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Role of Prior Knowledge on Naming and Lexical Decisions with Good and Poor Stimulus Information

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To what extent does prior knowledge of a superordinate category facilitate recognition of an instance of that category? In Experiment 1, observers named good and poor exemplars of categories with and without prior presentation of the category name. The test words were either printed in a normal upright position, or the words were rotated 180°. Prior priming with the category name shortened naming times, but only when the test stimulus was rotated. The prime facilitated recognition to a greater degree for the good exemplars than for the poor exemplars. To ensure that lexical access was not bypassed in the first experiment, the study was replicated in a lexical decision task. Nonwords were identical to the test words except that they were misspelled by one letter. Identical results were found in the lexical decision task. These experiments and other recent studies make apparent the trade-off between the facilitating effects of prior knowledge and stimulus information in word recognition.

One of the persistent concerns of experimental psychology since its origins has been the degree to which prior knowledge influences perception. Wundt developed the concept of apperception to describe the focus of attention, which was guided by internal knowledge of structure and motivation. External sensation could be dominated by active internal apperception; for example, looking for a friend in a crowd would increase the likelihood of making a false alarm or would preclude recognition of some other familiar person. James (1890/1950, p. 444) extended Wundt's principles with the maxim, "the only things which we commonly see are those which we preperceive." James believed that persons have eyes for only those qualities which they have already learned to see. In contemporary research and theory, these ideas in slightly different form are apparent in the questions concerning the degree to which prior knowledge facilitates or inhibits perceptual processing and encoding of a stimulus situation.

Reading exemplifies a situation in which contextual knowledge can facilitate visual processing of the text. The typical passage contains orthographic, syntactic, and semantic redundancy, and it is commonly assumed that the reader is capable of utilizing this information in reading (Massaro, 1975). Empirical tests of the role of prior knowledge in perception have been carried out in more controlled but less rich situations. One specific question has been the degree to which prior knowledge actually contributes to perceptual resolution of the stimulus environment. Although many experimental paradigms have been utilized, most positive demonstrations of prior knowledge can be interpreted as consequences of artificial guessing strategies in the experimental situation rather than as a result of enhanced perceptual resolution of the stimulus world.

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Tulving and Gold (1963) asked to what extent prior sentential context influences the perception of a test word. With a constrained context subjects would be given the sentence "The actress received praise for being an outstanding ______." Then the word *performer* would be flashed in a tachistoscope, and the duration of the test word would be increased on successive presentations using the ascending method of limits. The dependent measure was the duration required for correct identification. Subjects were better able to report the test word with shorter durations given a highly constrained context than given an irrelevant context or no context at all. This positive result may have been due to pure guessing rather than enhanced perceptual resolution, however. Given the repeated exposures and the opportunity for many responses, subjects could have simply guessed the correct answer sooner given the highly constrained context. As an example, subjects may not have utilized the contextual information during perceptual processing, but during a post hoc guessing period after perception was complete. Given the possibility that subjects saw the displays equally well regardless of context, it cannot be concluded that context influenced perceptual resolution of the display.

Another popular paradigm for studying how prior knowledge influences perception has been in the context of the physical match and name match tasks developed by Posner and his colleagues (Posner, Boies, Eichelman, & Taylor, 1969). Asked whether two letters have the same name, subjects usually respond faster if the letters are physically identical (AA) than if they are just nominally identical (Aa). Beller (1971) elaborated on this paradigm to include whether or not the subject was given prior knowledge about one of the items to be presented. On half of the trials, subjects were told the identity of one of the letters to be matched. On the other half of the trials, no prior information was given. Prior information (priming) shortened the time it took subjects to respond whether or not the two test letters had the same name. This result held for both physical (e.g., AA) and name (Aa) matches and even when the primed item was ambiguous with respect to the case of the forthcoming test items. Beller interpreted these results to mean that priming facilitated stimulus encoding, the forming of an internal representation of the test stimuli.

Beller's (1971) conclusion is not warranted by his experiments, however, since an alternative interpretation is possible. Consider the sequence of operations that is required on prime and no-prime trials. Without a letter prime, the subject must identify both letters and ask whether they have the same name. Identification of each of the letters is *not* always necessary on prime trials. The subject can simply determine if either of the letters is different from the letter prime. If either test letter is different, the subject can reliably select and execute a *different* response, since *same* trials must contain two instances of the priming letter. Assuming that the two test letters are processed sequentially, the advantage of priming trials on *different* trials is readily apparent. If the first letter processed is different from the prime letter, the subject can select a *different* response. On no-prime trials, identification of the first letter does not reduce uncertainty about the appropriate response. Even with parallel processing of the two letters, however, there could be a distinct advantage of prime over no-prime trials—one that has nothing to do with the quality of the encoding process as a function of prior information. On *same* trials, it may be easier and, therefore, faster to compare the two test letters to the prime on priming trials than to compare the two test letters to each other on no-prime trials. Even if this is not the case, the obvious advantage of priming on *different* trials should also facilitate performance with a prime on *same* trials given that performance on *same* trials is probably not independent of performance on *different* trials.

There is good evidence that readers can select a response before a letter is completely identified. Massaro, Venezky, and

Taylor (in press) asked subjects to indicate whether or not a target letter was present in a test string of six letters. Reaction time (RT) increased with the number of letters in the test string that were visually confusable with the target letter. Visual confusability was defined on the basis of the confusion matrices for lowercase letters given by Bouma (1971). Consider the case in which the subject was looking for the target letter *d* in the letter strings *cipner* and *ronkeb*, respectively. In both cases, the answer was no, but the subject was able to decide on this answer faster with the first than with the second string. The interpretation of this result was predicated on the assumption that recognition of the string is a temporally extended process and that some features are resolved before others. There is some evidence that overall letter shape can be resolved and made available to later stages of processing before the letter is completely recognized (Bouma, 1971; Massaro & Schmuller, 1975). If this is the case, a subject should be able to respond "no" to the first string very quickly, since none of the letters has the same overall ascender shape as the target letter. In contrast, the second string will require additional processing time. Other features of the ascending letters of this string must be resolved to distinguish these letters from the target letter. This interpretation was consistent with the general finding that the *no* RTs revealed a significant increase with increases in the number of similar letters in the test string.

