Journal of Experimental Psychology:
Learning, Memory, and Cognition
1982, Vol. 8, No. 5, 418-434

0278-7393/82/0805-0418$00.75

Can Automatic Picture Processing Influence Word Judgments?

Stephen J. Lupker and Albert N. Katz
University of Western Ontario, London, Ontario, Canada

Two experiments were undertaken in order to evaluate the influence of automatic semantic processing of pictures on word judgments. In both studies, picture-word analogs of the Stroop task were employed. In Experiment 1, subjects were required to make a semantic category judgment about the word; in Experiment 2, they were simply to respond yes or no to whether the word was DOG. Taken together, the results of these experiments indicated that (a) perceptual factors such as lateral masking influence responding in these types of tasks and their contributions must be partialed out from the effects of semantic factors, (b) picture processing can facilitate word processing but only in a restricted set of circumstances, and (c) background pictures incompatible with the correct response can interfere with word judgments. The facilitation observed was attributed to the effects automatic picture processing has on an initial input process, while the interference appears to arise at a response selection and execution stage. Further, the results suggest that the semantic nature of automatic picture processing is at least somewhat different from that of automatic word processing.

An individual's store of accessible information pertaining to any familiar concept is virtually limitless. Yet, only a fraction of this information is relevant to the process of understanding those concepts. That is, presented with an abstract representation of a concept, such as a picture or a word, the concept will be understood with little irrelevant information ever being retrieved. Moreover, the information that is retrieved seems to become available essentially automatically with little, if any, effort on the part of an observer.

The nature of these automatic retrieval operations most typically have been studied with "priming" procedures and have been examined using only word representations of the concepts. The first and prototypic example of this tradition was provided by Meyer and his colleagues (e.g., Meyer & Schvaneveldt, 1971). Using a lexical decision task, Meyer and co-workers discovered that a target word could be classified more rapidly if the previous word (the "prime") had been semantically similar. This result, which obtains even when subjects are not required to respond to the prime, demonstrates that the primes undergo some degree of automatic semantic processing.

While this procedure has yielded a number of intriguing findings (see Becker, 1980, for a recent review), the nature of the task is such that controlled as well as automatic processing is likely to occur (LaBerge & Samuels, 1974; Posner & Snyder, 1975; Shiffrin & Schneider, 1977). That is, when subjects realize the contingencies between the prime and target stimuli, they may then implement a processing strategy in which the prime is purposely processed in a way that will facilitate the processing of the target. The use of such strategies has, in fact, been demonstrated numerous times (e.g., Neely, 1977; Tweedy, Lapinski, & Schvaneveldt, 1977; and, most recently, Becker, 1980). Thus, although part of the priming effect is undoubtedly due to automatic processing (Fischler, 1977; Fischler & Goodman, 1978), it is at present difficult to disentangle the contributions of automatic and subject-controlled processing.

In recent years analogs of the Stroop

This research was supported by Grants A6333 and A7040 from the Natural Sciences and Engineering Research Council of Canada. The authors would like to thank Mike Callahan for his help in the data collection and analyses.

Requests for reprints should be sent to Stephen J. Lupker, Department of Psychology, University of Western Ontario, London, Ontario, Canada N6A 5C2.

(1935) color-word interference task have appeared which potentially could permit a clearer evaluation of the effects of automatic semantic processing. In these types of tasks, two-component stimuli are presented to the subjects, with only one component being relevant to the responding process. Typically, however, automatic processing of the irrelevant stimulus component (the "prime") does occur. However, the situation is such that neither this processing nor any additional processing can facilitate responding to the relevant stimulus component. In fact, the task demands are such that the optimal subject strategy would be to ignore the prime as much as possible. Thus, any effects the prime has can be fairly unambiguously attributed to automatic processing.

In the present tasks, the two components are a picture (i.e., line drawing) and a word superimposed on the picture. In the most commonly examined version of this task, participants are asked to name the pictures. Naming latencies are longer in this situation than in the situation in which no words are superimposed on the pictures (Lupker, 1979; Rosinski, 1977). This result demonstrates quite nicely that, even though irrelevant to the task, the word is being automatically processed and that this processing is having an influence on task performance.

A second finding in the picture-word interference task relevant to the present discussion is Rosinski's demonstration that additional interference is observed when the word is the name of a member of the picture's semantic category. If word processing were only to the phonetic level such an effect should not occur. Thus, the presence of this semantic category effect indicates that some of the automatic processing the word receives is also semantic in nature, suggesting that the paradigm has sufficient flexibility to be used in the study of automatic semantic processing.

The focus of the present article is the automatic semantic processing of pictures and how it may influence decisions being made about words. To this end, a variant of the picture-word interference task is employed. In this task subjects are asked to ignore the picture and make a response to the word. Thus, any interference that does arise should be attributable to automatic picture processing.

There have been a few investigators who have used this type of paradigm to examine the effect of automatic word processing on the processing of other words (e.g., Shaffer & LaBerge, 1979). This research has shown that the processing of a target word can be influenced by the simultaneous presentation of a semantically similar word. It has been argued elsewhere (e.g., Nelson, Reed, & McEvoy, 1977; Potter & Faulconer, 1975) that pictures allow access to semantic information more rapidly than words. If so, there would seemingly be ample opportunity for pictures to influence the processing of a target word as well. In fact, if one adopts a strict unitary code model of memory (e.g., Friedman & Bourne, 1976; Nelson et al., 1977), it would be expected that pictures would influence word processing in much the same way as other words do. Yet, evidence for such influence available from priming studies is somewhat scarce, even in situations in which the word and the picture represent the same concept. For example, Scarborough, Gerard, and Cortese (1979) reported that naming a picture does not facilitate a subsequent lexical decision about that picture's name. Durso and Johnson (1979) reported essentially the same result in a task in which both stimuli were to be named. With respect to a picture influencing the processing of semantically related concepts, Sperber, McCauley, Ragain, and Weil (1979) reported that naming a priming picture can facilitate naming a semantically related word. However, even though this effect was apparently significant, it resulted in a savings of only 8 msec. On the other hand, Durso and Johnson did report some facilitation in a task in which the picture and the word both had to be categorized as natural or man-made. This result suggests that the depth to which the word must be processed may be a critical variable. When words are named or when a lexical decision must be made, word processing may be to too shallow a level, in the Craik and Lockhart (1972) sense, to be influenced by picture processing. However, tasks that necessitate the retrieval of a substantial amount of stored information, like categorization tasks, may allow the influence of picture processing to be manifest.

