desk (65)		6.62	duty (61)	2.32	2.41	juey
baby (145)	6.70	6.47	hour (144)	2.93	3.88	wesp
cart (5)		6.66	pact	3.77	3.43	tomp
lever (14)		6.07	vigor	2.60	3.10	nutch
skirt (21)		6.57	glory	1.77	2.29	acate
yacht (4)	6.77	6.50	spree	2.81	3.21	plonk
jelly (3)	6.40	6.55	greed	1.73	2.68	aglet
attic (16)		6.44	quest	2.76	2.89	blype
mouse (10)		6.82	grief	1.86	3.03	dreve
couch (12)		6.52	irony	2.10	2.28	erbor
tooth (20)		6.85	mercy	1.59	2.25	swoin
opera (47)		5.65	humor	2.31	2.64	steck
girls (142)	6.87 (girl)	6.07	moral	1.39	1.69	pirry
juice (11)		6.30	ghost	2.97	3.77	betch
thumb (10)		6.86	folly	2.63	2.64	ruban
wheat (9)		6.59	demon	2.56	3.63	japer
hotel (126)		6.54	truth	1.69	1.86	plime
zebra (1)		6.79	amour	2.65	2.67	winze
adult (25)		5.23	devil	2.13	3.29	cruck
nurse (17)		6.47	chaos	2.50	3.13	tinal
field (274)		5.69	death (277)	2.97	3.23	cloar
fellow (63)		4.87	belief (64)	1.55	2.14	buddle
garter (2)		6.61	deceit	1.66	2.52	dowter
jungle (20)		6.25	hatred	1.59	2.77	ligure
spider (2)		6.81	malice	1.53	2.48	sheder
bottle (76)	6.57	6.69	memory	1.78	2.63	gelson
father (183)		6.05	spirit (182)	1.86	2.12	gebang
friend (133)	6.37	4.64	theory (129)	1.90	2.43	bonang
grapes (7)		6.80	vanity	1.77	2.72	nirles
carbon (30)		5.73	virtue	1.46	1.62	topepo
throat (51)		6.71	advice	2.08	3.02	brosna
winter (83)	6.53	5.65	crisis (82)	2.81	3.03	konnel
insect (14)	6.10	6.55	custom	2.99	2.93	nazzle
letter (145)	6.37	6.19	effort	2.22	3.19	colugo
bucket (7)		6.84	equity	2.57	2.05	fantor
recipe (8)		5.79	gaiety	2.15	3.03	planch
flower (23)	6.57	6.56	genius	2.76	2.76	morion
lawyer (43)		5.84	heaven	2.75	1.91	puteli
square (143)	6.37	6.08	method (142)	2.20	3.07	daftar
picnic (15)		5.79	misery	2.28	2.93	quenda

CONCRETE			ABSTRACT			PSEUDOWORDS
street (244)	6.57	6.36	moment (246)	2.52	3.07	praiss
button (10)		6.71	rating	2.66	2.52	wellet
dollar (46)	6.50	6.30	safety (47)	2.25	3.10	shrenk
turkey (9)		6.76	satire	2.33	2.73	unchor
journal (42)	5.60	5.80	anxiety	1.63	2.49	tartine
windows (53)	6.37 (window)	6.70	welfare	2.35	3.04	slifter
avocado (11)		6.72	boredom	1.93	3.08	hallock
library (62)	6.71	6.13	victory (61)	2.95	3.10	galipot
rubbish (4)		5.78	bravery	1.93	2.64	schloss
evening (133)		5.26	trouble (134)	2.25	2.89	stammel
captain (85)		5.76	concept	1.69	1.69	chrotta
missile (28)	6.80	6.15	tragedy (49)	2.59	3.07	halidom
rancher (5)		6.01	essence	1.66	1.84	parxtle
feather (6)		6.82	sadness	2.47	2.76	letruce
crayons (1)		6.85	fallacy	1.89	2.53	ostoich
mittens (2)		6.72	figment	1.90	2.25	ricyble
officer (101)	6.23	5.83	opinion (96)	2.29	2.66	pratons
husband (131)		5.40	freedom (128)	1.98	1.70	arctoon
buffalo (16)		6.79	miracle	2.25	2.24	quocken
capitol (22)		5.39	loyalty	1.56	2.46	nurtain
luggage (10)		6.54	mastery	2.20	2.30	crumnal
textile (28)		5.61	passion	1.66	2.88	exprack
volcano (2)	6.63	6.56	madness	2.35	2.49	thapter
pianist (14)	6.43	6.09	fantasy	2.03	2.55	speamer
chapter (74)		5.21	ability	2.03	2.65	fuballo
pattern (113)		4.06	justice (114)	2.18	1.96	carobin
organdy (3)		4.05	agility	2.93	3.61	roolist
nucleus (11)		4.14	interim	2.67	2.87	pesfure
address (78)		5.26	economy (79)	2.28	3.30	voxcera
operator (49)		5.56	tendency	1.78	2.32	tragopan
ointment (3)		6.34	allegory	2.56	2.41	geelhout
calendar (28)		6.28	prestige (29)	1.73	2.58	arbalest
brochure (2)		5.98	atrocity	2.38	3.32	hawlined
computer (13)		6.31	nonsense	1.90	2.28	chernies
pinnacle (1)		----	banality	2.44	2.16	bangaloo
mustache (5)		6.57	kindness	1.63	2.78	himation
governor (83)		6.00	capacity	2.41	2.67	abralian
teaspoon (4)		6.82	jealousy	1.77	2.64	insepior
porridge (1)		6.62	exertion	2.88	3.55	stalbard
realtors (19)		5.32	devotion	1.48	2.43	slockery
carriage (11)		6.22	facility	2.20	3.36	arpnaper
pumpkins (2)		6.88	clemency	1.97	2.43	diagoner
stallion (3)		6.51	heredity	2.98	3.11	valatory
princess (10)		----	blessing	1.75	2.72	chirmist
consumer (37)		4.80	illusion	2.03	2.53	thribble
sculptor (6)		5.80	betrayal	1.77	2.75	strollop
director (101)		5.47	instance (82)	2.87	2.50	egashire
hospital (110)	6.53	6.62	attitude (107)	1.83	2.25	conscrit
lavatory (4)		6.54	jeopardy	2.00	2.65	fermalin
pamphlet (3)		6.47	aptitude	1.62	2.53	haratons
hostages (3)	5.57 (hostage)	6.01	pacifism	2.06	2.41	ettercap
audience (115)		5.97	reaction (124)	2.93	3.14	smarkish
mechanic (5)		5.85	mischief	2.90	3.30	endrumpf

CONCRETE			ABSTRACT			PSEUDOWORDS
district (135)		4.77	strength (136)	2.90	3.45	dreckler
bungalow (1)	6.13	6.07	temerity	2.19	2.42	spanghew