The results and analysis in the preceding paragraph are relevant to Beller's (1971) priming task. The priming letter may have speeded responding because less information was necessary for an accurate response. Therefore, the *quality* of perceptual analysis may not have been enhanced with a letter prime, and the role of selective attention in perceptual processing remains uncertain. What is required is a demonstration that prior knowledge modifies the quality of the perceptual analyses (Pachella, 1975). Rather than concluding that the perceptual experience was somehow clearer and more accurate on prime trials, our analysis shows that the opposite could have been the case. If subjects were able to make a decision based on *less* information with a letter prime, the perceptual experience may have actually been *poorer* in this condition. For example, given the prime letter *O*, detection of just one straight line in the test letter *W* would be sufficient to terminate perceptual processing and to execute a different response. Given that the same information would not be sufficient on no-prime trials, a deeper resolution of the test letters would be necessary. In this case, the subject would "see" a clearer *W* in the no-prime than in the prime condition.

Rosch (1975) utilized the priming task to study the representations generated by superordinate semantic category names. First, norms for how well a given examplar represents a given category were developed. Then experiments were carried out to see if the perceptual encoding of these examplars could be influenced by prior knowledge of the appropriate category. Although the experiments showed a large effect of prior knowledge on performance in the tasks, the experiments were not completely successful in defining the stage(s) of processing responsible for the results. The present experiments are designed to extend the Rosch experiments, with special concern for isolating the stage of processing that is influenced by prior knowledge.

Rosch's (1975) experiments were based on the idea that a prime should be effective only if "it makes possible generation of a mental code which contains within it some of the information needed to make the response" (p. 199). If the mental representation generated by a semantic category name is equally relevant or applicable to all instances, then the prime should be equally effective for all instances. In contrast, the prime may be effective for only some instances if the mental representation of the category name contains information that is relevant to only the most ideal or prototypical examples of the semantic category. In the latter case we might expect that good instances should show more of a priming effect than poor instances.

In order to establish the category norms, Rosch (1975) obtained ratings on the extent to which each instance of a category represented the rater's ideal meaning of the category norm. The ratings were extremely sensitive and reliable across the various instances of a category. For example, the instances *chair* and *sofa* were rated as ideal instances of furniture by at least 200 of the 209 subjects. For 9 of the 10 categories, 95% of the subjects gave the instance with the mean best rating an ideal rating. Correlations of the mean ratings carried out between split halves of the subjects divided at random were .97 or higher. The results show that humans can reliably index how well an instance represents their ideal of the category name, and there is a general consensus among humans of a given culture group on what this ideal should be.

Instances were selected according to whether they were rated as good, medium, or poor exemplars of the superordinate category. Four of each rank from each of nine categories were used in the priming experiment. Special care was taken to insure that a given item would be categorized as a member of only a designated category. This precaution was not completely successful; for example, the toys *tricycle* and *skates* might actually be better instances of vehicles (Loftus, 1975). Two different groups of subjects were tested on different sets, and a third group was tested on a set that eliminated the instances with ambiguous category membership. Subjects were asked to indicate whether or not a pair of items belonged to the same semantic category. There were three types of trials: physically identical pairs (e.g., lamp–lamp), pairs of items belonging to the same semantic category but not physically identical (lamp–desk), and pairs of items belonging to different superordinate categories (lamp–boat). Each set of stimuli contained 25% physically identical pairs, 25% categorically but not physically identical pairs, and 50% categorically different pairs. Both members of a pair were always of the same rank (good, medium, or poor exemplars). Each pair was presented with and without a priming stimulus. The prime was the relevant category name of at least one of the items of a pair. When the prime was relevant to only one member of a pair, that member was equally likely to be left or right of the fixation point. The prime was read by the experimenter 2 sec before the test pair presentation. On no-prime trials the experimenter simply read the word *blank* 2 sec before the test pair presentation. The subject repeated the word, fixated a cross in the tachistoscope, saw the test pair with one item to the left and one item to the right of fixation, and pressed one of two keys to indicate whether or not the two test items belonged to the same superordinate category.

In agreement with previous results in this paradigm, overall RTs were faster for physically identical pairs than for categorically identical or different pairs. There was also a general facilitative effect of the prime relative to the no-prime conditions. The prime facilitated performance for both the same-category and different-category responses for all three rankings of the pairs. In contrast, the prime facilitated performance for the good instances of the physically identical pairs but interfered with performance for the poor instances of the physically identical pairs.

