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The role of semantic memory in picture and word processing

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The Ohio State University, 1994
THE ROLE OF SEMANTIC MEMORY IN
PICTURE AND WORD PROCESSING

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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To Toby
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CHAPTER I

LITERATURE REVIEW AND STATEMENT OF THE PROBLEM

During the last century in experimental psychology, one particular set of phenomena has enjoyed almost constant popularity. It began with the work of James McKeen Cattell (see Cattell, 1886) under Wilhelm Wundt and blossomed into a fruitful line of research, including the famous work of J. Ridley Stroop (1935). The fundamental differences in the cognitive processing of words and of nonlinguistic stimuli such as pictures, colors, and objects have proven to be so intriguing that this line of research still receives constant attention in the literature. In fact, MacLeod (1992) and Bruce and Bahrick (1992) have reported that Stroop's (1935) classic article is one of those most frequently cited in experimental psychology. In keeping with that tradition, a goal of the current studies is to investigate fundamental differences in the ways words and nonlinguistic stimuli access information in permanent memory.
In his doctoral dissertation, James McKeen Cattell (see Cattell, 1886) demonstrated that subjects require more time to name a list of pictures or colors than they do to read a list of the corresponding words aloud. Thus, naming a picture of a star takes longer than reading the word star. Cattell explained this phenomenon in terms of the association between a stimulus and its name. For a word, a very strong association accumulates over time, due to practice. For a picture or a color, the same kind of association does not build-up, because one does not practice naming colors and objects in the way that one practices reading words. As a result, reading becomes relatively automatic, while naming nonlinguistic stimuli requires more intentional effort. However, as the following discussion will demonstrate, the issue is far more complex than the solution suggested by Cattell.

THE NATURE OF THE LEXICON AND SEMANTIC MEMORY

A critical issue involved in understanding how words and nonlinguistic displays (e.g., pictures, colors) are interpreted and named concerns the extent to which those types of displays might have privileged access to certain types of information in permanent memory. The term "privileged access" is intended to mean that a particular
type of stimulus may activate specific information in permanent memory more quickly than another type of stimulus. However, it is not assumed that privileged access necessarily requires fewer steps for processing one type of stimulus than the other. In fact, a parsimonious model of picture and word processing may account for privileged access either by positing that processing is generally faster for a particular type of stimulus or by proposing that fewer steps are involved in processing that type of stimulus.

As will be discussed in more detail below, it has been suggested that nonlinguistic items (e.g., colors, pictures, objects) have privileged access to information in semantic memory, and words seem to have privileged access to information in the lexicon (Potter & Faulconer, 1975; Smith & Magee, 1980). It is the goal of the current experiments to address issues concerning privileged access to information in permanent memory for words and pictures, and to investigate the nature of associations among representations in permanent memory to which words and pictures might have privileged access.
The Structure of the Lexicon

The lexicon is generally conceived as an internal dictionary that exists as a part of permanent memory. It is viewed as containing information concerning the orthographic and phonological characteristics of a word, but not its meaning (see Johnson & Pugh, in press, for more detailed treatment of that point). Words are represented as entries within the lexicon, and it may be the case that associations, or links, exist between those lexical entries, and the nature of those links has been a topic of considerable study (Pattee, 1982; Fischler & Goodman, 1978; Fischler, 1977).

The organization of entries in the lexicon can be specified in terms as simple as predicting that associational links between lexical nodes would increase in strength as a function of the number of times two words have been paired in an individual's experience. Thus, the lexical representations of car and street might share a relatively strong associational link, because those two words would have occurred together frequently in one's experience. On the other hand, car and shoe might not be associated in the lexicon at all, because they are words that rarely, if ever, occur together.
The research of Pattee (1982) concerning the syntagmatic-paradigmatic shift (McNeill, 1966) in second-language learning indicates that some associations may be stored as lexical-lexical links in permanent memory. The syntagmatic-paradigmatic shift is the tendency for young children (e.g., under age eight) to change, with increasing experience with a language, from giving sequential word associations (e.g., GREEN-GRASS, SOFT-PILLOW, etc.) to giving responses that are the same part of speech as the target (e.g., GREEN-RED, SOFT-HARD, etc.). However, the issue is the extent to which these associations reflect links between lexical entries in the lexicon or between conceptual representations in semantic memory.

If the links involved in those associations are between the underlying conceptual (i.e., semantic) representations of those words, then even though a new name for that representation is acquired in second-language learning, the link reflected in a word association task involving the new name would still be the old conceptual association, and the data pattern would be the same as if the target were from one's native language. On the other hand, if the link reflected in word associations is between lexical entries, then the pattern
of word association data for the second language should reflect the same syntagmatic-paradigmatic shift, as the second language is acquired, as is evident in learning one's native language.

Pattee's (1982) data were clear. He used both English and Spanish word association tests for American college students learning Spanish as a second language. As students' experience with Spanish increased, there was no change in the tendency to give paradigmatic responses when the test was in their native English, but when the test was in Spanish, there was a significant increase in their tendency to give paradigmatic responses. That suggests that these word associations reflect links within the lexicon, rather than conceptual relationships within semantic memory. Thus, lexical-lexical links may actually exist, and an important issue involves the types of associations they might represent, such as semantic associations (i.e., items from the same category such as CAR-TRUCK) or nonsemantic associative relationships (i.e., spatial-temporal associations; e.g., CAR-STREET).

Pattee's (1982) observations are relevant to the current studies, because Lupker (1979) has demonstrated in a picture-word interference task that distractor words which are nonsemantic associates (e.g., CAR-STREET, LADY-
DRESS) of a picture do not interfere with picture naming, relative to distractor words that are unrelated to the picture target, but semantic associates do interfere with picture naming. Those results indicate again that there may be an important qualitative difference between nonsemantic associative relationships that are based upon spatial-temporal contiguity (i.e., different-category associations; e.g., CAR-STREET) and semantic relationships that can be defined in terms of an overlap in meaning between two items (e.g., same-category associations between items that share semantic features like LADY and WOMAN).

However, semantically related items can share a nonsemantic associative relationship as well, and vice versa. For example, BREAD and BUTTER are semantically related, because they are both members of the category FOOD. In addition, they share a certain nonsemantic relationship—-one of spatial-temporal contiguity—pertaining to spreading one (i.e., BUTTER) on the other (i.e., BREAD). Of course, if pictures do have privileged access to information in semantic memory, then Lupker’s results may indicate that information about nonsemantic, associative relationships, such as spatial-temporal contiguities, may not be contained in semantic memory at
all. In fact, they might only be stored as lexical-lexical links, and Pattee's (1982) data lend support to that notion.

Overall, then, the notion that information may be stored as associations in the lexicon is supported by the research of Pattee (1982). However, questions concerning the nature of those associations remain open, and one goal of the current project was to address that issue with respect to whether nonsemantic, associative relationships might be stored as lexical-lexical links in permanent memory.

The Structure of Semantic Memory

Another critical matter concerns the organization of semantic memory. According to the theory of Collins and Loftus (1975; see also Quillian, 1968), access to information about concepts and their exemplars in semantic memory occurs through a spreading-activation from an initial node to nodes that are connected with it, and that activation decreases in strength as a function of the distance a given node is from the node that was activated initially.

Collins and Loftus (1975) proposed that the arrangement of concept nodes in memory is governed by a
hierarchy. The highest level in the hierarchy might be considered a superordinate-level concept. Thus, ANIMAL might represent a high-level node, and stored at that node would be information about the typical features of an animal, such as that it breathes oxygen, has skin or some similar external covering (e.g., scales), and eats food. Linked to that high-level node would be a lower level of nodes, called the basic level, which would represent classes of animals, like BIRD and FISH, and stored at each of those nodes would be information specific to those classes. Likewise, those nodes would be linked to a lower level in the hierarchy where exemplar information (i.e., specific types of birds and fish) would be represented, and that level is called the subordinate level.

According to Collins and Loftus (1975) the amount of time required to verify a proposition about the characteristics of a concept should vary as a function of the distance in the hierarchy between the needed information and the concept node which was initially activated. If the information is stored at that node, then verification should be relatively rapid, but if the information is stored at another location, then more time should be required to verify the proposition, because a longer distance would have to be traversed in the
hierarchy before the information is reached. Thus, one should be able to verify quickly that an animal has skin, because such information would be stored at the ANIMAL node. However, one should require more time to verify that a bluebird has skin, because that information is not stored at the BLUEBIRD node, but is stored at the more distant ANIMAL node.

Collins and Loftus (1975) accounted for differences in reaction times for verifying different propositions by taking semantic distance (i.e., the distance from one node to another) into account, but they also considered semantic relatedness. Not only does the distance from one node to another determine the amount of time required to verify a proposition, but also the number of links between those two nodes affects the verification time. If many links connect two nodes, then spreading activation will occur faster from one node to the other, than if the nodes were connected by just one link. Thus, verification times should be shorter in the former condition. Unfortunately, Collins and Loftus did not operationally define semantic distance or relatedness, and that limits the testability of their conceptual arguments.

In the current set of experiments, a critical issue concerns whether associative relationships and semantic
relationships are both stored in semantic memory. Theoretically, links could exist in semantic memory between nonsemantic associates (e.g., CAR-STREET, LADY-DRESS), and that has been suggested by Collins and Loftus (1975), although it was not included in the initial theory of spreading-activation set forth by Quillian (1968). However, that would lead to the prediction that pictures would have privileged access to that information, relative to words, because pictures presumably access information about their meanings (i.e., in semantic memory) faster than do words (i.e., pictures are categorized faster than words, Potter & Faulconer, 1975; Smith & Magee, 1980). Unfortunately, that prediction has not been supported by the data (Lupker, 1979), and those empirical observations will be discussed in more detail below (i.e., pp. 17-55).

It should be noted that Collins and Loftus' (1975) conceptualization of the organization of information in semantic memory is not the only one that is possible. A potential problem with their approach is in specifying the location at which a particular fact is stored. According to their theory, "has skin," "breathes oxygen," and "eats food" are all features which are stored at the concept node for ANIMAL and not at lower nodes. That being the
In this case, information about those features should be directly accessible if the ANIMAL node is activated.

A critical issue with regard to the ways in which pictures and words access semantic memory is whether the notion of spreading-activation is supported by empirical findings. One effect that is predicted by the theory of spreading-activation is that typical items of a category should be identified faster than atypical items, regardless of whether the stimuli are pictures or words. That is due to the fact that, within the context of a spreading-activation network (see Collins and Loftus, 1975), there would be a shorter semantic distance (and higher semantic relatedness) between a typical exemplar and the category node than between an atypical exemplar and the category node in semantic memory.

As will be discussed in more detail below, effects of the taxonomic frequency of category exemplars have been observed by Nogaboam and Pellegrino (1978). They asked subjects to verify whether a picture or word was a member of a predesignated category. Subjects identified category members significantly faster when they were exemplars of high taxonomic frequency than when they were category members of low taxonomic frequency. If one presumes that, in general, exemplars of high taxonomic frequency are also
the most typical exemplars of a category, then Hogaboam and Pellegrino's observations are like typicality effects and, as a consequence, are consistent with the notion of spreading-activation.

However, Lupker (1979) did not observe typicality effects in a picture-word interference task. Instead, he reported that distractor words from the same category as the target picture produced the same amount of interference with picture naming, regardless of whether the distractors were typical or atypical members of the category. Given the contradiction between Hogaboam and Pellegrino's (1978) results and those of Lupker (1979), the issue of typicality effects in picture processing remains unresolved, and that will be discussed in more detail below. The reason typicality is a relevant issue in this context is that the Collins and Loftus (1975) theory has been incorporated into one particularly important model of picture and word processing (i.e., the model of Glaser & Glaser, 1989), and, thus, has implications for theoretical accounts of picture-word processing differences.

Collins and Loftus' (1975) notion of spreading-activation is not the only theory of semantic memory, and an alternative theory of semantic memory might be better
suited for incorporation into a theory of word, color, and picture processing. Smith, Shoben, and Rips (1974) theorized that the meaning of a concept is represented as a list of features which define its fundamental traits. Thus, BIRD might be represented by "has wings," "can fly," "lays eggs." Smith et al.'s (1974) theory was designed primarily to account for a phenomenon with which spreading-activation theory had difficulty: the foregoing typicality effect. Spreading-activation theory had to place different exemplars of a concept at different distances from the concept node (i.e., in semantic memory) in order for spreading-activation to reach typical members first, thereby accounting for typicality effects.

Since that is a rather ad hoc method of accounting for the typicality effect, Smith et al. (1974) proposed a different solution. Exemplars are identified as members of a category according to the number of overlapping features they share with the category concept. Since typical members have more overlapping features than atypical members, they should be identified faster.