Smith and Magee (1980) did, in fact, combine the picture–word interference paradigm with a task involving deeper word processing to show that a background picture can influence the processing of a superimposed word. Using a yes/no semantic category decision task, Smith and Magee demonstrated that words that named the background picture (the identity condition) could be responded to more rapidly than when the background picture was congruent with the alternate semantic category and, hence, the alternate response (the incongruent condition). From these data the investigators argued that pictures supply semantic category information automatically and more rapidly than that same information can be retrieved by means of a word (see also Potter & Faulconer, 1975). Further, this information apparently cannot be ignored by the subject, producing the delay in response latency.

An additional finding in Smith and Magee's study, however, suggests that this conclusion is incomplete. Smith and Magee also included a word-alone condition (no background picture) that actually produced shorter reaction times than their identity condition. The obvious question is, if semantic category information from pictures does influence subjects' category decisions about words, why was there no facilitation when the background picture and the word represented the same concept? One explanation would be based on the idea that the word was encased in a set of background lines in the identity condition but not in the word-alone condition. Thus, whatever facilitation may have been provided by the picture may have been more than compensated for by general perceptual problems, such as lateral masking. This possibility was investigated in Experiment 1.

The task was the same as in Smith and Magee's experiment. Subjects were required to make a yes/no semantic category judgment about words. In particular, they were to decide whether the word named an animal. In the first condition, the word appeared by itself. In the second condition, the word appeared with a background picture representing the same concept. A third condition was now included in an attempt to evaluate the contribution of any general perceptual effects. In this condition the word was surrounded by a background nonpicture (see Figure 1). These nonpictures were quite picturelike in the sense that they had good Gestalt properties; however, they had no resemblance to any physical objects and, thus, normally should not allow the retrieval of any semantic information. Any difference between this condition and the word-alone condition should be attributable to these types of perceptual problems. Further, such a difference would imply that similar problems also exist in any picture conditions. Unfortunately, there would be no way of exactly equating the size of this effect across conditions. However, the nonpicture–word-alone difference can be taken as at least a rough estimate of the size of the effects involved in the picture conditions. Thus, the nonpicture condition can be used as an alternate control. Any difference between this condition and the identity condition would be evidence for facilitation from the background picture. If Smith and Magee are correct, such facilitation should obtain.

The above manipulation should answer the question of whether automatic picture processing can facilitate as well as interfere with word judgments. Still at issue, however, would be the nature and locus of these effects. Following the analysis suggested by Sternberg (1969) and recently adopted by Lupker and Katz (1981), there would, in fact, be a number of processes that could be affected. The initial, input, process involves the basic perceptual analysis of the display in order to access the appropriate location in memory. The rapid identification of a semantically similar picture, as in the identity condition, may facilitate word processing. Meyer, Schvaneveldt, and Ruddy (1975) did, in fact, demonstrate that at least some of the facilitation observed in their semantic priming paradigm involves this process. While in principle one may also conceive of costs occurring at this level, the weight of the evidence is that semantically dissimilar items do not hinder access to a concept's memory location (Dyer, 1973; Schvaneveldt & Meyer, 1973).

The second process in the sequence involves the analysis of the information available from memory in order to make the decision that the task requires. Information automatically provided by picture processing may interact with the information about the word's concept, causing problems when the sources are semantically dissimilar and leading to benefits when they are semantically similar. Shaffer and LaBerge (1979) suggested that the facilitation in their three-word tasks occurred at this level. Smith and Magee (1980) are apparently arguing for interference at this level in their task. Any effects observed at this level in the present tasks would indicate that the nature of stored information about pictures and words must be quite similar, in line with a unitary code model of memory (e.g., Nelson et al., 1977).

Finally, there would be an output process characterized by response selection and execution. In the standard picture–word interference task in which subjects are required to name the picture, automatic word processing may actually evoke a strong response tendency, the tendency to say the word, interfering with response execution. In the present task, it seems unlikely that automatic picture processing would cause a similar problem. However, pictures incompatible with the correct response may interfere with the response-*selection* process by suggesting an incorrect response. In fact, interference at this level has typically been found in tasks of this sort (Dyer, 1973; Keele, 1973). Facilitation would be possible here as well if the picture were to supply the correct response, as suggested by Posner (1978; Posner & Snyder, 1975). Posner's argument is based on Hintzman, Carre, Eskridge, Owens, Shaff, and Sparks's (1972) finding in the Stroop task that congruent color words produced faster color naming than Hintzman et al.'s control condition. However, these results are problematic for two reasons. First, the author's control condition (color name anagrams with the initial letter remaining in place) was quite inappropriate (Regan, 1978), as is witnessed by the fact that it caused as much interference as their noncolor word condition (see Klein, 1964). Second, even if facilitation with respect to an appropriate control had been obtained, no evidence is available to localize this effect at the output level. Studies that have looked at this issue more directly (Krueger & Shapiro, 1980; Shaffer & LaBerge, 1979; Taylor, 1977) appear to indicate that such facilitation does not occur.

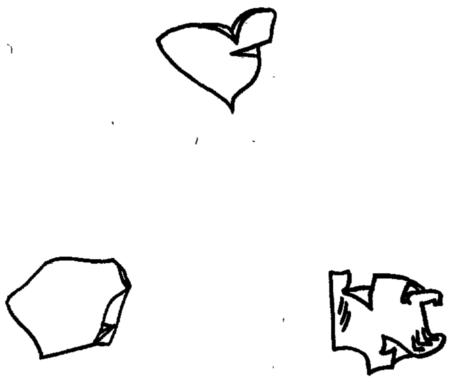

Figure 1. Examples of typical nonpictures.

In an effort to gain a better understanding of how automatic picture processing affects the stages of word processing, two new conditions were added, an animal picture condition and a nonanimal picture condition. The former condition on negative trials and the latter condition on positive trials are analogous to the incongruent condition in Smith and Magee's (1980) study. It would be expected that these pictures would produce interference at any stage that can be affected by picture processing. On positive trials the animal picture condition could potentially facilitate any of the stages in word processing. Performance in this condition should, in fact, be essentially equivalent to that in the identity condition at every level except one. That is, both sets of pictures are compatible with a positive response and both can provide semantic information compatible only with an "animal" decision. However, identity pictures may serve as better primes for memory access than do pictures of semantically related concepts. If this process can then be affected by picture processing, whatever facilitation is observed in the animal picture condition may be less than that observed in the identity condition.

The results in the nonanimal picture condition on negative trials should aid in the evaluation of any facilitation observed in the animal picture condition on positive trials.

That is, these nonanimal pictures would also be compatible with the appropriate response and could provide semantic information compatible only with the appropriate "nonanimal" decision. Thus, if either the decision or response-selection process can be influenced, both conditions should benefit equally. However, to the extent that semantically related pictures influence memory access, the animal pictures on positive trials should provide relatively more facilitation than the nonanimal pictures on negative trials.