In general, Rosch's (1975) results demonstrate the importance of priming and the categorical goodness of items in this task, but no conclusions can be reached about the stage(s) of information processing responsible for the results. Table 1 presents a hypothetical sequence of psychological operations that could have occurred on prime and no-prime trials, respectively. The critical difference is that an extra operation is required on no-prime trials relative to prime trials. On prime trials, the subject is first given a category name, such as *fruit*. When the test pair is presented, the subject can simply recognize and encode each instance and ask whether each is a fruit (for example, given recognition of *fig*, the subject asks if it is

Table 1
Proposed Sequence of Psychological Operations that Occur on Prime and No-Prime Trials in Rosch's (1975) Priming Experiment

Observable events	Psychological operations
Priming trials	
1. Present category name.	1. Recognize and encode category name.
2. Wait 2 sec.	2. Wait, thinking of category properties.
3. Present test pair.	3a. Recognize and encode test instances.
	3b. Determine if both match category prime. If yes, select *same* response. If no, select *different* response.
4. Response.	4. Output response.
No-priming trials	
1. Present *blank*.	1. Recognize and encode *blank*.
2. Wait 2 sec.	2. Wait, thinking of nothing specific.
3. Present test pair.	3a. Recognize and encode test instances.
	3b. Determine category of each instance.
	3c. Determine if both belong to same category. If yes, select *same* response. If no, select *different* response.
4. Response.	4. Output response.

a fruit). If a nonfruit is found, the subject can respond *different*; if both instances are fruits, the subject can respond *same*. On no-prime trials, the subject does not know the relevant category, and must determine it for each instance. Given recognition of *fig*, for example, the subject must ask what is fig's superordinate category before proceeding further.

It seems reasonable that more time will be required to determine the superordinate category of *fig* relative to determining whether *fig* belongs to the superordinate category *fruit*. In the framework of memory search, Rosch's (1975) subjects had a memory set of nine possible categories in the first condition and a memory set of just *one* category in the second. The extra search time should increase no-prime RTs relative to RTs on priming trials. On priming trials subjects ask whether fig is a fruit, whereas they must ask which of the nine categories in the experiment does fig belong to on no-prime trials. Given the extra processing required after recognition has occurred on no-prime relative to priming trials, the prime must be having some of its effect on processing that is required after initial recognition and encoding of the test instances has occurred. This analysis is analogus to our earlier interpretation of priming in the letter matching task. In both cases additional processing is required when no prime is presented relative to the prime condition.[1]

At first glance, it is surprising that both priming and category goodness influenced RTs to physically identical pairs. Beller (1971) also found that priming shortened RT to physically identical pairs of letters. Optimally, subjects should have been able to make a quick physical match and respond *same* regardless of the category goodness of the items and whether or not a prime was given. Loftus (1975), in fact, hypothesized that subjects performed a physical match before any retrieval of superordinate category information took place. The RT differences for primed and

[1] A reviewer of this article pointed out that the analysis predicts that exemplar typicality and priming should interact, since it might be expected that the two memory search conditions would be differentially affected by the typicality of the test instance. We do not believe that this is a necessary consequence of the present interpretation, however, and even the direction of the presumed interaction is not immediately obvious.

unprimed trials and for level of category goodness, therefore, led her to conclude that these variables influenced encoding time in addition to whatever effects they have at later stages of processing. What subjects would optimally do, and what they do do, however, is the psychological question; there is no independent evidence that a physical match occurred before any later stages of processing were operative.

One reasonable although not elegant interpretation would be that the physical match operations overlap with the operations required for the retrieval of the appropriate category information. In our analysis (see Table 1), Step 3b could have begun before a physical match was completed. Assume that the average physical match operations take time t_p, whereas the average category match operations take time t_{c1} on prime trials (Step 3b on prime trials in Table 1) and time t_{c2} on no-prime trials (Steps 3b and 3c on no-prime trials in Table 1). As discussed earlier, t_{c2} should be greater than t_{c1}, since an accurate decision requires more information on no-prime trials relative to prime trials. It is also reasonable to assume that t_{c2} should be a direct function of category goodness. Subjects should take longer to determine the appropriate superordinate category of submarine than of automobile. Similarly, t_{c1} should differ as a function of category goodness. Deciding whether submarine is a vehicle may take much longer than deciding whether automobile is a vehicle (Rips, Shoben, & Smith, 1973; Sanford, Garrod, & Boyle, 1977; Wilkins, 1971). A category prime and a test instance with high category goodness would give the shortest times for the category match operations. In this case the average time for a category match might be less than that for a physical match. It follows that the advantage of priming of items high in category goodness on physical match trials may reflect differences in the category matching operations rather than differences in perceptual encoding.

The interference of the prime with items low in category goodness might reflect the fact that the subject was more likely to complete the physical match operations on no-prime than on priming trials. Although we would also expect some advantage of priming for items low in category goodness, the higher proportion of physical matches on no-prime trials than on prime trials might account for the RT differences. That is to say, the prime may have encouraged subjects to give more processing capacity to the category match operations than to the physical match operations, when in fact the physical match may have been more optimal (because the category match operations were so slow on items poor in category goodness).

In another study, presenting the prime simultaneously with the test instances eliminated its effects on physically identical test items, although priming continued to facilitate performance on same-category and different-category trials. Given that the simultaneous prime had no effect on physically identical test items, Rosch (1975) argued that the interaction observed when the prime was presented before the test items must have been due to perceptual encoding rather than due to later category match operations. It could have been the case, however, that the simultaneous prime was too late to influence the category match operations given physically identical instances. Identification of and utilization of the prime requires some time, and the physical match operations may have ended before the prime could have influenced the category match operations. Without having the prime in advance, the category match operations would always take longer than the physical match operations, and no effect of priming would be observed.