Unfortunately, Smith et al.'s (1974) theory is extremely limited. Since it identifies associated items on the basis of overlapping features, it is unclear how it accounts for comparison of exemplars from certain
categories for which it is difficult to identify defining features (i.e., fuzzy concepts). For example, the category FURNITURE is difficult to define. Some articles, such as chairs and sofas, are designed specifically to sit on, but other members of the category, like lamps, do not support that function.

In order to account for the fuzziness of some concepts, Rosch and Mervis (1975) proposed a prototype view of semantic memory. In particular, concepts in semantic memory are organized around an example which summarizes the most typical features of a concept's exemplars. That central example is the prototype, and the similarity of a stimulus to that prototype determines the category membership of the item. Thus, the amount of time a subject requires to identify an item as a member of a category is a reflection of the match between that item and the prototype, and presumably that provides a means for indexing the "prototypicality" of a given exemplar (see Rosch and Mervis, 1975).

For prototype theory, the inability of a subject to name the defining features of a concept is not a problem, because prototypes are based upon the most typical, but not necessarily defining, features of a category. In addition, prototype theory accounts for typicality effects
quite easily. The more similar an exemplar is to a concept's prototype, the faster it will be identified as a member of that category.

Unfortunately, prototype theory also has flaws. The prototype is like a measure of central tendency for category exemplars, but Barsalou (1985) has demonstrated that some categories are organized around ideal properties, not central properties. For example, DIET FOODS are not defined by some average number of calories; instead, that concept is organized around an ideal, i.e., zero calories.

Another flaw in prototype theory is that it does not account for context effects in classification. Some exemplars are better examples of a category in particular contexts, but not in others. For instance, MITTEN is a good example of CLOTHING in the context of a blizzard, but not at the beach.

Finally, a prototype theory does not account for how well items "hang together" as concept exemplars. That notion is called the "coherence" of the category (Murphy & Medin, 1985). According to a prototype theory, there is no basis for extracting coherence from category structure. As long as a prototype can be constructed, there is no way to define one category as more coherent than another.
However, one could argue that coherence is indexed by the relative ease with which one can construct a prototype.

Overall, then, there are many theories of semantic memory that could be considered within the context of the current discussion. One goal is to describe the ways in which pictures and words activate information in permanent memory. That indicates a need to consider different theories (of the organization) of semantic memory. As was mentioned previously, the theory of Collins and Loftus (1975) is of particular interest, because Glaser and Glaser (1989) have incorporated it into their model of picture and word processing.

Moreover, when one considers that pictures might have privileged access to information in semantic memory, as has been suggested by Smith and Magee (1980) and as will be discussed in more detail below, then it becomes pertinent to ask what might be the nature of that privilege. The following discussion will address issues concerning the organization of various types of associations in permanent memory.

STATEMENT OF THE PROBLEM

As was explained above, previous research raised issues concerning the cognitive processing of words and of
nonlinguistic stimuli. Cattell's (1886) ground-breaking research was followed by work indicating that words have privileged access to information in the lexicon and that nonlinguistic items have privileged access to information in semantic memory (e.g., Hentschel, 1973; Potter & Faulconer, 1975; Smith & Magee, 1980). If that is true, then it becomes necessary to define the nature of such privilege by specifying the types of information that are activated in the initial cognitive processing of words and of colors/pictures. In addition, a fundamental concern of the current studies is in specifying the nature of associations between entries in the lexicon (i.e., to which words presumably have privileged access) and of associations between concepts in semantic memory (i.e., to which pictures presumably have privileged access).

Previous Research

Critical issues concerning cognitive processing of words and of nonlinguistic stimuli have been set forth in research on the Stroop effect (Stroop, 1935) and picture-word interference (Hentschel, 1973). Within the context of these issues, the two prevailing paradigms are naming and categorization. Presumably, in the simplest cases, naming requires lexical access, and categorization requires
activation of information in semantic memory. However, in some cases that supposition may not be true, because it may be possible to categorize pictures and objects on the basis of visual similarity without activating information about their meanings (Snodgrass & McCullough, 1986).

Naming Paradigms

Traditionally, naming paradigms have been utilized to investigate basic differences in processing between words and nonlinguistic stimuli, and, in general, they were adopted from Cattell (1886). Early research that followed Cattell's focused more on the word-color distinction than on the word-picture difference. Brown (1915), Woodworth and Wells (1911), Garrett and Lemmon (1924), and Lund (1927) revised Cattell's task in order to address questions such as how practice affects the speed of color-naming. The most famous adaptation of Cattell's paradigm was Stroop's (1935) interference task which revealed different effects of incongruent words on color naming than of incongruent colors on word reading.

In his first experiment, Stroop (1935) demonstrated that when subjects were asked to read a list of color names printed in incongruent ink colors there was no interfering effect of the ink colors. He compared that
condition to one in which subjects read the same color names printed in black ink instead of colored ink. MacLeod (see MacLeod, 1991) has recently replicated those results and the difference in latencies between the two conditions was not statistically significant.

In his second experiment, Stroop (1935) reported that when subjects viewed color names printed in incongruent ink colors and were required to name the ink colors, rather than reading the color names, they had great difficulty. Often, they would accidentally read the words, instead of naming the ink colors. In fact, they were much slower in that condition than they were when they simply had to name the ink colors of colored patches, with no conflicting color names present. MacLeod (see MacLeod, 1991) has also replicated those results, and reported that the difference between color-naming latencies in those two conditions was statistically significant.

Like Cattell (1886), Stroop (1935) proposed that his observations were evidence for an influence of practice on reading that does not also benefit color naming. In fact, in his third experiment, he observed that the interfering effects of color names upon ink-color naming decreased with extended practice (i.e., eight days). He proposed that a word has only one possible name, but that an ink
color has several possible labels which might readily be applied to it. For example, a red patch of ink might readily be labelled, "color," "red," "crimson," or "scarlet," but the word red specifies its own label. Thus, according to Stroop, the facts that ink colors have multiple potential responses and that one practices reading words far more often than naming ink colors both explain the Stroop phenomenon.

It was not until quite a few years later that the same kind of effect Stroop (1935) had demonstrated for colors was observed for pictures as well. Hentschel (1973) presented line drawings with words embedded in them and asked subjects to name the drawings. He observed that incongruent words interfered with picture naming, but that there was also a slight interference of incongruent pictures with word reading. More recent studies have demonstrated that the latter effect is not statistically reliable (Rosinski, Golinkoff, & Kukish, 1975; Smith & Magee, 1980; Glaser & Glaser, 1989).

Hentschel's (1973) results indicated that picture naming might be subject to the same kind of interference from incongruent words as color naming. If that were true, then it might also be true that the initial encodings of colors and pictures are more similar to each other than
they are to the initial encodings of their respective color names and picture names. In fact, it may be that the initial cognitive representations of colors, pictures, and objects are semantic (i.e., meaning-based), while the initial cognitive representations of words are lexical (i.e., a cognitive representation of the word which contains both orthographic and phonological information) (Pellegrino, Rosinski, Chiesi, & Siegel, 1977; Seifert & Johnson, in press).

Hentschel's (1973) picture-word task was adopted by Rosinski, Golinkoff, and Kukish (1975), who proposed a substantial semantic component to picture-word interference, because of greater interference of incongruent words on picture naming than of pronounceable nonwords on picture naming. They employed words and also nonwords which rhymed with the names of the words. In that way, they could rule out the effects of phonological dissimilarity between words and nonwords on picture naming. They observed that words interfered more with picture naming than nonwords and concluded that this was because of a greater semantic component in the interference of words with picture naming than in the interference of nonwords with picture naming.
However, that is not the only potential explanation for Rosinski et al.'s (1975) results. It is conceivable that words interfered with picture naming, because they were activated in the lexicon during the interval when the subject was also attempting to access the name of the picture in the lexicon. Thus, two names would be activated in the lexicon, and the subject would have difficulty choosing between them. On the other hand, when nonwords are employed as distractors, they may not activate any words in the lexicon. If there is no lexical access for nonwords, then there would be no other lexical representation to compete with the name of the picture when it is activated.

Another way of considering the issue of lexical access for low and high frequency words involves a distinction between assembled and addressed phonological representations (Patterson & Coltheart, 1987; Patterson, 1982). It is conceivable that a word of high cultural frequency might interfere more with picture naming than a low frequency word. If lexical access is slower for less familiar words, then that might be due to the fact that the phonological representation of a high frequency word would be addressable, and that would allow its lexical representation to become available very quickly. Thus, it
would have more of an opportunity to interfere with picture naming.

On the other hand, the phonological representation of a low frequency word might not be directly addressable, but instead, would be assembled. That would indicate that more time would be required to activate the lexical entry for the word. Thus, the phonological representation would have less of an opportunity to interfere with picture naming.

Subsequent to Rosinski et al.'s (1975) work, Rosinski (1977) investigated the interference effects of same-category and other-category words on picture naming. Using a picture-word task, Rosinski observed that word distractors which name exemplars from the same category, but which were not the same item as the picture target, interfered more with picture naming than word distractors which named exemplars of other categories. For example, the word cat embedded in a picture of a dog would interfere more with picture naming than would the word desk embedded in the same picture. That research led many experimenters to theorize that any word which is semantically related to a picture, but that is not the picture's name might interfere with the naming of that picture.
That might occur, because the semantic associate would be activated in semantic memory at the same time as the target item, and that might be a possible source of interference. Also, both the name of the associate and the name of the target would be activated in the lexicon and could compete for production as the naming response. Consequently, latencies would be slower than if the target had been presented alone or with an unrelated item. Distractors that are unrelated to the target should not interfere with picture naming in that way, because they would not produce enough activation in semantic memory to, in turn, activate the entry for the distractor in the lexicon.

Smith and Magee (1980) suggested that pictures have privileged access to semantic information, while words have privileged access to lexical information. Subjects were asked to name lists of pictures, lists of words, and lists of pictures which had incongruent words printed in the middle of them (i.e., the name of an exemplar from a different category). Reaction times were measured as the amount of time a subject required to name all the items on a list.

Word reading was significantly faster than picture naming, with picture naming on the picture-word lists
being significantly slower than response times for any other type of list. Also, there was no significant difference between reaction times for word reading on word-only lists and word reading on picture-word lists. All of those results support the hypothesis that words have privileged access to lexical information.

The Role of Semantic Relationships and Related Effects

In addition to naming, Smith and Magee (1980) performed a study in which pictures and words were categorized. They presented subjects with the same types of lists (i.e., picture lists, word lists, and picture-word lists) and asked them to respond "yes" or "no," depending upon whether each target was a member of a predesignated category. Smith and Magee observed that response times on picture-only and word-only lists were not significantly different, and they theorized that this might have been due to the extremely high prototypicality of their exemplars. The rationale for that hypothesis was that previous authors had found picture categorization to be significantly faster than word categorization with stimuli that were less typical exemplars of particular categories (See Hogaboam & Pellegrino, 1978).
However, the discrepancy between Smith and Magee's (1980) results and Hogaboam and Pellegrino's (1978) may arise from differences in their experimental procedures. In the former case, subjects responded verbally (e.g., "yes" and "no"), and that would presumably require verbal mediation via the lexicon. In the latter case,keypress responses were utilized, and that may not have required verbal mediation (i.e., no activation of the lexical entries for "yes" and "no"). As a consequence, if pictures do have privileged access to information in semantic memory, it may have been concealed by extra time spent accessing the lexicon in Smith and Magee's task.

In the same series of studies, Smith and Magee (1980) observed that inconsistent pictures can significantly interfere with the categorization of words. Word categorization on those interference lists was significantly slower than categorization on any other list. Smith and Magee argued that those results supported their supposition that pictures have privileged access to semantic information.

Given the aforementioned observations (i.e., Smith & Magee, 1980), it might be of interest to investigate whether the strength of the semantic relationship between a target picture and a distractor word could influence the
degree to which the distractor would interfere with naming the target. If one assumes that semantic information is activated simultaneously when a target and distractor are processed at the same time, then one might expect interference from semantic associates (i.e., that are distractors) whenever information about a concept is activated in semantic memory. The concept node in semantic memory that represents the meaning of the target picture would be activated, and the concept node for the words meaning might also be activated. Those concept nodes would be conceptually linked, and if they were activated at the same time, their lexical representations might also be activated. Those activated lexical entries could, in turn, compete for priority in the production of a response. However, that assumes an automatic activation of a word’s meaning.

Interference in a traditional Stroop color-naming task does appear to be influenced by the semantic relationship between the target color and the distractor words. A semantic distance effect has been observed, with incongruent color names producing the most interference, color associates (e.g., lemon, fire, grass) producing slightly less interference, and unrelated words producing little or no interference (Klein, 1964). However, as was
mentioned previously, a semantic distance effect was not observed by Lupker (1979) in a picture-word interference task.