Method

Subjects. Fifty University of Western Ontario undergraduate volunteers (14 males and 36 females) received course credit for participating in this experiment and another, unrelated experiment in the same 1-hour session. All were native English speakers.

Materials and equipment. The names of 20 well-known objects were selected for use in this experiment. Ten of those were animals (the positive trials), and 10 were members of other semantic categories (the negative trials). Each of these words appeared once in each of the five experimental conditions.

The actual stimuli were created by placing each of these words, with or without a background picture, in the middle of a 23 × 25.6 cm card. To create the stimuli for the identity, animal picture, and nonanimal picture conditions, we chose line drawings ("pictures") for each of the words from children's coloring books. In the identity condition, each picture appeared with its name superimposed. In the animal picture condition on positive trials, each of the animal names appeared with a different animal picture. In this condition on negative trials, each of the nonanimal words was superimposed on one of the animal pictures. In the nonanimal picture condition on positive trials, each of the animal words was superimposed on one of the nonanimal pictures. In this condition on negative trials, each of the nonanimal words appeared on a different nonanimal picture. In order to create the stimuli for the nonpicture condition, 10 nonpictures were selected and 2 instances of each were created. One instance appeared with an animal word on the positive trials; the other, with a nonanimal word on the negative trials. Finally, for the word-alone condition, each of the 20 words appeared with no background picture. The names of the pictures and the words used are reported in Appendix A.

A Gerbrands (Model 1-3B-7C) three-field tachistoscope was used to present the stimuli. Viewing distance was 77 cm and viewing was binocular. The letters typically subtended a visual angle of .24° horizontally and .36° vertically. The pictures subtended visual angles between 1.90° and 5.74° horizontally and 3.84° and 5.74° vertically. A Hunter Klockounter (Model 120) timer was used to time the subject's vocal response. An Electro-Voice (Model 621) microphone was positioned approximately 7 cm away from the subject's mouth. The microphone was attached to a Lafayette Instruments (Model 18010) voice-activated relay which stopped the timer at the initiation of the subject's vocal response.

Procedure. The subjects were tested individually. Each subject first participated in another, unrelated experiment and then in the present experiment. Before this experiment subjects were told that they would be seeing a series of words, many of which would be superimposed on pictures, and that their job would be to classify each word as to whether it named an animal or not. When the word was an animal name, they were to respond by saying "yes"; when it did not name an animal, they were to respond by saying "no." They were instructed to respond as rapidly and accurately as possible. The subjects then responded to each of the 100 stimuli in a random order.[1] Onset of the stimulus started the timer which was stopped by the subject's vocal response. Each stimulus remained in view for 750 msec regardless of the subject's reaction time. The interval between stimulus presentations was used by the experimenter to record the response latency and reset the equipment for the next trial. Thus, this time was not held constant but was generally around 5 sec. Errors were recorded, and those pictures were randomly placed back into the set of to-be-presented stimuli. Both experiments together took approximately 1 hour.

Results

The mean correct reaction times for the five conditions for both positive and negative trials are presented in the upper panel of Table 1. Each of these means is based on 500 observations. For the positive trials, a simple one-way analysis of variance (ANOVA) was performed. The analysis revealed a highly significant effect of conditions, $F(4, 196) = 43.73$, $p < .001$.[2] A subsequent New-

[1] In both experiments, randomization for a new subject was accomplished by an approximately 1-min shuffle of the stimulus cards. No attempt was made to counterbalance presentation order. The present process does, of course, not guarantee that stimuli from the various conditions were distributed equally throughout the trial block. Since a first exposure to a stimulus may facilitate the processing of its subsequent occurrences, an unequal distribution of the various conditions could cause interpretation problems. Further, as suggested by a reviewer, potentially the different conditions could benefit unequally from this first exposure. Although the present data do not allow an evaluation of either possibility, previous research in our laboratory (Lupker, 1979, in press; Lupker & Katz, 1981) using this shuffling technique suggests that neither of these problems is a real one. In most of these studies, two trial blocks were used per subject, and there has never been even a hint of a trial blocks by conditions interaction.

[2] Because of the arguments presented by Wike and Church (1976) and others, stimulus materials was not treated as a random factor as suggested by Clark (1973) in this or any subsequent analysis.

man-Keuls analysis revealed that these means could be partitioned into three sets. Reaction times in the identity and word-alone conditions were equivalent and shorter than those in any other condition ($p < .01$). Reaction times in the nonanimal picture condition were significantly slower than in all other conditions ($p < .01$). Finally, reaction times in the animal picture and nonpicture conditions were equivalent and intermediate.

A similar analysis was carried out on the negative reaction times. Again, the ANOVA revealed a significant effect of conditions, $F(4, 196) = 43.38$, $p < .001$. A subsequent Newman-Keuls analysis again revealed that these means could be partitioned into three sets. The 16 msec difference between the identity and the word-alone conditions, although larger than that on positive trials, failed to reach significance ($p > .05$). The reaction times in the nonanimal picture and nonpicture conditions were equivalent and significantly larger than in the first two conditions ($p < .01$). Finally, the reaction times in the animal picture condition were significantly larger than in all other conditions ($p < .01$).

As is typically the case in vocal reaction time experiments, errors were few. In all conditions except the nonanimal picture condition on positive trials, error rates were 1% or less (5 errors in 500 trials). This condition showed an error rate of 4.4%, which indicates, as does the reaction time data, that this clearly was the most difficult condition on positive trials.

Discussion

The first thing to note about the results of Experiment 1 is that an approximately 40 msec difference was observed between the nonpicture and the word-alone conditions on both positive and negative trials. This result indicates that general perceptual problems such as lateral masking do influence responding to the word component of picture–word stimuli. Unfortunately, this finding indicates that there will always be a certain amount of difficulty in evaluating semantic effects in these kinds of experiments. That is, although the nonpictures in the present experiment reliably produced 40 msec of interference, this number can be used only as a rough estimate of the size of these effects in the picture conditions. Nonetheless, in

Table 1
Reaction Times (in msec) as a Function of Experimental Conditions in Experiments 1 and 2

	Experiment 1					
	Condition					
Trials	ID	AP	NAP	NP	WA	Needed for significance $p < .05$
Positive	670	720	765	709	666	17 msec
Negative	714	773	749	740	698	16 msec
	Experiment 2					
	Condition					
	DOG	AP	NAP	NP	WA	Needed for significance $p < .05$
Positive	591	613	609	593	567	11 msec
Negative	645	640	623	623	601	11 msec
		UR	OR	SR		
Negative trial word conditions		616	645	618		

Note. ID = word names the picture; AP = animal picture; NAP = nonanimal picture; NP = nonpicture; WA = word alone; DOG = dog picture; UR = unrelated words; OR = orthographically similar words; SR = semantically similar words.

order to evaluate the effects of semantic factors, the contributions of these effects must be taken into account, and some sort of nonpicture condition should be used to provide an additional control.