It is now clear that a plethora of models could be formulated to be consistent with the results. Although the degree of truthfulness of the models cannot be determined, it is readily apparent that Rosch's (1975) experiments do not unambiguously demonstrate a facilitation of prior knowledge on perceptual encoding. The goal set for the current experiments is to provide a direct assessment of whether a superordinate category prime influences recognition and encoding of an item. The task was modified to eliminate gross differences in the memory comparison stage under prime and no-prime conditions. In the first experiment, subjects were asked to name an instance as quickly as possible under the prime and the no-prime conditions. If priming facilitates recognition and encoding of ideal instances of a category, naming RTs should be shorter for the ideal instances when they are preceded by the category prime relative to no-prime trials. The limitation in the proposed experiment is that shorter RTs on prime trials will not necessarily imply that priming decreased recognition time. Priming might have its effect at some other stage of processing such as response selection. The additive-factor methodology can be utilized to eliminate this alternative interpretation by independently varying a second independent variable with the prime variable. Given that the visual quality of the test stimulus can be expected to influence recognition time, the test word was presented upright or upside down (rotated 180°). Varying prior knowledge and the quality of the test stimulus should allow a test of whether priming influences recognition or some other stage of processing (Becker & Killion, 1977; Meyer, Schvaneveldt, & Ruddy, 1975; Sanford et al., 1977). Their effects should be additive if the two independent variables influence different stages of processing. If prior knowledge influences recognition, then the most likely effects of the two variables (prior knowledge and stimulus quality) should be nonadditive; that is, they should interact. The most likely interaction would be that priming will have a larger effect on performance to the extent that rotating the test stimulus lowers the quality of the stimulus information. In this case, the increase in RT as a result of rotation should be less for the prime than the no-prime condition.

Experiment 1

Method

Subjects. Twelve introductory psychology students participated an hour a day for 2 consecutive days. They received extra credit in the course for their participation.

Apparatus. A Kodak Carousel projector rear projected the stimulus words onto a partially opaque screen directly in front of the subject. All words appeared within a 10 × 18 cm fixation area of the screen. Microphones connected to voice-activated relays were placed in front of both the experimenter and the subject. The experimenter saying the cue word thus triggered the timer, which regulated the 1.5-sec interval between the start of the cue word and the opening of the shutter by the shutter driver. The interval seemed appropriate, since Rosch (1975) had shown no difference in facilitation from a 400-msec to a 2-sec interval. The reaction time (RT) was measured from the onset of the opening of the shutter to the onset of the subject's spoken response, which also closed the shutter.

Materials. The stimulus words were drawn from the tables of norms for goodness-of-example ratings for the 10 semantic categories reported by Rosch (1975). Care was also taken to choose items that belonged to only one category. The semantic category *toys* was eliminated because of the ambiguity of category membership of those items listed as toys (Loftus, 1975). Twenty items were selected from each of the remaining nine semantic categories, 10 with very high ratings and 10 with very low ratings on the categorical goodness dimension. These two goodness classes were equated on average word length within each category. The test words are listed in Table A1 (p. 512). Two slides were made of each of the 180 stimulus words. The words were typed in uppercase letters and were copied onto transparencies. The words were therefore seen as black on white.

Design. There were 2 test days with 360 test trials on each day. There were 20 exemplars, 10 good and 10 poor, of each of the nine categories. These 180 different words were presented twice each day, once upright and once rotated 180°. On each test day, each word was either primed or not primed on both of its presentations. Those words that were primed on the first day were not primed on the second. Thus, reaction times for each subject were recorded for 720 distinct trials.

There were eight trial types, reflecting the combinations of two levels of each of three independent variables: stimulus quality, prime or no prime, and goodness level. The trial types were randomized within blocks of eight, so that every trial type was presented before any one was repeated. Each Carousel tray held 72 words, and the order of presentation of the trays was randomized between subjects and between days. In addition, the presentation order within the slide tray on the second day was the reverse of the first day.

Procedure. The subjects were instructed that a word would be presented within the fixation area on the screen in front of them. They had to read the word aloud as fast as possible, without making any errors. Some of the words were presented upright, and some were upside down. Prior to each word presentation, the experimenter said either a category name or *blank*. If the experimenter said a category name, an example of that category always followed. Subjects were advised to pay attention to the experimenter's cue, as it would help them in the task.

Fifteen practice trials were given at the beginning of each day. These were the numbers from 1 to 20, and they were presented upright or rotated and were primed with the cues *one digit* or *two digits*, or the word *blank*. There were also two buffer slides at the beginning and end of each slide tray. These slides contained words from the same categories and were presented in the same manner as the test slides. An average reaction time was computed for each subject on each day for each of the eight experimental conditions of interest. This gives 45 observations (minus error trials) per data point per subject. An analysis of variance was carried out with subjects, days, priming, stimulus quality, and exemplar goodness as factors, with both RTs (in msec) and error rates (in percentages times 10) as dependent measures.

Results

Figure 1 gives the mean naming reaction time as a function of priming, exemplar goodness, and quality of the test stimulus. Each of these variables had a substantial and significant influence on the RTs, but the interactions between the variables are of primary interest. Priming had a small 7-msec facilitation on naming the normal upright test words, whereas priming decreased naming RTs by 121 msec for the rotated test words. The Prime × Stimulus Quality interaction was significant over subjects, $F(1, 11) = 12.31$, $p < .005$, $MS_e = 12{,}667$. Rotating the test words slowed down naming responses by 270 msec, and this effect was much larger for the poor than the good category exemplars, $F(1, 11) = 15.23$, $p < .001$, $MS_e = 4{,}455$. Although naming the poor exemplars took just 30 msec longer than naming the good exemplars when the test items were upright, this effect was 105 msec when the test items were rotated. Priming decreased naming RTs for the good exemplars by 85 msec, twice the size of the facilitation of priming the poor exemplars, $F(1, 11) = 4.59$, $p < .06$, $MS_e = 4{,}959$.