Lupker (1979) asked subjects to name the pictures in a list of picture-word stimuli. He observed that distractor words which are from the same category as the target (i.e., semantic associates of the target) produce significantly more interference than unrelated words, and those data are consistent with the previous reports of Rosinski (1977). However, Lupker also reported that it did not matter whether the same-category distractors were typical or atypical members of the category; both typical and atypical exemplars produced the same amount of interference on picture naming.

Since Lupker (1979) did not observe a semantic distance effect in the picture-word task, it could be argued that all information in semantic memory which pertains to category membership is directly accessible. If that were true, then all the information about all of the exemplars of a category might become available immediately upon activation of the concept node for that category in semantic memory. That would suggest that the representations are categorical, rather than nodes in a quasi-Euclidean space.
As mentioned above, Hogaboam and Pellegrino (1978), on the other hand, had previously reported that subjects require more time to verify that a word or picture belongs to a predesignated category when it is of low taxonomic frequency within a category than when it is of high taxonomic frequency. Since typicality and taxonomic frequency are usually positively correlated, it seems that Lupker’s (1979) data are inconsistent with Hogaboam and Pellegrino’s. That being the case, it is still uncertain whether all the information about category membership in semantic memory becomes available immediately upon activation of the concept node for a particular category.

One way of accounting for the difference between Lupker’s (1979) results and Hogaboam and Pellegrino’s (1978) data may be in terms of the extent to which the tasks they used engaged information in semantic memory explicitly or implicitly (Schacter, 1992), and that might be as simple as distinguishing between tasks that require volitional activation of information in semantic memory and tasks that do not. Since Lupker’s task required that subjects name pictures with distractor-words embedded in them, information in semantic memory might have been activated in an implicit manner, rather than through an explicit (i.e., volitionally-executed) search of semantic
memory. On the other hand, Hogaboam and Pellegrino (1978) specifically asked subjects to verify whether a picture or word was a member of a predesignated category, which probably requires an explicit search of relevant information in semantic memory.

In addition, it could be argued that the explicit case might be less immune to contamination from consciously invoked search strategies. Subjects would consciously attempt to locate specific information in semantic memory and they might employ any number of intentional strategies in order to locate the information. In such cases, experimental observations might reflect the influences of those intentional search strategies on semantic memory, rather than the naturally occurring organization of semantic memory. Thus, the explicit case might yield a distorted view of semantic memory.

In the set of studies discussed above, Lupker (1979) also reported that associates which were members of a different category than the target (e.g., LADY and DRESS) produced no more interference with picture naming in a picture-word task than did unrelated words. However, members of the same category do produce interference in picture naming relative to unrelated words (Rosinski, 1977). This indicates that the initial semantic encoding
of a picture may include only limited information, such as category-membership, but not any of the nonsemantic associates of the item.

In summary, Lupker's (1979) observations suggest that semantic relationships between items are important in determining performance in the picture-word interference task, but the strength of such relationships may be irrelevant. In addition, nonsemantic, spatial-temporal associations may not play an important role in picture-word interference, because nonsemantic associates produce no more interference than words unrelated to the target picture. That latter observation may indicate that information about nonsemantic, associative relationships may not be directly accessible in semantic memory or, perhaps, it is not contained there at all, but is, instead, contained within the lexicon as lexical-lexical associations.

However, if nonsemantic associations are represented as lexical-lexical links (i.e., in the lexicon), then one might still expect enhanced interference on picture naming from distractor words that are nonsemantic associates of the target. Picture naming would require activation of the lexical representation for the target in order for a response to be produced, and presumably, the distractor
word would also activate its lexical representation. Consequently, the two would compete for priority with respect to the naming response, and interference from that competition might increase as a function of any associations that exist between the two lexical entries.

The whole notion of competition complicates interpretation of picture-word naming data in terms of the organization of information in semantic memory. If naming requires lexical access, then any interference of distractors with picture naming or reading must be interpreted in terms of both the possibility that associations in semantic memory, as well as links between entries in the lexicon, might be responsible. In fact, those associations may only be a part of the whole story, since interference effects may also be influenced by input phenomena (e.g., perceptibility of stimuli; Theios & Amrhein, 1989) and output phenomena (e.g., verbal response competition due to targets and distractors vying for vocalization resources; see MacLeod, 1991).

Direct Access to Semantic Memory for Pictures: Counterindications

As was suggested by the previous discussion, much of the research on the cognitive processing of pictures and
words has yielded results supporting the notion that pictures have privileged access to information in semantic memory. However, the crucial evidence is conflicting. Snodgrass and McCullough (1986) proposed that the advantage for pictures in categorization tasks is the result of higher visual similarity for pictures that belong to the same category than for pictures which belong to different categories. High visual similarity for pictures from the same category could provide an aid to subjects in classification tasks, and, in fact, that may indicate a means by which pictures could have privileged access to information about category membership. Words, on the other hand, are all somewhat visually similar, regardless of whether they name items from the same category or not. Of course, some words are unavoidably similar in both meaning and appearance, like words that share the same stem (e.g., symbol and symbolic; Carr, McCauley, Sperber, & Parmalee, 1982).

In order to address this issue, Snodgrass and McCullough (1986) manipulated the visual similarity of picture stimuli in a categorization task. They varied the extent to which items from the same and from different categories were visually similar. Interestingly, they observed a reversal of the advantage for pictures when
exemplars from different categories were visually similar. Presumably, when picture stimuli are no longer visually distinct from one category to another, then subjects cannot categorize pictures faster than words, because they can no longer use visual features as the basis for categorizing the pictures.

That being the case, subjects must access information in semantic memory in order to categorize pictures, as well as words. Since the advantage for pictures is reversed under those conditions, it might indicate that pictures do not have privileged access to semantic information. Alternatively, words might actually enjoy that privilege. In fact, neither of them may have privileged access to semantic memory, as has been suggested by Theios and Amrhein (1989).

At the very least, those results complicate the notion that picture and word categorization tasks necessarily lead to insights about access to semantic memory. If visual features play an important role in categorization, then it is unclear to what extent performance on such tasks relies upon access to semantic memory.

Snodgrass and McCullough’s (1986) research indicates that categorization of pictures may be determined by
comparisons between the visual features of a stimulus and some representation of those features in memory (Snodgrass & McCullough, 1986). However, it is unclear whether that comparison involves a representation of those features as images in memory and/or as semantic features, because there may be a great degree of overlap between semantic features (e.g., as they have been described by Collins & Loftus, 1975) and the visual features of a picture. For example, a semantic feature of the category BIRD might be "has wings," but certainly that is also a visual feature of a picture of a bird.

However, Job, Rumiati, and Lotto's (1992) observations contradicted the Snodgrass and McCullough (1986) study. They repeated Snodgrass and McCullough's investigation and observed that items from categories whose exemplars are visually similar require significantly more time to categorize than do items from categories whose exemplars are visually dissimilar, regardless of whether the targets are pictures or words. That comparison is critical, because it indicates that the effect observed by Snodgrass and McCullough is not merely the result of perceptual comparisons of pictorial features in the early stages of processing. Instead, both the visual similarities between exemplars (e.g., apples and potatoes
resemble each other), and their semantic similarities (i.e., apples and potatoes share semantic features like "has a peel/skin"), may have contributed to the effect.

Another potential explanation for Snodgrass and McCullough’s (1986) results is that the lack of visual similarity between items in the same category may have prompted subjects to adopt a more conservative response strategy. Thus, the effect may have been a result of a change in response strategy, rather than a change in subjects’ sensitivity to items from different categories. If that is the case, then Snodgrass and McCullough’s results would not necessarily address the issue of whether pictures have privileged access to information in semantic memory.

Another argument against pictures having privileged access to information in semantic memory has been made by Haase and Theios (1992). They employed a task in which subjects were required to categorize words and pictures represented by corporate names and their logos, respectively (i.e., categorizing on the basis of what those companies sell or produce). They reported that corporate names were categorized faster than logos, but that there was also a confound between type of stimulus and stimulus familiarity (i.e., words being more familiar
than logos). When they re-analyzed the data, statistically removing the effect of familiarity, there was no significant difference between word and picture classification. Haase and Theios argued that those data are consistent with a model of cognitive processing which posits no difference in the time required to categorize pictures and words.

One might argue that this result is to be expected if one considers the nature of the pictorial stimuli Haase and Theios (1992) utilized. Corporate logos are, in a sense, quasi-symbolic. That is, they represent a particular company or business in much the same way that a word like dog represents a furry, four-legged mammal that barks. The relationship is largely an arbitrary one. Thus corporate logos are much like words that arbitrarily represent objects and unlike real pictures, which are non-arbitrary representations of real-world objects. Consequently, when controlling for familiarity, Haase and Theios should have found no difference between word and picture classification, because their "picture" stimuli were really pseudo-words.

Haase and Theios' (1992) categories may represent little more than "ad hoc" categories (Barsalou, 1983), and, as such, may not reveal much about how well-
established information is organized in semantic memory. Ad hoc categories are computed on-the-fly for use in special circumstances, such as "things to carry out of the house in case of a fire" or "places to visit on a trip to New York City." Barsalou (1983) has reported evidence that they are created spontaneously, and as such, are not well established in permanent memory.

In the first phase of Haase and Theios' (1992) study, subjects studied corporate names and logos in order to become familiar with them. The fact that this was necessary prior to the categorization phase of the study suggests that the names of the companies and their logos were probably not well established in semantic memory prior to the experiment. In the second phase of that study, Haase and Theios asked subjects to categorize the stimuli in terms of whether they signified companies which produce or distribute certain products (e.g., gasoline, computers, food).

Since these were not stimuli with which the subjects were particularly familiar before the experiment, the categories may have been generated spontaneous by subjects in order to suit the task, e.g., "places I could go to buy gasoline." If that is true, then the categories were, indeed, ad hoc (Barsalou, 1983). Consequently, the
data may not be indicative of the organization of or access to information which is firmly established in semantic memory, but might instead represent the relative speed with which subjects can generate ad hoc categories on-the-fly when presented with various symbols (i.e., logos) or words.

Also, Haase and Theios (1992) and Theios and Amrhein (1989) have argued that the results from previous experiments indicating pictures have privileged access to information in semantic memory are potentially flawed, because researchers have not used picture and word stimuli that are equally perceptible. Specifically, Haase and Theios proposed that pictures are commonly of much lower spatial frequency than words, and that this enables subjects to identify them more quickly than words. As a result, they can categorize pictures faster than words.

However, if that is true, then it is puzzling that the benefit was exclusively for categorization tasks and neglectful of naming paradigms. If big pictures can be recognized faster than little words (Theios & Amrhein, 1989, p.6), then it is surprising that picture-naming performance did not benefit as well. Moreover, equating pictures and words in terms of perceptibility requires an implicit assumption that there is a way to equate them.
For example, the critical issue may not be the size of the display, but the size of the components. However, while letters may be the components of words, it is unclear what comprises the components of pictures. Furthermore, pictures and words may require very different stages and/or types of cognitive processing, and that implies that manipulating the sizes or visual angle of presentation of the stimuli does not necessarily indicate equal perceptibility of the items. In a sense, this is an arbitrary criterion for establishing equivalent perceptibility of pictures and words which may not reflect true equivalence.

It might be advisable to utilize conventional-size pictures and words (i.e., in which the words are approximately 10-pitch and the pictures are approximately 3 cm X 5 cm; see Hentschel, 1973). At least under those conditions, the picture-word interference task is more ecologically valid with respect to the stimuli utilized. One often encounters words that are 3mm-high in the real world, but not pictures that small. Indeed, such pictures are extremely difficult to discern, whereas words that size can be seen very clearly.

Overall, then, many previous researchers have suggested that pictures have privileged access to
information in semantic memory, because pictures are
categorized faster than words (Potter & Faulconer, 1975;
Smith & Magee, 1980; Glaser & Dunganhoff, 1984). However,
Theios and Amrhein (1989) and Snodgrass and McCullough
(1986) have questioned that assumption, and it is of
particular concern that the issues raised by Theios and
Amrhein remain unsettled.

Implications for a Theory of the Organization
of Information in Permanent Memory

Given Pattee's (1982) observations supporting the
notion that lexical-lexical links may exist in the
lexicon, and the well-documented observation that
nonsemantic associates do facilitate recognition of each
other in lexical decision tasks (Meyer & Schvaneveldt,
1971), it is possible that, as suggested above,
nonsemantic associations are word-word links between
entries in the lexicon, while semantic relationships are
represented by links between concept nodes in semantic
memory. On the other hand, as was noted previously,
information about nonsemantic associations may actually be
contained within semantic memory, but may not be directly
accessible. Instead, it may be computed on-the-fly as
needed. If that were true, then pictures would not have
privileged access to that information (i.e., relative to words), because it would not be contained within the initial encoding for such an item in semantic memory. For example, a subject might require just as much time to verify that pictures of CAKE and PLATE are related as to verify that the words *cake* and *plate* are related, because additional processing would be required after the initial access to information in semantic memory in order to access information concerning indirect links or relationships.