The second thing to note about the present results is that the reaction times in the identity conditions were significantly shorter than those in the nonpicture conditions and essentially equivalent to those in the word-alone conditions. In the identity conditions, as in the nonpicture conditions, the words were encased in a figure, and thus judgments were undoubtedly slowed due to the general perceptual problems noted above. Although it can not be assumed that these conditions were influenced equally, it seems highly unlikely that differential perceptual problems alone could produce the identity–nonpicture differences. Thus, at least part of this difference must represent a semantic effect. As suggested earlier, background pictures in the present task do engage a certain amount of automatic semantic processing. The present findings demonstrate that if the results of that processing are compatible with the specific concept represented by the word, a category judgment being made about that word can be facilitated.

The lack of a difference between the word-alone and the identity conditions is, of course, a nonreplication of one aspect of Smith and Magee's (1980) results. However, this nonreplication is probably a result of the different experimental procedures used in the two studies. The present task used a discrete-trials procedure. On the basis of the argument presented above, there were two factors involved in our word-alone–identity comparison: perceptually-based difficulties, which delayed reaction time in the identity condition, and semantic information from the picture, which aided the identity condition. Together, these two factors apparently canceled each other out, producing equivalent results in the two conditions. Smith and Magee, however, used a somewhat different method of stimulus presentation which introduced a third factor. The stimuli in their study were presented on sheets, and response time for the full sheet was recorded. This method of presentation allows subjects to view the next stimulus peripherally while processing the previous stimulus. Thus, at least a certain amount of processing of a stimulus can begin before it is actually in foveal attention. When a subsequent word is encased in a picture, peripheral processing would be much more difficult than in a word-alone condition due to factors like lateral masking or simply the difficulty in locating the word in the middle of the picture. Thus, with Smith and Magee's technique the word-alone condition would benefit much more from peripheral processing, producing the word alone advantage that these authors observed.

The third aspect of the data to note involves the two maximally incongruent conditions, the nonanimal picture condition on positive trials and the animal picture condition on negative trials. These two conditions involved pictures incompatible with the word's concept, with the word's semantic category, and with the correct response. Replicating Smith and Magee's results, these conditions produced longer reaction times than any other condition. The fact that there is a large difference between these conditions and their respective nonpicture conditions is especially relevant since again these differences can most likely be attributed to semantic factors. Thus, these findings substantiate Smith and Magee's claim that the results of automatic semantic processing of pictures can interfere with semantic category decisions being made about words.

Before discussing the locus of these effects, the possibility should be considered that the present results are due to subject strategies. Each picture in Experiment 1 was used three times, twice for one type of response, once for the other type (e.g., the cat picture contained the words CAT, SHEEP, and STAR). Thus, if the first appearance of the cat picture contained the word STAR, subsequent appearances of that picture would require a positive response. If subjects discovered this relationship and remembered earlier stimuli, they may have been able to respond very rapidly to later occurrences of the pictures. If this argument is valid, it would suggest that the facilitation observed may be an artifact of the procedure. However, a number of facts argue against this interpretation. First of all, useful implementation of this strategy would require an immense memory load. Pictures in Experiment 1 occurred, on average, 33 trials apart. Further, this relationship between words and pictures was not explained to the subjects beforehand; thus it would have had to have been discovered during the experiment. Considering that only one block of 100 trials was presented to any subject, the acquisition of this knowledge seems improbable. Finally, if subjects really could and did follow this strategy, facilitation would be expected in the animal word condition on positive trials and the nonanimal word condition on negative trials as well as in the two identity conditions. As noted, these effects did not occur. Thus, this explanation of the facilitation in Experiment 1 appears unlikely. It is even more difficult to construct a similar argument to explain the interference in Experiment 1. Rather than try, perhaps it is best to note that our interference effects paralleled those of Smith and Magee (1980) whose design is not subject to the same criticism.

The conditions discussed above provide evidence for the conclusion that automatic semantic processing of pictures can both facilitate and inhibit semantic category decisions being made about words. The final two conditions provide some insight into the nature of those effects. Recall that the task is to decide whether a word represents an instance of the category animal. Consider the case when such a word (e.g., DOG) is, first, superimposed on a picture of the same concept (i.e., a picture of a dog) or, second, upon a picture of another animal (e.g., a picture of a cat). In both these conditions, automatic processing of the picture should provide information compatible with the decision (animal) and with the response (yes). Yet only in the identity condition was facilitation observed. When the background picture was of an animal different from that represented by the word, neither facilitation nor inhibition was observed relative to the nonpicture control condition. This suggests that the facilitation does not arise at either the decision or response-selection levels. Apparently, the facilitation observed is a result of automatic processing of the picture, allowing the target word to access memory more rapidly.

Consider next the condition in which nonanimal words are superimposed on nonanimal pictures. Like the two conditions discussed above, the information made available from the picture is compatible with the decision (nonanimal) and with the response (no) appropriate to the word. Yet, again, with the nonpicture control used as a rough baseline, this nonanimal picture condition provides neither facilitation nor interference. This result, together with that in the animal picture condition on positive trials, suggests that the appropriate way to characterize the interference in the incongruent conditions is as a response-selection problem. That is, as noted above, pictures seem to allow more rapid access to semantic information than do words. If this information were mixing with the information about the word at the decision level, facilitation would be expected in both the animal picture condition on positive trials and the nonanimal picture condition on negative trials. The absence of an effect in both conditions indicates that the sources of information can be kept separate at this level. Instead, it appears that the processing that the animal pictures receive suggests a positive response while the processing that the nonanimal pictures receive suggests a negative response. Thus, on negative trials response selection becomes problematic in the former condition, while on positive trials response-selection problems emerge in the latter. However, in line with earlier results (Shaffer & LaBerge, 1979; Taylor, 1977), when the response suggested by the irrelevant component is compatible with the appropriate response, no facilitation results.

The lack of a facilitatory effect in the animal picture condition on positive trials stands in contrast to the results reported by Shaffer and LaBerge (1979), using what is essentially a word–word analog of the present task. In their study, flanking words from the same semantic category facilitated category decisions essentially as much as identical words. One hypothesis that could be entertained to explain this difference between experiments is based on the category typicality of the animals used. No effort was made in the present study to control for this factor. However, as Rosch (1975) seemed to suggest, highly typical category members may facilitate processing of other category members, and atypical members may inhibit it. Thus, our lack of an effect could represent a facilitation of typical words balanced by an inhibition of atypical words or a facilitation from typical pictures balanced by an inhibition from atypical pictures. We attempted to evaluate this possibility by doing two analyses. In the first, a median split was done on the words by using Battig and Montague's (1969) production norms as a measure of typicality and then comparing interference scores for these two groups of stimuli (i.e., the difference between the stimuli containing these words in the nonpicture and animal picture conditions on postive trials). In the second analysis, a median split was done on the pictures again using Battig and Montague's (1969) norms, and again interference scores were calculated. In both analyses the highly typical group actually produced slightly more interference than the atypical group. Thus, this hypothesis appears to be an unlikely one.