Table 2 gives these same results for each of the 2 days of the experiment. Naming times decreased by 162 msec across the 2 days, $F(1, 11) = 12.93$, $p < .005$. Similar results were found on both days, but the magnitude of the main effects and interactions were significantly smaller on the second day of the experiment. Naming errors involved misidentifying or mispronouncing the test word. The associated error percentages for 8 of the 12 subjects are also presented in Table 2. The errors for the other 4 subjects could not be analyzed, since the

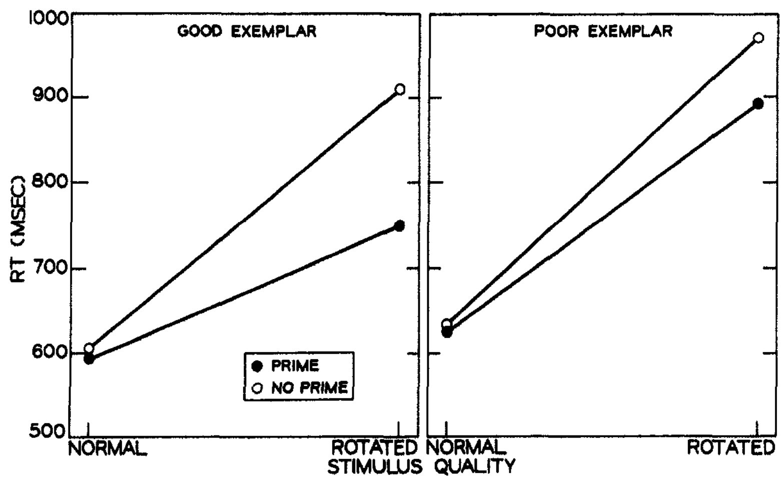

Figure 1. Mean naming times as a function of priming, exemplar goodness, and whether the test word was presented in normal or rotated format.

Table 2
Reaction Times (RT; in msec) and Error Rates (in percent) for Naming the Test Stimulus

		Day 1				Day 2			
		Prime		No prime		Prime		No prime	
Quality	Exemplar goodness	RT	% error	RT	% error	RT	% error	RT	% error
Normal	Good	632	1.7	643	1.4	552	.3	563	.3
	Poor	688	2.8	679	2.5	563	.8	579	2.0
Rotated	Good	788	1.7	1,042	7.1	711	1.7	780	3.9
	Poor	1,013	3.7	1,146	5.1	778	2.2	805	3.1

experimenter did not distinguish between actual errors and unavoidable events such as a cough tripping the voice-activated relay. Although the error rates averaged only 2.5%, there is the common finding of a positive correlation between RTs and error rates. Subjects tended to make significantly fewer errors on the second day of the experiment, on prime trials, and with the normal upright test stimuli (all $ps < .025$).

In the previous analysis, the data were pooled across the nine categories; the next analysis determined to what extent the results held for each of the nine categories. Table 3 gives the mean naming times as a function of the presence or absence of a category prime and the visual quality of the test word for each of the nine categories used in the experiment. The priming effect varied between −14 and 51 msec for the normal upright presentation and between 53 and 123 msec for the rotated test words. The only category that did not give a much larger priming effect for rotated test words was *fruit*, which gave a 51-msec facilitation for the upright presentation and a 53-msec facilitation for the rotated presentation. The category *fruit* was also the only category that gave a healthy priming effect with the normal upright presentation; the priming effect for any other category was never more than half of that for the category *fruit*.

Table 3
Mean Naming Times (in msec) for Each of the Nine Categories in Experiment 1

	Normal		Rotated	
Category	Prime	No prime	Prime	No prime
Birds	614	631	745	837
Clothing	576	589	746	852
Fruit	574	625	736	789
Furniture	584	608	768	826
Sports	624	622	811	923
Tools	636	622	831	921
Vegetables	635	628	784	907
Vehicles	578	597	737	846
Weapons	582	586	744	821

The primary interest in the present study is the influence of category priming on perceptual encoding of a test word. The results appear to be highly reliable for the categories and test words used in the study, but one must be cautious in generalizing the results to other categories and/or other test words. We were reluctant to use the statistical tests proposed by Clark (1973) to warrant generalization to other categories and items, since neither the categories nor the items within the categories were sampled randomly (Wike & Church, 1976). Our sample of categories exhausted those that were available in terms of having measures of exemplar goodness. In addition, we essentially sampled all of the good and poor items within each of these categories. Most importantly, we are unwilling to generalize because the more important question of what properties of the category prime are responsible for priming has not been addressed. There was some evidence that typicality was important, since good exemplars were facilitated more by priming than were poor exemplars when the test word was rotated. We are currently providing a more exhaustive study of category priming with the goal of evaluating the relationships between the category prime and the test word that contribute to the facilitation of priming a stimulus-degraded test word.

Discussion

The present experiment was designed to test whether priming the superordinate category would facilitate recognition of a test word. Priming had a small insignificant 7-msec facilitation when the test word was presented in its normal upright mode, suggesting that priming is not especially functional when the observer is faced with good stimulus information. These results support the present analysis of Rosch's (1975) studies. The naming task eliminated any differential contribution of the later comparison and decision stages that were present in Rosch's same–different task. Given the small effect of priming with normal stimuli in the present tasks, it seems that much of the facilitative effects in Rosch's task were due to other stages of processing than a perceptual encoding stage per se.

In contrast to the normal upright presentation, however, category priming significantly speeded perceptual processing of the rotated test words by 121 msec relative to the no-context condition. When the quality of the stimulus information is poor, prior knowledge can facilitate its processing. According to this interpretation, prior knowledge can enhance perceptual processing, but only when stimulus information is poor.