In a manner of speaking, the notion that some information in semantic memory is directly accessible (e.g., information about certain category memberships), while other information is computed on-the-fly as needed (e.g., information about nonsemantic associations) is similar to the idea that phonological representations can be either addressed or assembled. Perhaps, that type of conceptual distinction can apply to semantic memory as well. If it did, then one might conjecture that some relationships in semantic memory might be addressed (i.e., directly accessible), while other information is assembled (i.e., computed on-the-fly as needed). Of course, it should be noted that the two types of relationships previously discussed (i.e., nonsemantic associations like
CAR-STREET and semantic relationships like LADY-WOMAN) are not the only definable relationships between items. As discussed above, Barsalou (1983) described another type of relationship that is embodied in "ad hoc" categories, which are "created spontaneously for use in special contexts" (Barsalou, 1983, p.211).

In summary, then, most previous research suggests that pictures have privileged access to information in semantic memory, relative to words (see Glaser, 1992). As was discussed above, Snodgrass and McCullough's (1986) challenge to that argument is contradicted by the observations of Job, Rumiati, and Lotto (1992). However, the concerns of Theios and Amrhein (1989) have not been subjected to adequate empirical tests, and, therefore, remain unsettled.

Another critical issue is the manner in which information about nonsemantic, associative relationships is stored in permanent memory (e.g., SHOE-FOOT). The observations of Pattee (1982) suggest that information can be stored as links between entries in the lexicon, and previous observations that associates can prime lexical decisions (Meyer & Schvaneveldt, 1971) are consistent with that notion. Overall, then, it is not unreasonable to speculate that nonsemantic, associative relationships
could be stored as lexical-lexical links in permanent memory, and that is an important aspect of the current discussion.

Two Models of Picture/Word Processing

A theory of picture and word processing must account for the aforementioned phenomena. Specifically, it must predict an advantage for words over pictures in naming tasks and an advantage for pictures over words in categorization paradigms, and it must account for those phenomena by describing the manner in which differences in cognitive processing of words and pictures result in those effects. Recently, two different models have been devised to accomplish just that.

The model set forth by Theios and Amrhein (1989) posits an abstract, amodal semantic memory which is separate from the lexicon and from the "surface pictorial processor." Since semantic memory is amodal, Theios and Amrhein predict that neither pictures nor words have privileged access to it. A very different approach is presented by Glaser and Glaser (1989) who assert that imagistic/pictorial information and semantic information are all stored in semantic memory. Thus, Glaser and Glaser predict privileged access to semantic memory for pictures.
Theios and Amrhein's Model (1989)

Theios and Amrhein (1989) set forth an account of some of the aforementioned phenomena. They proposed a model of picture and word processing that includes a conceptual model and a system of linear equations that predict increments in latencies dependent upon processing demands. The conceptual model consists of an "early visual processing system" that encodes all visual stimuli in a very primitive form. Then, if the information is linguistic, it is transferred to a "surface linguistic processor" where the orthography, phonology, and articulatory codes for the word are activated, and lexical access is presumed to be automatic for words. If the stimulus is a picture, then information is transferred from the early visual processing system to a "surface pictorial processor" that recodes the information into an abstract, image-based form.

With regard to those mechanisms, an important issue concerns how the early visual processing system can determine whether to send information to the surface linguistic processor or the surface pictorial processor. Theios and Amrhein (1989) did not address that question, but the implication is that either the early visual processing system has the ability to differentiate words...
from nonlinguistic stimuli (e.g., pictures), or the surface linguistic and surface pictorial processors can actively select input compatible with their coding mechanisms. Overall, neither of those explanations is acceptable, because they both imply that words and nonlinguistic stimuli are differentiated at some point before they are recoded by the surface processors, and it is not clear how that would be accomplished if they have not yet been recoded into their respective lexical or image-based forms.

A possible alternative explanation is that the early visual processing system sends all information to both the surface linguistic processor and the surface pictorial processor. Presumably, that information would only be compatible with one of the surface processors, and the other surface processor would be unable to cope with it. Consequently, linguistic information would be processed by the surface linguistic processor, and pictorial information would be processed by the surface pictorial processor. Thus, no active selection process would occur. Instead, information would be recoded by the appropriate surface processor by virtue of the fact that the alternative surface processor could not cope with it.
With respect to picture processing, Theios and Amrhein (1989) have suggested that it involves an imagistic processor and a separate abstract, semantic processor. When a picture is being perceived, that may be true, because there is probably some early representation of the picture that preserves its visual features (i.e., imagistic). Then, only after that, would a more abstract representation of the picture become available in semantic memory.

According to Theios and Amrhein (1989), if the goal of a task is naming, then subjects can easily produce a response to a word, because the information available in the surface linguistic processor is sufficient to activate the appropriate articulatory codes in the speech production system. However, for a picture, the imagistic code available in the surface pictorial processor is incompatible with the speech production system. Consequently, the imagistic code must be recoded in the "abstract conceptual processor," and that will activate the meaning of the picture. After that, the semantic code(s) for the picture will be recoded in the surface linguistic processor, where it will activate the name of the item. As a consequence, the speech production system
will then be able to produce the appropriate naming response.

Theios and Amrhein (1989) have proposed that picture-naming requires more time than reading, because of the two additional steps in processing that are required for pictures (i.e., processing in the surface pictorial processor and in the abstract conceptual processor). They have also proposed that, because the abstract conceptual processor is separate from both of the surface processors (i.e., pictorial and linguistic), there should be no difference in the amount of time required to categorize pictures and words. They have suggested that any report of categorization differences is probably due to the failure of the experimenter to control the perceptual discriminability of the stimuli, and that would result in differences in the amount of time required to encode the stimulus in the early visual processing system.

To support their argument, Theios and Amrhein (1989) investigated the effects of manipulating the size and featural line width of pictures and words in naming and categorization experiments. They replicated the general observation that reading is faster than picture-naming, and they reported an interaction between stimulus type and stimulus size, indicating that smaller pictures may have
a disadvantage (Theios and Amrhein, 1989, Experiment 1). However, caution should be taken in interpreting those results, because Theios and Amrhein co-varied stimulus size and featural line width with stimulus plurality. That is, they used both singular and plural forms of words (e.g., circle and circles) and single and multiple displays of the same picture (e.g., "o" and "ooooooo").

In so doing, Theios and Amrhein (1989) may have gained equivalence in featural line width at the expense of conceptual equivalence. That is, because it is a word, circles may conceptually represent a single unitary stimulus pattern that subjects can process holistically (Johnson, 1991). On the other hand, a row of circles may conceptually represent several separate stimuli, and the subject may be forced to parse the row of shapes and process each individual shape separately.

Johnson and Blum (1988) have reported data to support that notion. They observed that subjects required more time to verify that a letter was present in a row of identical letters (e.g., "BBBBB") than when it was presented alone (e.g., "B"). That result suggests that, in the case of a row of identical letters, subjects were forced to parse the stimulus apart in order to cope with each of the individual letters, and that required more
processing time than when a stimulus letter was presented alone. That may also have occurred in Theios and Amrhein's (1989) experiment, and that is indicated by the fact that subjects required more time to name a row of shapes (i.e., 689 msec) than to name a single shape (i.e., 668 msec).

The same conceptual problem complicates interpretation of Theios and Amrhein's (1989) second study, which was designed to address the issue of perceptual discriminability within the context of a categorization task. Subjects were asked to respond whether two stimuli were the same or different. Items were presented sequentially, and presumably, conceptual processing would be involved when the two items were a picture and a word, because they would both have to be encoded in the abstract conceptual processor in order for a comparison to be made. Unfortunately, Theios and Amrhein only utilized the plural forms of words and pictures in that experiment, which raises the same concerns that were mentioned previously with regard to their naming study. Consequently, Theios and Amrhein's theory has not been tested adequately to be evaluated.

Glaser and Glaser (1989; see also Glaser, 1992) have also set forth a model of picture, color, and word processing. Unlike the model of Theios and Amrhein (1989), it emphasizes privileged access to semantic memory for pictures. However, like Theios and Amrhein (1989), Glaser and Glaser proposed that there is a functional distinction between semantic memory and the lexicon and, in fact, that they are "locationally separated" in the brain (Glaser & Glaser, 1989, p.30). They theorized that there is a subsystem of permanent memory which contains one's conceptual knowledge, and they labelled that subsystem semantic memory in order to distinguish it from the lexicon, which holds information about all the words or morphemes one knows, including information about the orthography and phonology, but not the meanings of words.

Glaser and Glaser (1989) proposed that semantic memory functions according to Collins and Loftus' (1975) theory of spreading-activation. That is, access to information about concepts and their exemplars in semantic memory occurs through a spreading-activation from an initial node to nodes that are connected with it, and that activation decreases in strength as a function of the
distance a given node is from the node that was activated initially.

Glaser and Glaser (1989) hypothesized that entries in both semantic memory and in the lexicon are represented by nodes. In semantic memory, the nodes are constrained by sets of semantic links which connect them to related concepts. Unfortunately, it is less clear exactly how items in the lexicon are arranged, as this is not specified by Glaser and Glaser. However, one might conceive of nodes in the lexicon as being connected by links which represent the frequency with which two words have been paired over time (i.e., the lexical-lexical, associative links discussed earlier). If that were true, then words, not pictures, might actually have privileged access to information about associational frequency, because it would be contained in the lexicon, and that specification for lexical-lexical links could be added quite easily to the model of Glaser and Glaser or the model of Theios and Amrhein (1989).

It should be noted that the existence of lexical-lexical links that represent nonsemantic, associative relationships might be consistent with the model of Glaser and Glaser (1989), but it is inconsistent with an underlying assumption about semantic memory made by
Collins and Loftus (1975). They suggested that, like semantic associations (e.g., SHOE-BOOT), nonsemantic relationships (e.g., SHOE-FOOT) might be stored in semantic memory. That is particularly important, because Glaser and Glaser integrated the spreading-activation theory of Collins and Loftus into their model. Thus, it would be necessary to add a caveat to Glaser and Glaser's model before asserting the existence of lexical-lexical associative links, and that could be as simple as stipulating that information about nonsemantic associative relationships is stored only in the lexicon, rather than being stored in semantic memory.

According to Glaser and Glaser (1989), each concept node in semantic memory is connected to the node which represents its name in the lexicon. These links are bidirectional, so that a word node can activate its meaning in semantic memory, and so that a concept node can activate its name in the lexicon. In addition, some mappings may be many-to-one or one-to-many, depending upon whether a name can represent more than one concept or whether a concept has more than one name. Of critical importance is the fact that Glaser and Glaser proposed that both semantic and imagistic/pictorial information are stored in semantic memory. Therefore, there was no need
for positing the existence of a pictorial processor separate from semantic memory, and that is very different from the separate pictorial processor (i.e., separate from semantic memory) proposed by Theios and Amrhein (1989).

In Glaser and Glaser's (1989) model, executive systems govern perception and action. They are like gates that control the flow of information in and out of (i.e., storage and retrieval) their respective memory systems (i.e., semantic memory and the lexicon). A semantic executive system administers the affairs of perceiving nonlinguistic stimuli (e.g., pictures, objects, colors) and of responding to them without the use of language (e.g., pressing a key or drawing a picture); and it is associated with semantic memory.

Two executive systems subsume the duties of perception and action associated with the lexicon. In particular, Glaser and Glaser (1989) have specified a graphemic subsystem and a phonemic subsystem. The former subsystem is responsible for perceiving visual stimuli (e.g., reading) and creating visual stimuli (e.g., writing) that involve the use of language. The latter subsystem is responsible for perceiving sounds (e.g., hearing speech) and producing vocal responses (e.g., speaking) which are linguistic.
The notion of executive systems set forth by Glaser and Glaser (1989) is not completely different from the suggestion of Theios and Amrhein (1989) that there are particular types of perception and action which are more consistent with one type of processing than another. For example, the latter authors proposed that reading and hearing speech are types of perception more consistent with lexical processing (i.e., their surface lexical processor) than with pictorial processing (i.e., their surface pictorial processor), and writing and speaking are types of action more consistent with lexical processing than pictorial processing. Overall, those views of perception and action are not inconsistent with Glaser and Glaser's notion of executive systems.

The critical predictions of the Glaser and Glaser (1989) model involve specific privileged pathways that run both within and between the various systems, and those pathways can be ranked in terms of the speed with which they operate. Pathway 1 is a simple one, consisting of the activation of one node in the lexicon. It is employed when one reads a word. Pathway 2 involves the activation of two nodes: one in semantic memory and one in the lexicon. It is employed when one names a picture.
Pathway 3 involves the activation of three nodes: two in semantic memory and one in the lexicon. It is employed when one names a higher-order category of which a picture is a member. First, the concept node for the picture is activated in semantic memory. Then, its activation prompts activation of the concept node for the category to which the picture belongs via the path that links those two nodes in semantic memory. Finally, activation of the concept node for the category prompts activation along the bidirectional pathway linking it to the lexical node representing the name of that category (i.e., in the lexicon). That enables the production of a naming response.