Instead, it seems more likely that the difference between the present study and Shaffer and LaBerge's (1979) is a real picture–word difference. The actual locus of the facilitation in Shaffer and LaBerge's study is, unfortunately, indeterminate. The input process, as in the present study, or the decision process, because the nature of the semantic category information from the irrelevant words is such that it can be used in decision making, or both processes may be responsible. The point is that identical and same semantic category words affect these two processes identically, while similar category examples represented as pictures do not. It may be suggested that if a different "level" category had been used (e.g., dog as the category; poodle, collie, terrier, etc. as examples) in the present experiment or if some lead time had been given to the picture, automatic processing of a same semantic category picture may have also facilitated category decisions. Nonetheless, even if true, the present results indicate that pictures and words do tend to affect the input process for words in somewhat different ways. Coupled with the inability of semantic information from pictures to influence the category decision process, these results argue for definite differences in the automatic semantic processing capabilities of pictures and words.

In summary, the results of Experiment 1 allow three conclusions. First, general perceptual difficulties do affect responding to the word component of picture–word stimuli. Although the contribution of these factors cannot actually be equated across conditions, some sort of measure of it should be taken in experiments of this type. Second, facilitation tends to be limited to situations in which the word and the picture represent the same specific concept. In these situations picture processing apparently allows the word to access memory and thus retrieve the sought-after information more rapidly. This effect does not appear to be due to a mixing of the semantic information at the decision level. Finally, the interference observed in this task appears to be due to the response-selection process. Picture processing appears to suggest the response that would be appropriate if the decision were to be made to the picture. If this response is incompatible with the correct response, response-selection problems arise. If not, the response appropriate to the word can be selected just as when no picture is involved, and thus no interference or facilitation results.

Experiment 2

In Experiment 2, the task was changed somewhat in order to get converging evidence for each of these conclusions. The task employed required the subjects to make a yes/no judgment as to whether the word was DOG. The effects of general perceptual problems are once again examined by comparing a word-alone condition to a nonpicture condition. A significant difference on both positive and negative trials will reinforce the conclusion that these problems must be taken into account in tasks of this sort.

The present task allowed an examination of the conclusion about the locus of facilitation in the following manner. Task demands do not now require that subjects access memory in order to make the appropriate decision. Instead, responses can be based solely on the available visual information. If subjects are following this type of strategy, the implication is that no facilitation should arise. To verify that subjects did indeed base their decision solely on visual information, we used three types of foils: unrelated words, orthographically similar words (e.g., DOLL), and semantically similar words (e.g., CAT). The unrelated words provide the baseline. The use of visual information in decision making would be indexed by longer reaction times for the orthographically similar words. The lack of involvement of semantic information in decision making would be indexed by no difference between the semantically similar words and the unrelated words. If this pattern of results obtains, there should be no evidence of facilitation in Experiment 2.

Finally, Experiment 2 allowed a further investigation into the nature of the influence of automatic picture processing on the response-selection process. Previous discussion of the interference in these types of tasks (e.g., Dyer, 1973; Posner & Snyder, 1975) has always implied that response-selection problems occur only when the information automatically available from the irrelevant stimulus is the same type of information as that being evaluated. That is to say, if subjects are basing their decisions solely on orthographic information, only orthographic information from the picture could produce interference and then only if it is available before that from the word. It seems highly unlikely that pictures would automatically supply orthographic information, and even if they did, it would not be available prior to the orthographic information from the word. Thus, if this theorizing is correct, no interference would be expected in Experiment 2.

Alternatively, one may wish to conceptualize response selection as more of an executive process, that is, it accepts evidence from a number of sources while attempting to concern itself only with the set of potential responses. In the present task, the response set consists of the words yes and no. Both of these responses should be quite near threshold and, therefore, potentially somewhat easily suggested by the presence of a background picture. In this situation semantic processing of the pictures may lead to the suggestion of a response. Depending on the nature of the response-selection process, it may then have to deal with this response, even though its promotion was not based on orthographic information. If so, interference would arise in the present task when the picture and the word are not compatible with the same response.

Three additional conditions beyond the word-alone and nonpicture conditions were added to evaluate these hypotheses. The third condition involved a set of dog pictures. If the above theorizing about the nature of facilitation is correct, these pictures should not facilitate responding on positive trials. On negative trials these pictures may have the potential to produce interference. A fourth condition involved nonanimal pictures. On negative trials these pictures should cause no more problems than nonpictures. On positive trials, however, they may suggest a negative response and thus delay response selection. Finally, a fifth condition, with animal pictures, was added. Again, on positive trials these pictures have the potential, depending on the nature of the response-selection process, of producing interference. On negative trials, the implications are much less clear. Although these pictures are compatible with a negative response, their processing may be biased by the context created by Experiment 2. That is, because more than half of the trials involved the dog concept, the memory location for this concept should be highly primed. In this situation the visual information that animal pictures provide may be enough doglike that their processing may allow access to the memory location appropriate to "dog" as well. If so, a positive response would be promoted. Thus, this condition may produce some interference on both positive and negative trials.

Method

Subjects. Fifty University of Western Ontario undergraduate volunteers (28 males and 22 females) received course credit for participating in this experiment. All were native English speakers.

Materials and equipment. The stimuli were, as before, words, with or without a background picture, presented in the middle of 23 × 25.6 cm cards. Half of the stimuli, those for the positive trials, contained simply the word DOG. There were 12 of these stimuli per condition. For the negative trials, 12 other words were selected, 4 of which named animals, 4 of which began with the letters DO, and 4 of which had no obvious relationship to any attribute of the concept of a dog. Each of these words appeared once in each of the experimental conditions.

As before, all pictures were selected from children's coloring books. For the dog condition, 12 different pictures of dogs were selected. Each picture appeared once on a positive trial (i.e., with the word DOG superimposed) and once on a negative trial (i.e., with one of the other words superimposed). For the animal picture condition, 12 animal pictures were selected, and each appeared once with the word DOG and once with one of the other words. In order to create the nonanimal picture condition, 12 pictures of inanimate objects were selected, and each appeared once with the word DOG and once with one of the other words. The nonpicture condition was created by selecting 12 nonpictures and having each appear once with the word DOG and once with one of the other words. Finally, for the word-alone condition, the word DOG appeared 12 times and the other words once each with no background pictures. The names of the pictures and the words used are reported in Appendix B.