On the other hand, it might be argued that the lack of a priming effect with normal words may also be a function of the naming task. There are two primary ways subjects may have performed the task. First, the lexical representation would be accessed, and then the retrieved articulatory code would be implemented. Second the letter-string may have been resolved just to the level of spelling patterns, and these spelling patterns would be transformed into an articulation. With this second strategy, subjects would be able to name the items without lexical access. On a few trials, some subjects did mispronounce words that had irregular spelling-to-sound patterns; for example, the *w* in *sword* would be pronounced. These responses were counted as errors, however, and the error rates were very low. Therefore, it seems unlikely that articulation was not mediated by lexical access in the naming task.

Although lexical access did occur in the naming task, a task requiring more extended processing might reveal larger effects of priming even with good stimulus information. To test this idea, the task was changed to a lexical decision task in which nonwords were created by misspelling the test words by just a single letter. It seems reasonable that more extended processing would be required in this task relative to the naming task. If the lack of a priming effect with a good quality stimulus is unique to the naming task, the results should not be replicated in the lexical decision task. On the other hand, if lexical access given good stimulus information is not substantially modified by priming, the results in the lexical decision task should replicate those in the naming task.

Experiment 2

Method

Subjects. Six subjects selected from the same pool as those in Experiment 1 participated for an hour a day for 4 days.

Apparatus. The apparatus was the same as in the first experiment.

Materials and design. In addition to the 180 word stimuli used in the first experiment, 180 orthographically possible nonwords were included. The nonwords were generated by changing one letter in each word of the original word list. Consonants were replaced only with consonants, vowels only with vowels. For example, the word *cardinal* was transformed into *carminal*. Within each goodness level of each category, the position of the replace-

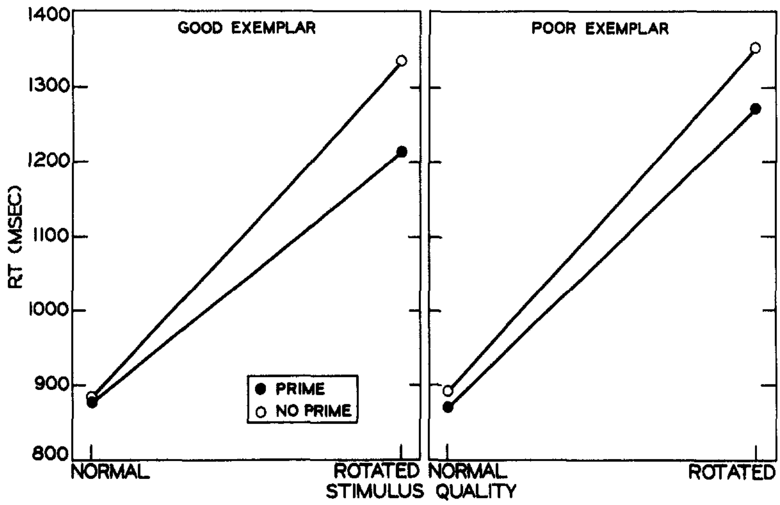

Figure 2. Mean lexical decision times as a function of priming, exemplar goodness, and whether the test item was presented in a normal or rotated format.

ment letter occurred at the beginning, middle, or end of a letter string an equal number of times.

The original design was doubled by the inclusion of the nonwords. Eight words and eight nonwords were randomized within a block of 16 trials. A restriction made on the randomization procedure was that a word and its corresponding nonword could not occur in the same block of trials. A total of 720 distinct slides were used. There were 11 slide trays with 64 slides each, and 1 tray of 16 slides. On the first two days of testing each stimulus was presented once upright and once rotated. By random assignment half the words and their nonword derivatives were primed on the first 2 test days. The other half were primed on the second 2 days. The order of slide trays was reversed on the second 2 days. There were 40 initial practice slides on each day. These were word and nonword representations of the digits 5–15.

Procedure. Subjects were instructed to say *yes* if a word was presented and to say *no* if a nonword was presented. Subjects were advised about speed, accuracy, and utilization of the prime as in Experiment 1. Subjects were told that a prime would be presented on word and nonword trials. The prime was always accurate in that the test word, whether or not it was spelled correctly, was always a member of its superordinate category.

There were 1,440 test trials per subject, giving a total of 45 observations at each of the 32 conditions of interest. These conditions were prime, stimulus quality, exemplar goodness, word–nonword, and first half versus second half of the experiment. An analysis of variance was carried out with these five variables as factors and RTs and error rates as dependent variables.

Results

Figure 2 gives the mean RTs for the lexical decision as a function of priming and category goodness of the test stimulus for the normal and rotated test words. Rotating the test words slowed down RTs by 410 msec, $F(1, 5) = 16.96$, $p < .05$, $MS_e = 474{,}380$. Although priming shortened RT, the effect was just 14 msec for normal stimulus items and 93 msec for rotated items, $F(1, 5) = 9.73$, $p < .05$, $MS_e = 7{,}744$. The poor exemplars required 52 msec longer than the good exemplars when the items were rotated, but there was no difference when the items were upright, $F(1, 5) = 6.24$, $p < .06$, $MS_e = 3{,}267$.