Pathway 4 involves the activation of four nodes: two in semantic memory and two in the lexicon. It is utilized when one names the category to which a particular word belongs. Initially, the lexical node for the word is activated in the lexicon. That prompts activation along the bidirectional pathway linking that lexical node with the concept node for that word in semantic memory. Once the corresponding concept node has been activated in semantic memory, it prompts activation of the concept node for the category to which that item belongs via the path linking those two concept nodes in semantic memory.
Finally, the concept node for that category can prompt activation of the name for the category in the lexicon via the bidirectional pathway that links them, and that makes the production of an appropriate verbal response possible.

Glaser and Glaser (1989) predicted that Pathway 1 would be executed faster than Pathway 2, thus accounting for the advantage of reading over picture and color naming, and that prediction is consistent with both their model and that of Theios and Amrhein (1989). In addition, Pathway 3 should be executed faster than Pathway 4, thus accounting for the advantage of pictures and colors over words in classification tasks, and that prediction is inconsistent with the model of Theios and Amrhein, because they proposed a separate amodal, semantic memory to which neither words nor pictures have privileged access. Overall, then, in the Glaser and Glaser model, an advantage for one type of stimulus over another is accounted for by different speeds with which various pathways are executed, and those speeds are affected by the number of nodes involved in processing.

When one reads a word, all processing should take place in the lexicon and its associated executive subsystems (i.e., Pathway 1 involving the lexicon and the graphemic and phonemic subsystems), because lexical access
would not require activation of information in semantic memory. However, when one names a picture, both semantic memory and the lexicon are involved, in addition to their respective executive systems (i.e., Pathway 2), because the meaning of a picture must be activated before its name can be determined. Thus, the model predicts that reading should be faster than picture/color naming, because reading involves activation of only one system (i.e., the lexicon) and of only one node within that system, but naming nonlinguistic stimuli involves utilization of both the lexicon and semantic memory (i.e., two nodes and two systems: the lexicon and semantic memory).

Picture classification requiring a verbal response would involve activation of three nodes (i.e., Pathway 3: two concept nodes and one lexical node), and it should be faster than word classification, because the latter involves activation of four nodes (i.e., Pathway 4: two nodes in the lexicon and two in semantic memory. That being the case, Glaser and Glaser’s (1989) model is consistent with much research, such as that of Smith and Magee (1980), but it is inconsistent with the experiments of Snodgrass and McCullough (1986) and Haase and Theios (1992). Finally, although Glaser and Glaser did not discuss the issue, it seems relatively simple to extend
the model to accommodate a classification task involving a keypress response (i.e., with keypress responses being mediated by semantic memory and produced by the semantic executive subsystem, rather than being mediated by the lexicon and produced by the phonemic executive subsystem).

Potential problems with the Glaser and Glaser (1989) model. While Glaser and Glaser’s (1989) model of picture, color, and word processing seems to be largely acceptable in terms of its account of the advantage for words over both pictures and colors in naming tasks, and with regard to its account of the advantage of nonlinguistic stimuli over words in categorization tasks, one might still have reservations about their conceptualizations of the lexicon and of semantic memory. First, Glaser and Glaser offered no specifications for the organization of items in the lexicon. Thus, it is entirely unclear whether lexical nodes are associated at all (i.e., connected by associational links) and, if they are associated, then by what means such links might have materialized.

Another potential problem with Glaser and Glaser’s (1989) model is their conceptualization of semantic memory. They have incorporated Collins and Loftus’ (1975)
theory of spreading-activation into their model of semantic memory. As was mentioned above, some important predictions about feature-verification effects for picture and word stimuli arise from the spreading-activation theory. However, Glaser and Glaser did not address those issues. In addition, as was mentioned previously, the Collins and Loftus (1975) proposal that nonsemantic associations are also stored in semantic memory may complicate an addition of lexical-lexical links that represent nonsemantic associations to the Glaser and Glaser model.

In conclusion, Glaser and Glaser's (1989) model does seem to provide a good general account of some basic phenomena regarding picture, color, and word processing. However, the incorporation of Collins and Loftus' (1975) spreading-activation theory into the model leads to additional predictions which Glaser and Glaser did not discuss (i.e., feature-verification effects for pictures and an advantage of pictures over words in feature-verification tasks). Moreover, they did not explicitly describe the manner in which they thought information was organized in the lexicon. As yet, they have not addressed those issues.
The Present Studies

The purpose of the present studies was to address two critical issues. The first concerns the influence of stimulus size on the advantage for pictures over words in categorization (see Theios & Amrhein, 1989), and the second concerns the potential existence of lexical-lexical links in permanent memory that might represent nonsemantic, associative relationships. However, before conducting any experiments on the nature of the representation of information in permanent memory, it was necessary to determine the higher-order category label subjects most commonly associate with a given stimulus (i.e., picture or word), and that was the goal of the first experiment. Presumably, those normative data indicate the higher-order category most strongly associated with an item in permanent memory, and they will alleviate doubts as to whether the current studies have tapped into permanent memory, rather than into problem solving strategies for constructing ad hoc categories on-the-fly.

The issue of categories being well established in permanent memory is important, because, as was mentioned previously, one potential problem with the work of Haase and Theios (1992) is that the categories utilized in their
categorization task may be ad hoc categories, constructed spontaneously by subjects for use in that study. That being the case, Haase and Theios’ data may not present a true picture of the representation or activation of information in semantic memory. Instead, the results may be more indicative of subjects’ strategies for constructing ad hoc categories and using information in episodic memory.

As was mentioned above, another critical issue is Theios and Amrhein’s (1989) concern about differences in the perceptual discriminability of large pictures and small words which are typically employed as stimuli in picture-word interference tasks, and that issue has particular significance for models of picture and word processing. They attempted to settle that issue by determining the optimal visual angle of presentation for pictures and words in a naming task. They varied the sizes of items presented on a computer screen and compared subjects’ latencies for items of different sizes. Based upon their observations they proposed that a picture or word should subtend a visual angle of at least 3 degrees in order for all stimuli to be equally perceptible.

As previously noted, the problem with such a criterion for equivalent perceptibility of pictures and
words is that it is essentially arbitrary, because cognitive processing of pictures probably does not involve exactly the same stages in the same sequence as cognitive processing of words. Instead of comparing latencies for one size picture to latencies for another size word, it would seem more reasonable to compare latencies for many different sizes of pictures to each other and latencies for many different sizes of words to one another. In that way, a function could be plotted to describe the change in response rates for one type of stimulus (i.e., either pictures or words) as the size of the stimulus is manipulated. The asymptote of such a function would indicate the optimal size of a stimulus. Delineating such functions for pictures and words in naming and classification tasks, and identifying the size of an item that produces the most efficient processing, were the goals of the second study.

Experiment 2 was conceptually similar to the first experiment reported by Theios and Amrhein (1989). Subjects either named or categorized pictures and words of various sizes. However, the second study in the current set employed only single pictures and single words as stimuli, as opposed to the rows of identical pictures that Theios and Amrhein presented. In addition, in the current
studies, two-dimensional line-drawings of real three-dimensional objects were utilized in order to ensure that picture stimuli were not arbitrary representations of real-world objects.

The third experiment was much like Experiment 1, except that the objective was to norm stimuli for nonsemantic associations, rather than semantically-based associations. The goal was to devise stimuli for the fourth and final experiment, and it was necessary to compose two lists of item pairs: 1) a list of pairs that share semantic associations (i.e., sharing a common category membership) and 2) a list of pairs that do not share semantic associations, but do share nonsemantic associations (e.g., CAR-STREET). The former list could be drawn from items normed in the first experiment, but the latter could not. Thus, the third experiment required subjects to perform either a picture-association or word-association task by writing down the name of a noun related to each stimulus item. Thus, Experiment 3 provided a pool of nonsemantic-associate pairs from which stimuli for Experiment 4 could be drawn.

The fourth experiment investigated whether semantic memory contains information about category membership, but not information concerning nonsemantic associations (e.g.,
CAR-STREET), and that issue is particularly important for models of picture and word processing. As was mentioned previously, Pattee's (1982) research suggests that some associations might be represented in long-term memory as lexical-lexical links, and additional evidence that such links exist might suggest needed changes in models of picture and word processing. In order to investigate that notion, subjects in the fourth study were asked to make verification judgments about whether two items (i.e., either two words or two pictures) were related to one another (i.e., either by sharing a spatial-temporal relationship, or by sharing membership in a common higher-order category; e.g., CAR-STREET, CAR-TRAIN, respectively). Latencies and error rates were recorded for semantic associates, nonsemantic associates, and items that are not associated. The results of that study address the issue of whether information about nonsemantic associates is accessed faster for pictures or words, thereby indicating whether it is stored in the lexicon or in semantic memory.
CHAPTER II

EXPERIMENT 1

Before investigating the potential privilege pictures or words might have in activating information in permanent memory, it was necessary to determine which categories typically reside in permanent memory. Consequently, the first study was a norming experiment, and subjects were asked to name the category they most commonly associate with a given item. For example, if subjects were shown a picture of a horse, they might respond, "animal" or "mammal." The normative data from the first study indicate the higher-order category most strongly associated with an item in semantic memory, and they ease doubts as to whether the current experiments have tapped into permanent memory, rather than into problem solving strategies for constructing ad hoc categories on-the-fly. Consequently, those data could be used to select appropriate category labels for stimuli in categorization tasks in later experiments (i.e., the second and fourth studies).
Method

Subjects. Participants in the first experiment were 104 students in an introductory psychology course, and they were all native speakers of American English. In addition, they all reported having 20/20 vision or vision corrected to 20/20. Sixty subjects were female and 44 were male, and their ages were between 18 and 26 years, with a mean of 19.17, and a standard deviation of 1.66. It was specified that any subjects who exhibited problems reading words or identifying pictures (i.e., aloud) during the practice trials (i.e., ten items) would be disqualified, but none had difficulty.

Apparatus and Procedure. The stimuli consisted of 60 pictures and the printed names of those pictures (i.e., all printed in black ink on white paper, preserving size as published in Snodgrass & Vanderwart, 1980). The pictures all had medium to high familiarity (Mean familiarity = 3.86 (i.e., 5 = highest familiarity), SD = .86; Minimum = 1.95 for "fox;" Mode = 4.781, as well as medium-to-high name agreement (M = 92.02%, SD = 9.00; Minimum = 60% for airplane; Mode = 100%) based on the data of Snodgrass and Vanderwart (1980). Ten similar stimuli served as practice items. Stimulus type was varied as a between-subjects factor, with half of the subjects viewing pictures and the
other half viewing words. The order of stimuli was randomized across lists and matched across stimulus type. Subjects were assigned randomly to conditions as they arrived for the experiment.

Instructions were provided verbally, by the experimenter, prior to the onset of the task, as follows:

In the following task, you will view several WORDS (PICTURES). Please, study each individual item, and determine a category into which it fits. First, pick up the pen that I have supplied and lift the cover page off the list of items. Begin with the first item on the first page. Look at that item, and, as quickly as possible, determine a category into which that item commonly fits. Then, write the category name down next to the item. Please, do not just name the item, but actually try to think of a higher-order category. For example, if you saw THE WORD (A PICTURE OF A) ring, you might respond "jewelry," because a ring is a type of jewelry. If you saw THE WORD (A PICTURE OF A) house, you might respond "building," and if you saw THE WORD (A PICTURE OF A) penny, you might respond "money,"

because a penny is a type of money. After completing the first item, go on to the next one, and so on.

Please, respond as quickly as you can to each item by writing the name of the category down. Use the first category that pops into your mind, rather than trying to think of additional categories for any single item. It is very important that you use the first category that comes into your mind, and work as rapidly as possible. After you have finished one item, proceed to the next item, working from the top of each page to the bottom. When you reach the bottom of a page, do not stop. Please, go on to the next page. When you have reached the bottom of the last page, you have finished.

I will be timing your responses, so it is very important that you work quickly. Don’t worry too much about spelling the category names correctly. If you are unsure, just spell the name of the category as best you can, and move on to the next item. Finally, don’t worry about whether you are giving the "correct"
answer for each item. There are no predetermined correct answers for this task. In fact, what we are really trying to do, is find out what the correct answers SHOULD BE, on the basis of your answers and the answers of other students. Just try to give the first category that comes into your mind for a particular item. That is the best answer you can give.

Do you have any questions?

Each subject was supplied with a packet, including several pages with stimuli printed on them and a pen. Subjects were asked to view each stimulus and then write the name of the higher-order category with which they most often associate the stimulus. They were permitted to work at their own pace, except that the experimenter encouraged them to write the first category label that came to mind, without thinking too much about alternative labels.