Procedure. The procedure was almost identical to that of Experiment 1. The only differences were that (a) the subjects in the present experiment had not participated in a prior experiment, (b) the instructions were to respond "yes" if the word was DOG and "no" otherwise, and (c) 120 stimuli were now involved. As before, each subject was presented the 120 stimuli in a different random order that was set up by shuffling the stimulus cards. The entire procedure took approximately 30 minutes.

Results

The mean correct reaction times for the five conditions for both positive and negative trials are presented in the lower panel of Table 1. Each mean is based on 600 observations. For the positive trials a simple one-way ANOVA revealed a highly significant main effect of conditions, $F(4, 196) = 21.57$, $p < .001$. A subsequent Newman-Keuls analysis revealed that these means could be partitioned into three sets. Reaction times in the word-alone condition were significantly faster than in all other conditions ($p < .01$). Reaction times in the animal picture and nonanimal picture conditions were equivalent and significantly slower than in all other conditions ($p < .01$). Reaction times in the dog and nonpicture conditions were equivalent and intermediate.

For the negative trials a two-way ANOVA was performed, with foil type as the additional factor. Both main effects, conditions, $F(4, 196) = 9.14$, $p < .001$, and foil type $F(2, 98) = 36.76$, $p < .001$, were highly significant, while the interaction was not, $F(8, 392) = 1.45$, *ns*. These main effects were explored further through the use of a Newman-Keuls analysis. The effect of foil type was due to the fact that the orthographically similar words were significantly ($p < .01$) harder to reject than either the unrelated words or the animal words, which were equivalent. The analysis of the picture conditions revealed that the five means could be partitioned into three sets. Reaction times in the word-alone condition were again significantly shorter than those in all other conditions ($p < .01$). Reaction times in the dog condition and in the animal picture condition were equivalent and significantly longer than in all other conditions ($p < .01$). Reaction times in the nonanimal picture and nonpicture conditions were equivalent and intermediate.

As before, there were few errors in the present experiment. In no condition did the error rate exceed 1.5% (9 errors in 600 trials).

Discussion

First of all, the reader should note that these results support those of Experiment 1 in that nonpictures do cause interference with respect to the words alone. The nonpictures used were different from those used before, so it would be difficult to compare the size of this effect across experiments. However, the size of the effect is remarkably consistent across response type, which indicates that 24 msec is probably a reasonable estimate of the size of this effect in the present study.

With this nonpicture condition used as a baseline, the two major hypotheses about the effects of background pictures were supported. Interference was observed in the dog condition on negative trials and in the nonanimal picture condition on positive but not negative trials. In both situations automatic processing of the pictures apparently promoted an incorrect response, creating problems for the response-selection process. In addition, the dog condition on positive trials did not provide any facilitation. As suggested, the process that can be facilitated in these types of tasks appears to be the process of accessing memory. The present study was designed to eliminate the involvement of this process in the processing sequence. The results for the different foil types provide evidence that the manipulation was successful. Orthographically similar words were much more difficult to reject than unrelated words, indicating that subjects did tend to base their responses on visual information. Animal words were not different from unrelated words, indicating that stored semantic information was totally irrelevant to the subject's decision-making process. Thus, it appears that these decisions were being based totally on the visual information contained in the word and did not involve memory access. As such, it follows that no facilitation should have been observed.[3]

The other notable result of the present study was the equivalence of the animal picture condition to the nonanimal picture condition on positive trials and to the dog condition on negative trials. The first of these results is not at all surprising since these pictures would presumably be compatible with a negative response. The second result indicates that automatic picture processing does interact with context. With sufficient prior activation of the dog concept, the pictorial information contained in pictures of other animals can also suggest the presence of a dog, thus promoting a positive response and delaying the response-selection process on negative trials.

At least some support for this conclusion can be gained by doing typicality analyses as in Experiment 1. The typicality of the pictured concepts was again indexed by the concept's rating in Battig and Montague's (1969) norms. A median split was done on these ratings to divide the pictures into a typical set and an atypical set. Both types of pictures would be expected to activate their specific concept and suggest a negative response. However, in addition, since typical animals would presumably be more similar to a dog, their pictures may be more capable of activating the already activated dog concept and suggesting a positive response. On positive trials, since both types of pictures evoke a negative response and, as argued above, compatible tendencies do not facilitate responding, no typicality effect should be observed. None was, atypical pictures producing 18 msec of interference, typical pictures producing 23 msec of interference. On negative trials typical pictures should have more ability to generate an interfering response tendency. The results, although based on too few pictures to be statistically significant, definitely point in this direction (28 msec of interference for typical pictures, 6 msec of interference for atypical pictures).

General Discussion

The purpose of the present set of studies was to examine the influence of automatic semantic processing of pictures on word processing. A number of basic findings emerged. First, responses to words embedded in pictures are delayed due to the influence of perceptual factors like lateral masking. Second, pictures can facilitate word processing, but only in situations in which memory access is required and the two stimuli represent the same concept. Third, pictures not compatible with the appropriate response can delay responding to words. The analysis of these effects follows the processing model suggested by Sternberg (1969) and recently adopted by Lupker and Katz (1981).

The initial, input, stage in word processing involves the basic perceptual analysis of the word in order to access the appropriate location in memory. This process is presumed to occur whether or not memorial information is to be evaluated. On the basis of some recent results (Krueger & Shapiro, 1979; Massaro, 1979) and the results of Experiment 2, the rate of perceptual resolution of the word does not appear to be influenced by semantic aspects of the word, although

[3] One could, of course, hypothesize that the nonpicture control conditions underestimated the interference due to lateral masking-type problems in the picture conditions of Experiment 2. If the amount of underestimation was approximately 20 msec, the previous interpretation would change dramatically. That is, there would now be no evidence for interference as well as clear evidence for facilitation in the dog condition on positive trials. However, there would also be clear evidence of facilitation in the nonanimal picture condition on negative trials. Since no relationship of any sort existed between these words and pictures, facilitation in this condition would be extremely surprising. Thus, this hypothesis appears to be an unlikely one.

it can be slowed by nonsemantic perceptual problems. However, memory access is facilitated by the automatic processing of a simultaneously presented picture that represents the same concept as the target word. Pictures of semantically related concepts do not appear to have the same capability. This is not to say that priming paradigms cannot be devised in which evidence for pictures priming semantically related words can be obtained (e.g., Sperber et al., 1979). However, the present results suggest that such priming may very well be a result of subject strategies like those outlined by Becker (1980).