The triple interaction of prime, stimulus quality, and category goodness, $F(1, 5) = 9.59$, $p < .025$, $MS_e = 679$, can be seen in Figure 2. Overall the prime enhanced processing of the good exemplars and the poor exemplars equally, but the magnitude of the enhancement was also a function of stimulus quality. For normal upright stimuli, the prime enhanced processing of the poor exemplars more than the good, whereas the opposite was the case for the rotated stimuli. In general, the interaction of these three variables in the lexical

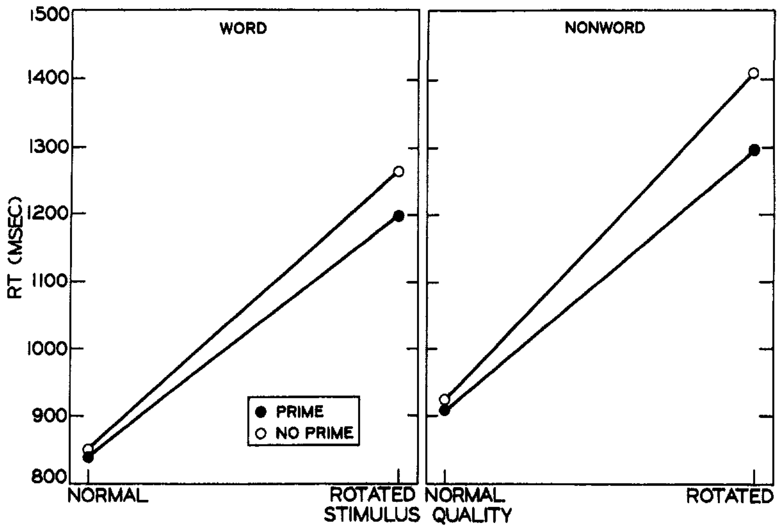

Figure 3. Mean lexical decision times as a function of priming, word or nonword, and whether the test item was presented in a normal or rotated format.

decision task provides a striking resemblance to that found in the naming tasks (cf. Figures 1 and 2).

Figure 3 plots the mean RTs for the lexical decision as a function of priming and stimulus quality for the word and nonword decisions separately. Although nonword decisions took 98 msec longer than word decisions, $F(1, 5) = 15.48$, $p < .025$, $MS_e = 29{,}898$, the two types of decision were affected in the same way by the prime and stimulus quality variables. Given that the prime was as effective for nonword as for word decisions, some lexical access must have also occurred on nonword trials.

Table 4 gives the results for each of the two halves of the experiment. Reaction times were 234 msec faster in the second half of the experiment, $F(1, 11) = 32.3$, $p < .001$, $MS_e = 4{,}359$. The main effects and interactions were significantly smaller in the second than in the first half of the experiment. The associated error percentages are also presented in Table 4. Error rates averaged 3.6%. The only significant effect was an uninteresting triple interaction of days, quality, and word–nonword, $F(1, 5) = 15.87$, $p < .025$, $MS_e = 159$.

Table 4
Reaction Times (RT; in msec) and Error Rates (in percent) for the Lexical Decision Task in Experiment 2

		Days 1 and 2				Days 3 and 4			
		Prime		No prime		Prime		No prime	
Quality	Lexical decision	RT	% error	RT	% error	RT	% error	RT	% error
Normal	Word	884	2.7	920	2.8	789	2.6	782	2.3
	Nonword	994	2.4	1,000	1.9	825	1.3	846	.6
Rotated	Word	1,318	4.7	1,411	6.8	1,066	3.5	1,113	7.3
	Nonword	1,450	4.1	1,634	3.6	1,137	6.6	1,185	4.3

Discussion

The experimental question addressed by the present experiments was whether priming a superordinate category would enhance perceptual processing (recognition) of an instance of that category. In the first experiment, subjects named a visually presented test word as quickly as possible without making errors. The test word was either presented in a normal upright position or rotated 180°. Priming the superordinate category of the test word facilitated the naming task only when the test word was rotated 180°. Given that the naming task may have been accomplished without lexical access, a second experiment was carried out using a lexical decision task. Subjects decided whether or not the test word was spelled correctly. Exactly the same results were found in the lexical decision task as in the naming task. The results reveal that the facilitating effect of a category prime on perceptual processing is inversely related to the quality of the stimulus information available. With good stimulus information, advance knowledge of category membership does not facilitate recognition. With poor stimulus information, knowledge of category membership contributes significantly more to the perceptual processing of the display.

The results of Experiment 1 replicate a recent study by Sanford et al. (1977). Subjects saw the name of a category followed by one of four kinds of test words: good category members, poor category members, related items, and unrelated items. The latter two types of items were not members of the prime category. For the category *fruit*, for example, the related item would be *juice*, whereas the unrelated item would be *major*. The test word was presented in a checkerboard pattern on half of the trials. In the naming task there was no significant difference among the four types of items with an intact stimulus presentation but a large difference in the degraded stimulus condition. Given a degraded test word, poor category members and unrelated words took significantly longer to name than good category members and related words.

Meyer et al. (1975) utilized the additive-factor methodology (Sternberg, 1969) to determine if semantic context influences word recognition. Semantic context and the visual quality of the test word were independently varied in both a lexical decision task and a naming task. The test word was degraded by embedding it in a dot pattern. The test word was preceded by either a semantically associated word or an unrelated word. For example, the test word *butter* might be preceded by *bread* or by *nurse*. Previous results had shown that the time to classify the word in the lexical decision task was faster when it was preceded by an associated word than by an unrelated word (e.g., Schvaneveldt & Meyer, 1973). (A recent study by Fischler [1977] showed that semantic relatedness rather than association value is the critical dimension that influences performance.) The test word was either presented intact or was degraded by superimposing a grid of dots over the word.

The results showed that the semantic context effect was significantly larger with the degraded than the intact words. The average semantic context effect across three experiments was 35 msec with intact words and 65 msec with degraded words. Becker and Killion (1977) found very similar results using stimulus intensity rather than a dot pattern to manipulate the quality of the test word. In terms of the additive-factor methodology, semantic context influences the same stage of processing that is affected by visual quality. The visual resolution of the display is the most likely stage that is affected by these two variables. The fact that semantic relatedness had a significant effect regardless of the quality of the display contrasts with the present results. In the present experiments the average context affect was 11 msec with the upright words and 107 msec with the rotated words. It could be the case that priming by semantically related words operates differently from priming by superordinate categories. Even so, the fact that priming has its largest effect with poor stimulus information in the Meyer et al. (1975), Becker and Killion (1977), and Sanford et al. (1977) studies, as well as the present experiments, makes apparent the general finding of a trade-off between the contributions of prior knowledge and stimulus information in word recognition.