The first ten items were practice, and the experimenter interrupted subjects' work after those ten to be sure they did not have any questions about the task before proceeding. Once a subject began working on the non-practice items, the experimenter used a stop-watch (accurate to 1/10 sec.) to measure the amount of time
required to complete the task. At the end of the session, subjects were debriefed and permitted to leave.

Results

The average time required to complete the task was 12.24 min. (SD = 3.80). For subjects who viewed pictures, average completion time was 11.33 min. (SD = 3.60), and for subjects who viewed words, it was 13.14 min. (SD = 3.81). Analyses revealed no significant effect of stimulus type on the time subjects required to complete the task, F (1,51) = 1.12, p > .3. The primary function of the stopwatch in Experiment 1 was to apply time pressure to subjects, so they would be more likely to write the first response that came to mind and not to take extra time to retrieve additional responses from memory for any single item.

An analysis of the frequencies of category labels generated by subjects for each of the 60 items revealed that each of 6 specific items did not clearly fit into one higher-order category. For POT, BOWL, GLASS, and PITCHER, subjects were equally likely to respond "utensil" or "dishware" (i.e., approximately 30 subjects out of 104 making each response). For LIPS, subjects were equally likely to respond "body part" or "part of the face." In addition, although, PIANO was often labelled a "musical instrument" (i.e., 55 out of 104 subjects), some subjects
responded that the item could be either an instrument or a piece of furniture. Since those items were ambiguous with respect to category membership, they were excluded from further analyses, because the goal of Experiment 1 was to identify categories whose most common exemplars possessed a single, undisputed category membership.

From the 54 remaining items, 7 categories were easily constructed. Fittingly, to each of those items a single high-frequency category label could be applied, based on subjects responses. A comparison between pictures and words (i.e., analyzing by item and collapsing across subjects) revealed no significant difference between the relative frequency with which the highest-frequency response was generated, \( F < 1.00 \). Thus, the type of item presented (i.e., picture or word) did not significantly influence the category-label generated by subjects for a particular item.

Seven categories constructed from the data are: animals, clothing, human body parts, furniture, transportation/vehicles, utensils, appliances. Those categories and their exemplars are listed in Appendix A, List 1. Interestingly, a good mix of different word lengths exists among the exemplars, and that proved to be useful in later experiments, because word length was not an indicator
of category membership. Thus, in general, subjects could not use it to bootstrap their categorization performance.

In devising those seven categories, a criterion frequency-of-generation was established such that no item was accepted into a higher-order category, unless at least 18 subjects out of 52 (i.e., in each condition: pictures or words), had generated that particular category label in response to the item. The average number of subjects who gave the highest frequency response for a given item was 36.04 ($SD = 7.60$), for words and 35.93 ($SD = 7.78$), for pictures, and as was stated previously, there was no significant difference between those means, $F < 1.00$. In addition, no item was accepted as a member of a specific category if it had frequently been labelled a member of another category (i.e., frequencies-of-generation within 9 points of each other).

Discussion

Overall, the results of the first experiment were not surprising. Similar, previous norming studies conducted by Snodgrass and Vanderwart (1980) and Battig and Montague (1969) have indicated that particular items fall easily into common categories. Of course, some subtle differences can be identified, depending upon whether one uses a higher-order category label as a cue for retrieval of
exemplars (i.e., retrieval of basic-level items; Rosch & Mervis, 1975) from memory (e.g., Battig & Montague, 1969) or whether one uses basic-level items as cues for generating higher-order category labels (e.g., the current study).

For instance, Battig and Montague (1969) observed that subjects generated exemplars such as KNIFE, SPOON, FORK, PAN, and POT when cued with the category KITCHEN UTENSIL. In the current study, however, when subjects were provided with an exemplar for which they generated a higher-order category, they were equally likely to place POT in the category COOKWARE or DISHWARE as KITCHEN UTENSIL. Nevertheless, the results of the first experiment provided a solid pool of items from which to draw stimuli for categorization and classification tasks employed in the second and fourth experiments, and those norming data are not at odds with the reports of Battig and Montague or Snodgrass and Vanderwart (1980).
CHAPTER III

EXPERIMENT 2

The purpose of the second study was to investigate the issue of perceptual discriminability of pictures and words. It was argued by Theios and Amrhein (1989) and Haase and Theios (1992) that previous conclusions about picture and word processing may be inaccurate, because they were based upon data from picture-word tasks in which pictures were more perceptible than words. Theios and Amrhein addressed that issue by varying the visual angle of presentation for words and pictures in naming and conceptual classification tasks.

Regrettably, in Theios and Amrhein’s (1989) first experiment, there was a confound between stimulus size and stimulus plurality (i.e., singular versus plural stimuli). For a given stimulus size (i.e., small, medium, large), pictures were actually quite a bit smaller than words in the singular condition. For example, in the "small stimulus condition," the average area of a singular picture (e.g., "o") was 3.75 square mm, but for a singular word (e.g.,
circle) it was 21.75 square mm. On the other hand, for a specific stimulus size in the plural condition, pictures (e.g., "oooooo") and words (e.g., circles) averaged the same area (e.g., with small, plural pictures and words averaging 25.5 square mm). In addition, as was mentioned above, processing demands for stimuli in the plural condition may have been considerably different for pictures and words, with words being processed holistically, while pictures were not.

Theios and Amrhein (1989) proposed that there is a certain size picture that is responded to with the same efficiency as a word of the same size (i.e., subtending at least 3 degrees of visual angle). However, that may be a somewhat arbitrary criterion for defining equivalent perceptibility of words and pictures. A less arbitrary way to cope with the issue of the perceptibility would be to plot separate response-time functions for pictures and for words, varying stimulus size. Then, the asymptotic value for each function would indicate the size of each type of stimulus (e.g., picture, word) that yields optimal perceptibility. That would make it possible for the current naming and categorization studies to compare mean latencies for optimally-sized pictures and words, rather than
comparing them for some arbitrary size of both pictures and words which may not represent an optimal size of either type of stimulus.

Theios and Amrhein (1989) compared picture naming and word reading performance in their first experiment. In naming tasks, words probably have privileged access to information in the lexicon, and that should result in a processing advantage for words. In fact, Theios and Amrhein did observe such an advantage.

Another important issue is whether pictures have privileged access to information in semantic memory, and that can be addressed using tasks which require classification. Theios and Amrhein (1989) employed a conceptual matching paradigm in their second experiment, but they utilized only the plural stimulus condition. Given the problems with that type of stimulus that were described previously, Theios and Amrhein (1989; Exp. 2) may not have adequately addressed the issue of privileged access to semantic memory when they used only plural stimuli in their second experiment.

Theios and Amrhein's (1989) second experiment investigated stimulus perceptibility. If pictures have privileged access to information in semantic memory (Smith
& Magee, 1980), that should produce an advantage for pictures over words in a conceptual matching task, even when the optimal stimulus size for each type of item is utilized. However, Theios and Amrhein have argued that, in fact, pictures do not have privileged access to information in semantic memory and that previous experiments (e.g., Smith & Magee, 1980) found evidence for such privilege simply because they employed pictures which were more perceptible than their word counterparts. Theios and Amrhein attempted to demonstrate that equating pictures and words in terms of perceptibility would yield no advantage for pictures over words in a conceptual classification task, thereby indicating that pictures do not have privileged access to information in semantic memory.

The work of Theios and his colleagues has thus far indicated that perhaps pictures do not have privileged access to information in semantic memory (see Theios & Amrhein, 1989; Haase & Theios, 1992). However, several methodological problems in those experiments justify further investigation of the issue. First, Theios and Amrhein (1989; Exp. 2) used only plural stimuli in their matching task, and it has already been argued that a plural
word (e.g., circles) may be processed holistically, while a plural shape (e.g., "ooooooo") might not be.

Another potential problem with Theios and Amrhein’s (1989) experiments is the nature of the pictures employed (i.e., shapes). Common shapes are pseudo-symbolic in the sense that they represent naturally occurring phenomena (i.e., the shapes of real objects) in an abstracted fashion (i.e., as regular geometric forms). As a consequence, pictures of shapes are different than pictures of real objects, because they are not literal representations of real-world objects.

The above-mentioned issue is also a potential problem for experiments conducted by Haase and Theios (1992). They used the names of corporations and their pictorial logos in a speeded classification task. As with the shapes in Theios and Amrhein’s (1989) experiments, logos may be pseudo-symbolic. After all, logos are arbitrary representations, because they do not simply capture a two-dimensional view of a three-dimensional object. Instead, logos result from a somewhat arbitrary pairing of a corporation and a picture selected to represent it. That relationship resembles the one between a word and the real-world object it arbitrarily represents more than it resembles the relationship between
a realistic two-dimensional picture and the three-dimensional object it represents (i.e., the latter association being non-arbitrary and most commonly based upon a Euclidean geometry).

After considering the potential flaws in the experiments of Theios and Amrhein (1989) and Haase and Theios (1992), one could argue that the question of privileged access to information in semantic memory for pictures remains open. In fact, it was a goal of the current experiment to address that issue within the context of naming and categorization paradigms. Theios and his colleagues have raised an important point with respect to the perceptibility of picture and word stimuli, and an objective of the current experiment was to contend with that concern. Consequently, perceptibility was manipulated as a function of stimulus size (i.e., of five different sizes) in both naming and categorization tasks in Experiment 2.

Method

Subjects. Sixty subjects participated in the second experiment: 20 naming and 40 categorizing. They were students in an introductory psychology course, and they were all native speakers of American English. In addition,
they all reported having 20/20 vision or vision corrected to 20/20.

Thirty-nine subjects were female and 21 were male, and their ages were between 18 and 35 years (M = 20.78, SD = 3.71). In the naming condition, 14 females and 6 males between the ages of 18 and 29 years (M = 20.05, SD = 2.68) participated. In the categorization task, 25 females and 15 males between ages 18 and 35 (M = 21.15, SD = 4.10) participated. It was specified that any subjects who exhibited problems reading words or naming pictures during the ten practice trials would be disqualified, but none did.

**Apparatus and Procedure.** Stimuli consisted of items normed in the first study: 54 pictures and their names (i.e., 54 words) printed individually in white on a black computer screen, and the items were members of seven categories: animals (i.e., fourteen items), clothing (i.e., twelve items), human body parts (i.e., nine items), furniture (i.e., seven items), transportation/vehicles (i.e., seven items), kitchen utensils (i.e., three items), and appliances (i.e., two items). The advantage of utilizing categories of different sizes was that it would not help if subjects kept mental count of items within a
category. Also, the only exemplars used were those for which the given higher-order category was the category generated most frequently by subjects in Experiment 1 and with no competitor within nine frequency points (i.e., as described in Experiment 1 and Appendix A).

Stimuli were presented one at a time, centered, on an enhanced VGA monitor in random order, with the constraint that no two items with the same name were presented consecutively. Subjects viewed the screen from a distance of approximately 55 cm. Half of all subjects examined items in one random order (Order A), and the other half viewed them in another random order (Order B). Half of all subjects examined words first, and the other half viewed pictures first.

Within each set of trials for a given stimulus type (i.e., words versus pictures), there were five blocks of 54 trials. Within each block, a picture or word with a given name occurred only once, and the size of each stimulus was varied across the five blocks (i.e., occurring once in each block, and being a different size in each). As a result, each subject viewed each picture five times and its corresponding name (i.e., a word) five times during the experiment. The five stimulus sizes were, approximately,
300 square mm, 1037 square mm, 2089 square mm, 3945 square mm, and 9962 square mm, with square millimeters specifying the area of the smallest regular quadrilateral in which each picture or word of a particular size-class could be enclosed. The average visual angles subtended by each size stimulus horizontally were 2.19, 4.37, 6.55, 8.73, and 14.45, respectively. The average visual angles subtended vertically were 1.38, 2.19, 3.09, 4.88, and 7.56, respectively.

Twenty subjects performed a naming task. They were instructed to name each item as quickly as possible upon its presentation, and if they made an error, they were not to correct it. Subjects responded by speaking into a microphone which triggered a voice key. That permitted latencies to be measured and recorded by an XT-compatible computer. Errors were recorded by the experimenter when subjects failed to read a word correctly or name a picture consistently.

Forty subjects performed a categorization task in which they were asked to verify whether each stimulus represented a member of a predesignated category (i.e., as determined by the results of the first study). In each list (i.e., a block of 54 trials), 27 were "yes" items and 27
were "no" items, and those designations were reversed for half the subjects. In addition, "yes" and "no" trials were randomly intermixed within a list. Before the presentation of each item, the experimenter pronounced the name of a category. When the item appeared on the screen, the subject was to verify, as quickly as possible, whether the item was a member of that category.