The second stage in the processing sequence involves an evaluation of the relevant information, either memorial information as in Experiment 1 or orthographic information as in Experiment 2, in order to make the decision required by the task. The present results, particularly the lack of facilitation in the animal picture condition on positive trials in Experiment 1, indicate that this process is unaffected by information automatically available from picture processing. Apparently, the nature of word-retrieved information is sufficiently different from the nature of the information from the pictures that the two sources can be kept separate at this level.

The final, output, stage in the processing sequence involves the selection and execution of the appropriate response. This process has been suggested as the locus of the interference in similar tasks numerous times previously (Eriksen & Eriksen, 1974; Keele, 1973; Klein, 1964; Posner & Snyder, 1975), and it appears to be responsible for the interference observed here as well. Picture processing in the present task appears to suggest some sort of response. When this response is incompatible with the appropriate response, difficulty is created for the selection process and reaction time is delayed. When the response suggested is the appropriate response, no competition takes place and word processing proceeds uninterrupted.

The response competition observed in the present task is, however, somewhat different than that observed in the standard picture–word or Stroop interference paradigms. In those tasks the normal processing of a word suggests a verbal response which can then compete not only at the response-selection level but also at the response-execution level if a strong tendency to say the word is produced. In the present studies, the evocation of response competition must be driven by the nature of the task. That is, in normal picture processing, pictures do not suggest a yes/no response, nor, perhaps, even a naming response (Nelson & Reed, 1976). Thus, the fact that they do here must be attributed to the experimental setup. As such, the nature of a response-selection process that could produce the present results as well as those of Smith and Magee (1980) deserves further comment.

To begin with, this process must be an amodal one, that is, one that accepts input from both picture processing and word processing. As well, it does not appear to be sensitive only to relevant information: That is, the results of Experiment 2 demonstrate that even though decision making involves the consideration of only orthographic information, semantic information from pictures does cause response-selection problems. Finally, the difficulty in dismissing an incorrect response appears to depend on the legitimacy of the response itself and not on the weight of the evidence behind it. That is, typical animal pictures in Experiment 2 appear to suggest a positive as well as a negative response. Clearly, however, the evidence for a positive response must have been much stronger when a dog picture was presented. Nonetheless, these two types of stimuli caused equivalent amounts of interference on negative trials. These observations together suggest that response selection should be viewed as an "executive" process concerned only with dealing with a set of possible responses. As picture and word processing go on in parallel, this process can be influenced by any input this processing may provide. In yes/no tasks the set of potential responses is quite limited as well as being highly familiar, and response selection will focus solely on evidence for one or the other of these responses. If evidence for only one response is acquired, response selection is simple. Only if more than one are suggested is it necessary to consider the source of the evidence for each response in order to select the correct one.

This notion that the response-selection

process can be interfered with but is not facilitated appears to stand in opposition to the cost-benefits analysis proposed by Posner (1978; Posner & Snyder, 1975). In Posner's framework, costs (interference) are a result of controlled, attended processing and should inevitably bring with them benefits. That is to say, although benefits can arise without costs, costs cannot arise without benefits. Clearly, the results of Experiment 2 do not follow this pattern. We are making the case in the present article, as does Posner when considering similar paradigms, that the costs we observed were the *result* of automatic processing. As such, these findings suggest that a distinction must be drawn between the processing itself and the product of that processing (related results and conclusions are given in Shiffrin and Schneider, 1977). In almost all interference tasks, automatic processing produces a product that tends to interfere with responding. However, that product is an entity separate from the processing that produced it. As such, there is no reason to argue that it must facilitate as well as inhibit. In some situations facilitation may very well arise. However, in the present situation as well as in a number of others mentioned earlier (Krueger & Shapiro, 1980; Shaffer & LaBerge, 1979; Taylor, 1977), such does not seem to be the case.

Finally, one may ask what the present results have told us about differences and similarities in the automatic processing of pictures and words. If we are correct that the interference effects observed here are due to executive decisions based on the results of automatic processing, then picture processing and word processing do not have to be greatly similar for interference to be produced. In fact, examination of interference effects within any one task may add little to our knowledge of picture–word processing differences. A better view is provided by contrasting the present results with those of Shaffer and LaBerge (1979). Recall that the present study indicated that automatic picture processing actually appeared to have very little influence on the normal course of word processing except in the single situation in which the two stimuli represented the same specific concept and memory access was involved. Shaffer and LaBerge (1979) have shown that the same cannot be said about the influence of word processing on word processing. In fact, even with a simultaneous presentation that should minimize the use of controlled processing, merely the existence of a semantic relationship between the two words influences response latency. As such, it appears that the semantic processing that the irrelevant word automatically received in those tasks must be different from the automatic semantic processing that the pictures received in the present studies.

References

Battig, W. F., & Montague, W. E. Category norms for verbal items in 56 categories: A replication and extention of the Connecticut category norms. *Journal of Experimental Psychology Monograph*, 1969, *80*(3, Pt. 2).

Becker, C. A. Semantic context effects in visual word recognition: An analysis of semantic strategies. *Memory & Cognition*, 1980, *8*, 493–512.

Clark, H. H. The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior*, 1973, *12*, 335–359.

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 1972, *11*, 671–684.

Durso, F. T., & Johnson, M. K. Facilitation in naming and categorizing repeated pictures and words. *Journal of Experimental Psychology: Human Learning and Memory*, 1979, *5*, 449–459.

Dyer, F. N. The Stroop phenomenon and its use in the study of perceptual cognitive and response processes. *Memory & Cognition*, 1973, *1*, 106–120.

Eriksen, B. A., & Eriksen, C. W. Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, 1974, *16*, 143–149.

Fischler, I. Semantic facilitation without association in a lexical decision task. *Memory & Cognition*, 1977, *5*, 335–339.

Fischler, I., & Goodman, G. O. Latency and associative activation in memory. *Journal of Experimental Psychology: Human Perception and Performance*, 1978, *4*, 455–470.

Friedman, A., & Bourne, L. E., Jr. Encoding the levels of information in pictures and words. *Journal of Experimental Psychology: General*, 1976, *105*, 169–190.

Hintzman, D. L., Carre, F. A., Eskridge, V. L., Owens, A. M., Shaff, S. S., & Sparks, M. E. "Stroop" effect: Input or output phenomenon. *Journal of Experimental Psychology*, 1972, *95*, 458–459.

Keele, S. W. *Attention and human performance*. Pacific Palisades, Calif.: Goodyear, 1973.

Klein, G. S. Semantic power measured through the interference of words with color-naming. *American Journal of Psychology*, 1964, *77*, 576–588.

Krueger, L. E., & Shapiro, R. G. Letter detection with rapid serial visual presentation: Evidence against word superiority at feature extraction. *Journal of*

Experimental Psychology: Human Perception and Performance, 1979, *5*, 657-673.