Given that the influence of priming is critically dependent on the quality of stimulus information, it is important to consider which situation is most representative of real-world processing. At first glance, one might assume that the reader usually has high-quality stimulus information, and therefore, prior knowledge plays a negligible role in normal reading. However, our observers were able to devote all of their processing to the word recognition task without the typical memory loads and parallel processing that are present in reading text. Also, the words were presented alone in foveal vision in the present task, whereas reading text can involve the recognition of words in parafoveal or peripheral vision. Given the rapid falloff in acuity toward the periphery, word recognition in the periphery may be similar in difficulty to the recognition of rotated words. Given these possibilities, it is difficult to conclude which stimulus condition is a better representation of the normal reading process. Until some converging experiments are carried out, no conclusions about ecological validity can be reached.

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Table A1
Test Words Used in the Naming and Lexical Decision Experiments and Nonwords Used in the Lexical Decision Task

Good exemplar		Poor exemplar	
Furniture			
Chair	Chait	Rug	Ruz
Sofa	Bofa	Stove	Slove
Couch	Coich	Counter	Couster
Table	Tablo	Clock	Cloch
Dresser	Cresser	Drapes	Brapes
Rocker	Ronker	Picture	Pisture
Desk	Dest	Closet	Closem
Bed	Jed	Vase	Hase
Bureau	Bumeau	Ashtray	Ashfray
Chest	Chelt	Fan	Fax
Fruit			
Orange	Orango	Prunes	Prunet
Apple	Upple	Date	Vate
Banana	Basana	Avocado	Avotado
Peach	Peath	Raisin	Raisid
Pear	Cear	Coconut	Toconut
Plum	Plim	Pumpkin	Pumskin
Grapes	Grapet	Fig	Fim
Berry	Rerry	Gourd	Lourd
Cherry	Chepry	Olive	Olave
Melon	Melop	Squash	Squast
Vehicle			
Automobile	Automobilo	Tricycle	Tricyclo
Truck	Kruck	Canoe	Ranoe
Bus	Bis	Raft	Rast
Taxi	Taxa	Sled	Sleb
Jeep	Meep	Horse	Torse
Motorcycle	Monorcycle	Rocket	Rosket
Train	Trair	Blimp	Blims
Bicycle	Bacycle	Skates	Shates
Airplane	Airprane	Camel	Capel
Boat	Boas	Elevator	Elevatob
Birds			
Robin	Rotin	Owl	Oll
Sparrow	Sparrop	Buzzard	Buzzarp
Bluejay	Sluejay	Flamingo	Blamingo
Bluebird	Bluedird	Swan	Swun
Canary	Canard	Peacock	Peacoch
Blackbird	Clackbird	Chicken	Shicken
Dove	Doge	Turkey	Tunkey
Oriole	Orioli	Ostrich	Ostrish
Starling	Sharling	Penguin	Fenguin
Cardinal	Carminal	Bat	Bot
Sports			
Football	Fortball	Judo	Jodo
Baseball	Basebalp	Hiking	Hikins
Basketball	Masketball	Croquet	Broquet
Tennis	Ternis	Billiards	Biltiards
Handball	Handbals	Camping	Campind
Sports (*continued*)			
Rugby	Sugby	Chess	Shess
Hockey	Hochey	Dancing	Dawcing
Swimming	Swimmine	Checkers	Checkert
Boxing	Roxing	Cards	Fards
Skiing	Skoing	Sunbathing	Sunrathing
Clothing			
Pants	Palts	Cane	Cate
Shirt	Shirf	Belt	Belp
Dress	Tress	Scarf	Sharf
Skirt	Skart	Gloves	Glones
Blouse	Bloune	Apron	Aprot
Suit	Guit	Earmuffs	Jarmuffs
Slacks	Slucks	Purse	Punse
Jacket	Jacken	Ring	Rint
Coat	Hoat	Watch	Wutch
Sweater	Sweaber	Necklace	Necklare
Weapons			
Gun	Gon	Stick	Swick
Pistol	Ristol	Poison	Poilon
Dagger	Dagget	Stone	Stode
Rifle	Bifle	Gas	Jas
Knife	Knide	Chain	Chaip
Sword	Swort	Scissors	Scishors
Bomb	Homb	Bricks	Fricks
Spear	Speat	Rope	Rofe
Cannon	Canson	Glass	Glasp
Club	Slub	Shoes	Choes
Vegetables			
Pea	Lea	Yams	Zams
Carrot	Carsot	Endive	Endove
Beans	Beals	Mushroom	Mushroop
Spinach	Stinach	Rhubarb	Shubarb
Broccoli	Bruccoli	Parsley	Pardley
Asparagus	Asparagup	Pickles	Picklet
Corn	Jorn	Seaweed	Neaweed
Lettuce	Lettace	Garlic	Garsic
Beets	Beebs	Peanut	Peanub
Tomato	Bomato	Rice	Wice
Tools			
Saw	Baw	Brush	Prush
Hammer	Hamser	Glue	Glye
Ruler	Rulep	Varnish	Varnith
Screwdriver	Shrewdriver	Stapler	Shapler
Drill	Drall	Plaster	Ploster
Level	Levem	Axe	Ane
Plane	Clane	Anvil	Anvit
File	Fike	Rags	Dags
Chisel	Chisen	Hatchet	Haschet
Square	Swuare	Crane	Frane

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