Subjects responded by pressing a key on a two-button keypad. The keys were arranged side-by-side, and the "yes" and "no" responses were counterbalanced across subjects so that half the subjects used the right key to respond "yes" and half used the left key to respond "yes." The keypad permitted latencies to be measured and recorded by an XT-compatible computer, and errors were recorded by the experimenter when subjects failed to identify an exemplar with its appropriate higher-order category.

For all subjects, trials were experimenter-paced and required about 3 sec each. Before each trial in the naming task, the experimenter said, "Ready," so that subjects could prepare for the next item and/or interrupt the session, if needed. Before each trial in the categorization condition, the experimenter uttered the name of a category, and that served the same purpose, as well as providing the
category to be verified for that trial. Subjects reported being comfortable with that arrangement, and they rarely interrupted the testing process. Reported data for latencies are for correct "yes" trials only.

Different numbers of subjects were utilized in each condition, because twice as many subjects were required in the categorization task to yield the same amount of data as in the naming task. That is, since the critical data in the categorization task were "yes" responses, and because only about half of the trials were "yes" trials for a given subject in that condition, twice as many subjects were required as in the naming condition (i.e., in which every trial was effectively a "yes" trial).

Results

Latency Data

Mean latencies for Experiment 2 are listed in Table 1. The overall analysis of variance for latencies (i.e., subjects X task X order of presentation X pictures/words first X type of stimulus X stimulus size) revealed that, in general, naming was faster than categorization, $F(1, 56) = 39.10, p < .001$, and words had an advantage over pictures, $F(1, 56) = 49.95, p < .001$. However, there was an interaction between those two variables, $F(1, 56) =$
162.37, \( p < .001 \), with a reliable advantage for words in the naming task, \( F (1, 18) = 53.22, \ p < .001 \), that was reversed in the categorization task, \( F (1, 36) = 34.83, \ p < .001 \). In the overall analysis by items (i.e., and collapsed across subjects), the results were the same with the smallest effect being the main effect of stimulus type, \( F (1, 106) = 215.17, \ p < .01 \).

Those effects are consistent with the observations of previous researchers (Smith & Magee, 1980; Glaser & Glaser, 1989), and they suggest that words have privileged access to information in the lexicon. More importantly, they also suggest that pictures have privileged access to information in semantic memory, and, as discussed below, the influence of stimulus size on that effect does not alter the general conclusion.

There was a significant effect of stimulus size, \( F (4, 224) = 5.02, \ p < .01 \), but that effect interacted with stimulus type, \( F (4, 224) = 12.78, \ p < .01 \), and stimulus size was modulated in such a way that larger sizes generally yielded better performance on pictures and poorer performance on words. Those effects were also reliable in the analysis of items, with the smallest effect being for stimulus size, \( F (4, 424) = 5.55, \ p < .01 \). The three-way
interaction between type-of-task, stimulus type, and stimulus size was not significant in the analysis by subjects or the analysis by items. Table 1 lists mean latencies for Experiment 2 by task (i.e., naming vs. categorization) and stimulus type (i.e., pictures vs. words).

**Naming latencies.** A separate analysis of variance of latencies by subject for naming (i.e., subjects X order of presentation X pictures/words first X stimulus type X stimulus size) revealed significant effects of stimulus type, $F(1, 18) = 241.68, p < .001$, and stimulus size, $F(4, 72) = 9.75, p < .001$, with a general trend toward faster performance on words and on larger stimuli. However, the effect of stimulus size cannot be interpreted alone, because it was modulated by the influence of stimulus type, $F(4, 72) = 29.60, p < .001$, with pictures being at a greater disadvantage when stimuli were smaller and words being at a greater advantage. No other effects were significant in the overall analysis of naming latencies, and those results were also observed in the analysis of naming latencies by item.

Planned comparisons indicated that reading was significantly faster than picture naming at the .01 level.
for all sizes of stimuli. The critical comparison between the size of word yielding the most efficient performance (i.e., size 1) and the size of picture generating the most efficient performance (i.e., size 5) yielded a significant advantage of reading over picture naming, \( F(1, 18) = 232.81, p < .01 \).

A separate analysis for picture naming revealed that, in general, larger stimuli had an advantage over smaller items, \( F(4, 72) = 16.95, p < .001 \), and performance for the smallest size picture (i.e., size 1) was significantly slower than performance for any other size picture, with the smallest effect being for the comparison between sizes 1 and 2, \( F(1, 18) = 21.19, p < .001 \). In addition, naming was significantly faster for pictures of size 5 than for pictures of either size 2, \( F(1,18) = 7.98, p = .01 \), or size 3, \( F(1, 18) = 7.23, p < .02 \), but the comparison between sizes 4 and 5 was not significant, even though the mean difference was in the expected direction. The analysis by items of latencies yielded the same results, and the same sets of comparisons were reliable at the .05 level, except that the comparison between sizes 2 and 5 was only marginally significant, \( F(1, 53) = 3.64, p = .06 \).
Overall, for word reading, smaller sizes had an advantage, \( F(1, 18) = 9.75, p < .01 \), with latencies being significantly slower for the largest stimuli (i.e., size 5) than for any other size of stimulus, with the contrast between sizes 2 and 5 being the smallest, \( F(1, 18) = 45.68, p < .001 \). Moreover, those comparisons also were all reliable at the .05 level in the analysis by items, with the smallest effect being the comparison between sizes 3 and 5, \( F(1, 53) = 50.36, p < .01 \). In addition, in the subject analysis, latencies for the two smallest sizes of stimuli (i.e., sizes 1 and 2) had a marginal advantage over the second largest size (i.e., size 4): \( F(1, 18) = 4.26, p = .054 \), for the comparison between sizes 1 and 4, and \( F(1, 18) = 4.34, p < .052 \), for the comparison between sizes 2 and 4, but those latter two comparisons were not reliable at the .05 level in the analysis by items.

**Categorization latencies.** A separate analysis of latencies by subject for the categorization task (i.e., subjects X order of presentation X picture/words first X stimulus type X stimulus size) revealed significant effects of stimulus type (pictures vs. words), \( F(1, 36) = 19.82, p < .001 \), and stimulus size, \( F(4, 144) = 4.10, p < .001 \), as well as a reliable interaction between stimulus type and
stimulus size, \( F(4, 144) = 5.17, p < .001 \). An analysis by item revealed the same effects: \( F(1, 53) = 92.97, p < .001 \), for stimulus type; \( F(4, 212) = 3.16, p < .02 \), for stimulus size; and \( F(4, 212) = 4.25, p < .003 \), for the interaction.

The interaction between stimulus type and stimulus size reflects marked differences in the influence of stimulus size on picture categorization and word categorization. For pictures, overall, there was a main effect of stimulus size, \( F(4, 144) = 4.54, p < .002 \). Analyses of mean differences for picture categorization revealed that latencies were significantly slower for pictures of size 1 than for pictures of any other size, with the contrast between sizes 1 and 3 being the smallest, \( F(1, 36) = 4.07, p = .05 \).

Results were similar for the analysis by item, except that the mean difference between sizes 1 and 3 was not significant, \( p = .12 \), but it was in the predicted direction. Also, contrasts between sizes 1 and 4 and between sizes 1 and 5 were only marginally significant, \( p = .078 \) and \( p = .057 \), respectively, but they were also in the predicted direction. Although the mean difference between items of sizes 2 and 3 was not reliable in the subject analysis, it
was in the analysis by items, indicating that subjects seemed to be faster at categorizing pictures of size 2 than at categorizing pictures of size 3. That is inconsistent with an overall trend toward better performance on larger items, like the trend evident in picture naming. Clearly, stimulus size has a more complicated effect on picture categorization than picture naming. In fact, it appears that optimal performance in categorization is achieved for both pictures and words when items of size 2 are utilized, and for that size of display subjects were significantly faster on pictures than words, $F(1, 36) = 11.17, p < .01$.

The influence of stimulus size on word categorization was reliable, $F(4, 144) = 4.68, p < .002$, although it was quite different than it was on picture categorization. In fact, the slowest latencies were for words of the largest sizes (i.e., sizes 4 and 5), with word categorization being fastest for items of size 2. None of the comparisons between means for words of sizes 1, 2, or 3 was significant, indicating that subjects could categorize words of sizes 1, 2, and 3 with about equal efficiency. On the other hand, latencies for words of sizes 4 and 5 were typically slower than for words of sizes 1, 2, and 3, with the smallest contrast being between sizes 3 and 5, $F(1,$
36) = 6.98, p = .012. An analysis of latencies by items yielded similar results, with the difference being reliable at the .01 level.

Overall, then, both pictures and words benefitted most in categorization when stimuli were of size 2, and, as was described above, for that stimulus size picture categorization was faster than word categorization. However, although the trends across sizes for words and for pictures were considerably different, both trends were rather consistent with the data from the naming task. Generally, sizes larger than normal print (i.e., sizes 3, 4, and 5, and especially the latter two sizes) slowed latencies for reading and word categorization. For pictures, though, it seems as if items smaller than normal print, with item-detail preserved (i.e., size 1), were the most difficult (i.e., slowest) to name and categorize.

Summary of the critical latency effects. With respect to the latency data, of importance is the persistence of the speed advantage for reading over picture naming when latencies of optimal-size items (i.e., words of sizes 1, 2, or 3 and pictures of sizes 4 or 5) are compared. Of even more critical importance, however, is the advantage for picture categorization over word
categorization which survived the same type of comparison. The latter effect is consistent with the notion that pictures do have privileged access to information in semantic memory, and that conclusion does not appear to hinge upon comparisons between large pictures and small words, as Theios and Amrhein (1989) suggested. In fact, in the categorization task, the most efficient responses for words (i.e., at size 2) were still slower than the most efficient responses for pictures (i.e., size 2).

Error data

Mean errors for Experiment 2 are listed in Table 2. Error analyses by subject (i.e., subjects X task X order X pictures/words first X stimulus type X stimulus size) revealed an effect of task type, $F(1, 52) = 5.84, p < .02$, with naming yielding significantly fewer errors than categorization. In addition, there was a significant effect of stimulus type, $F(4, 208) = 27.48, p < .001$, with words yielding fewer errors than pictures. The critical effect was an interaction between task type and stimulus type, $F(1, 52) = 31.55, p < .001$, with words having an advantage in the naming task and pictures having an advantage in the categorization task, and those effects will be detailed below.
The effect of stimulus size was not significant at the .05 level in either of the overall analyses of errors, and that may have been due to generally low error rates overall. As will be detailed below, the effect of stimulus size was reliable in the separate analysis of errors by subject for categorization, but not for the naming task. The analysis by items yielded similar results at the .05 level, with a reliable interaction between type of task and type of stimulus, $F(1, 106) = 9.09, p < .01$. The pattern of error data was essentially the same as in the latency data, except for the absence of a reliable main effect for stimulus size, and no speed-accuracy trade-off was evident, with the correlation between latencies and errors being $.30, p > .05$.

Naming errors. A separate analysis of errors (i.e., subjects $\times$ order $\times$ pictures/words first $\times$ stimulus type $\times$ stimulus size) for naming indicated that the only significant effect was the main effect of stimulus type, $F(1, 16) = 39.94, p < .001$, with reading having a reliable advantage over picture naming. Mean comparisons indicated that only the contrast between sizes 3 and 5 was significant for word stimuli, i.e., $F(1, 16) = 4.57, p < .05$. In addition, only the comparison between sizes 4 and
5 was significant for pictures, i.e., \( F(1, 16) = 5.12, p < .05 \). Overall, the analysis of errors by item revealed the same effects at the .05 level.

**Categorization errors.** A separate analysis of errors for categorization (i.e., subjects \( \times \) order \( \times \) pictures/words first \( \times \) stimulus type \( \times \) stimulus size) yielded a significant main effect of stimulus size, \( F(4, 144) = 2.67, p < .05 \), which was probably due to the high number of errors for stimuli of size 1, relative to stimuli of other sizes. Three contrasts were significant for word categorization: \( F(1, 36) = 5.59, p < .03 \), for the contrast between words of sizes 1 and 3; \( F(1, 36) = 5.15, p < .03 \), for the contrast between words of sizes 2 and 3; and \( F(1, 36) = 4.17, p < .05 \), for the comparison between words of sizes 3 and 4. Interestingly, the analyses of errors by items for categorization revealed no significant mean contrasts.

**Discussion**

The critical effect in Experiment 2 was the interaction between task type and stimulus type. As described above, words had a reliable advantage over pictures in the naming task, supporting the notion that words have privileged access to information in the lexicon.
That effect was significantly reversed in the categorization task, with pictures having an advantage over words, indicating that words have privileged access to information in semantic memory. In fact, those effects are still reliable when only the most efficient performance is considered for both words and pictures (i.e., naming size-1 words and size-5 pictures; categorizing size 2 items).