Krueger, L. E., & Shapiro, R. G. Repeating the target neither speeds nor slows its detection: Evidence for independent channels in letter processing. *Perception & Psychophysics*, 1980, *28*, 68-76.

LaBerge, D., & Samuels, S. J. Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 1974, *6*, 293-323.

Lupker, S. J. The semantic nature of response competition in the picture-word interference task. *Memory & Cognition*, 1979, *7*, 485-495.

Lupker, S. J. The role of phonetic and orthographic similarity in picture-word interference. *Canadian Journal of Psychology*, in press.

Lupker, S. J., & Katz, A. N. Input, decision, and response factors in picture-word interference. *Journal of Experimental Psychology: Human Learning and Memory*, 1981, *7*, 269-282.

Massaro, D. W. Letter information and orthographic context in word perception. *Journal of Experimental Psychology: Human Perception and Performance*, 1979, *5*, 595-609.

Meyer, D. E., & Schvaneveldt, R. W. Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, 1971, *90*, 227-234.

Meyer, D. E., Schvaneveldt, R. W., & Ruddy, M. G. Loci of contextual effects on visual word recognition. In P. M. A. Rabbitt & S. Dornic (Eds.), *Attention and performance V*. New York: Academic Press, 1975.

Neely, J. H. Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General*, 1977, *106*, 226-254.

Nelson, D. L., & Reed, V. S. On the nature of pictorial encoding: A levels-of-processing analysis. *Journal of Experimental Psychology: Human Learning and Memory*, 1976, *2*, 49-57.

Nelson, D. L., Reed, V. S., & McEvoy, C. L. Learning to order pictures and words: A model of sensory and semantic encoding. *Journal of Experimental Psychology: Human Learning and Memory*, 1977, *3*, 485-497.

Posner, M. I. *Chronometric explorations of mind*. Hillsdale, N.J.: Erlbaum, 1978.

Posner, M. I., & Snyder, C. R. R. Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium*. Hillsdale, N.J.: Erlbaum, 1975.

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

Regan, J. Involuntary automatic processing in color-naming tasks. *Perception & Psychophysics*, 1978, *24*, 130-136.

Rosch, E. Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, 1975, *104*, 192-233.

Rosinski, R. R. Picture-word interference is semantically based. *Child Development*, 1977, *48*, 643-647.

Scarborough, D. L., Gerard, L., & Cortese, C. Accessing lexical memory: The transfer of word repetition effects across task and modality. *Memory & Cognition*, 1979, *7*, 3-12.

Schvaneveldt, R. W., & Meyer, D. E. Retrieval and comparison processes in semantic memory. In S. Kornblum (Ed.), *Attention and performance IV*. New York: Academic Press, 1973.

Shaffer, W. O., & LaBerge, D. Automatic semantic processing of unattended words. *Journal of Verbal Learning and Verbal Behavior*, 1979, *18*, 413-426.

Shiffrin, R. M., & Schneider, W. Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review*, 1977, *84*, 127-190.

Smith, M. C., & Magee, L. E. Tracing the time course of picture-word processing. *Journal of Experimental Psychology: General*, 1980, *4*, 373-392.

Sperber, R. D., McCauley, C., Ragain, R. D., & Weil, C. M. Semantic priming effects on picture and word processing. *Memory & Cognition*, 1979, *7*, 339-345.

Sternberg, S. The discovery of processing stages: Extentions of Donders' method. *Acta Psychologica*, 1969, *30*, 276-315.

Stroop, J. R. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 1935, *18*, 643-662.

Taylor, D. A. Time course of context effects. *Journal of Experimental Psychology: General*, 1977, *106*, 404-426.

Tweedy, J. R., Lapinski, R. H., & Schvaneveldt, R. W. Semantic-context effects on word recognition: Influence of varying the proportion of items presented in an appropriate context. *Memory & Cognition*, 1977, *5*, 84-89.

Wike, E. L., & Church, J. D. Comments on Clark's "The language-as-fixed-effect fallacy." *Journal of Verbal Learning and Verbal Behavior*, 1976, *15*, 249-255.

Appendix A

Stimuli in Experiment 1

Words	ID	AP	NAP
		Positive trials	
CAT	CAT	SHEEP	DOOR
COW	COW	PIG	HAT
DOG	DOG	MOUSE	SHOE
GOAT	GOAT	MOOSE	PLANE
KANGAROO	KANGAROO	LION	STAR
LION	LION	KANGAROO	PUMPKIN
MOOSE	MOOSE	GOAT	FLOWER
MOUSE	MOUSE	DOG	FOOT
PIG	PIG	COW	BREAD
SHEEP	SHEEP	CAT	BANANA
		Negative trials	
BANANA	BANANA	SHEEP	DOOR
BREAD	BREAD	PIG	HAT
FLOWER	FLOWER	MOOSE	SHOE
FOOT	FOOT	MOUSE	PLANE
PUMPKIN	PUMPKIN	LION	STAR
HAT	HAT	KANGAROO	PUMPKIN
DOOR	DOOR	GOAT	FLOWER
SHOE	SHOE	DOG	FOOT
PLANE	PLANE	COW	BREAD
STAR	STAR	CAT	BANANA

Note. ID = word names the picture; AP = animal picture; NAP = nonanimal picture.

Appendix B

Stimuli in Experiment 2

Words	DOG	AP	NAP
		Positive trials	
DOG	DOG	CAMEL	APPLE
DOG	DOG	TIGER	CHURCH
DOG	DOG	FOX	SHIP
DOG	DOG	ELEPHANT	SAW
DOG	DOG	LION	HAT
DOG	DOG	HORSE	LAMP
DOG	DOG	SQUIRREL	SHOE
DOG	DOG	BEAR	CHAIR
DOG	DOG	MOOSE	TOASTER
DOG	DOG	CAT	STAR
DOG	DOG	RABBIT	BANANA
DOG	DOG	KANGAROO	PLANE
		Negative trials	
COW	DOG	TIGER	SHIP
GOAT	DOG	CAMEL	SAW
MOUSE	DOG	CAT	TOASTER
PIG	DOG	BEAR	SHOE
DOLL	DOG	RABBIT	BANANA
DOME	DOG	KANGAROO	PLANE
DOOR	DOG	ELEPHANT	APPLE
DOT	DOG	LION	STAR
BED	DOG	HORSE	HAT
CAR	DOG	SQUIRREL	LAMP
FOOT	DOG	MOOSE	CHAIR
LEAF	DOG	FOX	CHURCH

Note. DOG = dog picture; AP = animal picture; NAP = nonanimal picture.

Received July 20, 1981
Revision received January 7, 1982 ■