With respect to stimulus size, trends in the naming data indicate that reading has an advantage over picture naming for all sizes of stimuli employed in the current study. Even when picture naming performance was optimal (i.e., for pictures of size 5), it was still significantly slower than the least efficient reading performance (i.e., for words of size 5). The most striking finding in the naming task was that performance trends for words and pictures moved in opposite directions, with picture naming benefitting from larger-sized stimuli while reading suffered. At the same time, reading benefitted when stimuli were smaller, but picture naming suffered.

In the categorization task, the trends were not unidirectional for each type of stimulus. Instead, a particularly striking phenomenon emerged. Performance was especially poor for picture categorization when stimuli
were smallest (i.e., of size 1) and particularly poor for word categorization when items were largest (i.e., of size 5). Even more unusual was the finding that for both pictures and words, categorization was fastest for items of size 2 (i.e., the second smallest size).

Overall, the issue of perceptibility as it pertains to processing words and pictures cannot be completely resolved on the basis of the results of the current experiment. While subjects responded most quickly to words of size 1 and to pictures of size 5 in the naming task, the same data did not emerge in the categorization task. On the contrary, the fastest performance for words and pictures in the latter task was for items of size 2 (i.e., for both types of stimuli). However, most importantly, the data do support the notions that words have privileged access to the lexicon and that pictures have privileged access to semantic memory.
CHAPTER IV

EXPERIMENT 3

As was stated previously, the current studies were designed to address questions concerning privileged access to information in permanent memory, and one hypothesis is that pictures have privileged access to information in semantic memory. That supposition is supported by the results of the second experiment. An additional hypothesis is that information about nonsemantic associations may be stored as links between entries in the lexicon, rather than as links between concepts in semantic memory. If that were true, then words, rather than pictures, might have privileged access to that information. The goal of the fourth and final experiment was to address that question by requiring subjects to make speeded judgments about the relationships between items (i.e., between two pictures or two words that are semantically related, associatively related, or unrelated). However, before Experiment 4 could be conducted, it was necessary to establish a pool of stimuli.
As stated previously, Experiment 3 was much like the first study, except that the objective was to norm stimuli for nonsemantic associations (e.g., SHOE-FOOT), rather than semantic ones (e.g., SHOE-BOOT). In devising a set of stimuli for the fourth and final experiment, it was necessary to compose two lists of associated pairs: 1) a list of pairs that share semantic associations (i.e., sharing a common category membership) and 2) a list of pairs that do not share semantic associations, but do share nonsemantic associations. The former list was derived from items normed in the first experiment, but the latter could not be. Thus, the third experiment was designed to achieve that end, requiring subjects to perform either a picture-association or word-association task by writing down the name of a noun related to each stimulus item. Experiment 3 provided a pool of nonsemantic-associate pairs from which stimuli for Experiment 4 could be drawn.

Method

Subjects. Participants in the third study were 80 students in an introductory psychology course, and they were all native speakers of American English. In addition, they all reported having 20/20 vision or vision corrected to 20/20. Thirty-four were female and 46 were male, and
their ages were between 17 and 43 years ($M = 20.88$, $SD = 4.63$; Mode $= 19$). It was specified that any subjects who exhibited problems reading words or identifying pictures during the practice trials would be disqualified, but none did.

**Apparatus and Procedure.** The apparatus, design, and procedure were similar to those of Experiment 1. Subjects were presented with a packet of materials (i.e., either words or pictures) derived from Snodgrass and Vanderwart (1980) and Postman and Keppel (1970). The 75 test stimuli were generally of high name agreement ($M = 89.04\%$, $SD = 13.14$) and of medium-to-high familiarity ($M = 3.54$ out of $5$, $SD = 0.99$; see Snodgrass & Vanderwart, 1980), and 5 similar items served as practice stimuli.

Maintaining high name agreement and familiarity was particularly difficult in the third experiment, because the highest-frequency associates of any particular item may not necessarily be highly familiar or easy to represent in picture format. As was discovered, a few of the stimuli and their associates were either not familiar enough, or not "picturable" enough to be used in later studies. Also unfortunate, was the absence of previous norming data on familiarity and name agreement for pictures of 19 items
(see Appendix A, List 3). Nevertheless, those 19 items were utilized in Experiment 3, because it was presumed that the data would indicate any items unsuitable for use in later experiments.

The order of stimuli was pseudo-random, half of all subjects were presented with items in one random order, and the other half viewed items in another random order. Subjects were assigned at random to conditions (i.e., pictures or words; Order A or Order B) when they arrived for the experiment. Five items appeared on each page, and, generally, items in similar higher-order (i.e., semantic) categories were not placed on the same page.

In addition to order of presentation, directionality of associations was a concern. Both items in a pair would have to be normed. Originally, 37 items were selected from Snodgrass and Vanderwart (1980) as candidates for free association. Then, a potential high-frequency associate was selected for each of the original 37 items (i.e., from Postman & Keppel, 1970), except HAIR, for which two very high frequency associates were identified (i.e., BRUSH and COMB). That provided 38 additional stimuli.

Half of all subjects were presented with a list of 75 stimuli for which the first portion consisted of the 37
original items, followed by the 38 possible associates. The other half of the subjects viewed the 38 associates first, followed by the 37 original items. All subjects were naive about the composition of the list, and they were not given instructions concerning the possibility that items in the first half of the list might be associates for items in the second half. The implications of that detail are discussed below.

Subjects who viewed an item in the first half of the list did not respond significantly differently than subjects who viewed that item in the second half of the list (i.e., when items were analyzed by subject and frequency with respect to list order), \( F(3,72) = 2.30, p > .08 \), (i.e., for the 37 original stimuli) and \( F(3,72) = 2.13, p > .10 \), (i.e., for their 38 potential associates). However, debriefing data collected after subjects completed the task indicated that some subjects intentionally tried NOT to use items that appeared in the first half of the list as responses to stimuli in the second half of the list. Since subjects had been given no instructions with respect to using early items as responses to later items, it was determined that this presented a substantial problem for conceptualizing the data. For that reason, all further
discussions of subjects, stimulus lists, or data will disregard the second half of the items on each subject’s list, and data collected for any particular stimulus will be expressed as the frequency of responses out of 40, instead of 80.

Subjects were given the following instructions:
This is one of the studies I am currently working on, and it involves a task called free association. Please, write your age and gender on the cover sheet of the packet I have just given you. When you open the packet, you will see a list of several WORDS (PICTURES). After each item, write the name of the first thing you think of that is related to it. The only stipulation is that your response must be a noun, such as a thing, animal, or person, but it cannot be a proper noun (which is something that must be capitalized, like Saturday or Philadelphia). Also, please do not just write the name of the item shown.

Start with the first item on the first page. Respond to it and then move on to the next item. Work as quickly as you can, but do
not skip any items. Use only a single word to respond to each item, and don’t worry too much about spelling. Just spell your response as best you can. When you have finished, place your pen on the desk and let me know that you are done.

Please, remember that there are no predetermined correct answers to these items. So, don’t worry about whether your responses are correct or not. In fact, the purpose of this study is to find out what the correct responses should be.

Do you have any questions?

The first five items were practice, and the experimenter interrupted subjects’ work after those five to be sure they did not have any questions about the task before proceeding. When a subject began working on the non-practice items, the experimenter used a stop-watch (accurate to 1/10 sec.) to measure the amount of time required to complete the task. At the end of the session, subjects were debriefed and permitted to leave.

Results
The average time required to complete the task was 12.18 min. (SD = 3.61). For subjects who viewed words, average completion time was 11.37 min. (SD = 3.54), and for subjects who viewed pictures, it was 12.99 min. (SD = 3.54). As in Experiment 1, the presence of the stopwatch was primarily to enforce time pressure, and encourage subjects to write the first response that came to mind, rather than pondering alternative responses for any single item. Average completion time was not significantly different for pictures and words, F = 1.00.

An analysis of the frequency of free-association responses indicated that certain items were either unfamiliar or did not possess a single, strong high-frequency associate. Unfortunately, the highest-frequency associate for some items was a member of the same semantic category (e.g., BREAD-BUTTER, both being FOOD). All such items were eliminated as potential members of associative pairs for Experiment 4. The items excluded were: COWBOY, HUNTER, DEER, HOUSE, SCHOOL, BELL, CHURCH, PAIL, WELL, HONEY, SHIRT, BABY, CLOWN, BUGGY (i.e., BABY CARRIAGE in Snodgrass & Vanderwart, 1980), COW, STAMP, ENVELOPE, WOMAN, WORM, PEANUT, ARM, WATCH, FIRE, FENCE, ELEPHANT, DRESS, DESK, BARN, BALLOON, AX, DRESSER, STOVE.
From the remaining items, 25 pairs of nonsemantic associates were derived. Criteria for selecting pairs consisted of the following: 1) each being a high-frequency associate of the other (i.e., one of the 3 most frequent associates); 2) no semantic association, as determined by the absence of the pair from common membership in a higher-order category in Battig and Montague (1969) or Experiment 1 of the current set; 3) each item in a pair being a concrete noun that is "picturable" (e.g., 39 items from Snodgrass & Vanderwart and 11 drawn by the experimenter and tested on 10 subjects for recognition). Those pairs are listed as "nonsemantic associates" in Appendix A, List 2. Among those pairs appear three practice items from Experiment 3 for which the data proved compelling enough to warrant their inclusion (i.e., WITCH, HIVE, and EGGS).

In the initial study, EGGS was anticipated to cue the response "bird" most often. Unfortunately, it cued "chicken" much more frequently. For that reason, additional data collection was necessary in order to determine whether CHICKEN cues the response "egg(s)" frequently (i.e., whether the relationship is strongly bidirectional). Data from 20 additional subjects who responded either to the word chicken, or to a picture of a chicken yield results in
favor of the hypothesis that the relationship is strongly bidirectional with 14 subjects responding "egg(s)."

The same problem arose for WITCH, with its highest frequency associate "broom." Supplemental data indicate the relationship is bidirectional, but with a much stronger association when WITCH is the probe. For 20 subjects responding to BROOM, only 7 generated "witch," but for 40 subjects who responded to WITCH, 20 generated "broom."

The frequencies-of-generation of high-frequency associates were not significantly different for pictures and words. Newman-Keuls comparisons yielded, \( Q = 1.33, p > .05, \) for the 37 original items, and \( Q = .50, p > .05, \) for the 38 potential associates, and, as mentioned previously, data are reported only for subjects who viewed an item in the first half of their list. Additional item analyses indicated the directionality effect was significant, \( F(3,72) = 17.04, p < .001, \) with the 37 original items cuing the 38 additional items, as responses, significantly more frequently than vice versa.

Discussion

Overall, the data from Experiment 3 indicated that 25 pairs of nonsemantic associates were available for use in the fourth and final experiment of the current series.
Combined with the norming data from the first experiment, they provided an abundant pool of semantic and nonsemantic associates from which to draw stimuli for Experiment 4.
CHAPTER V

EXPERIMENT 4

The fourth experiment investigated the content and organization of information in semantic memory as revealed by picture and word processing. As was described above, the contradictory results of Lupker (1979) and Hogaboam and Pellegrino (1978) draw attention to the questions of whether pictures have privileged access to information in semantic memory and whether that privilege includes access to information about both semantic associations (e.g., BOOT-SHOE) and nonsemantic associations (e.g., spatial-temporal contiguities like CAR-STREET). It is possible that nonsemantic associations exist as links between entries in the lexicon, and not in semantic memory (Pattee, 1982). If that were true, then one would expect that words might have privileged access to that information, and would, therefore, yield faster, more accurate latencies than pictures when speeded decisions about nonsemantic relationships are required.
It should be noted that a finding of no difference in mean latencies for pictures and words with respect to judgments about nonsemantic associations might indicate that information about those relationships is computed on-the-fly in permanent memory, and that type of computation was discussed previously. If subjects can make judgments about associative relationships between words and between pictures with the same efficiency, then privileged access would not be proposed for either type of item (i.e., relative to the other type of item).

The goal of Experiment 4 was to test that hypothesis by requiring subjects to make speeded judgments about pairs of items. In each pair of stimuli, items were either both pictures or both words, and subjects were asked to decide whether they were related to one another, either semantically, or associatively. It was expected that pictures would have an advantage over words when pairs were semantically related, because the results of Experiment 2 indicate that pictures have privileged access to information in semantic memory pertaining to category membership.

With respect to associatively-related pairs, however, it was predicted that words might have an advantage over
pictures. As was described previously, Pattee's (1982) data indicate that information about associative relationships could be stored in the lexicon, rather than in semantic memory. If that is the case, then words should have privileged access to it, and Experiment 4 was designed to test that hypothesis.

Method

Subjects. Forty subjects participated in the fourth experiment. They were students in an introductory psychology course, and they were all native speakers of American English. In addition, they all reported having 20/20 vision or vision corrected to 20/20. Eighteen subjects were female and 22 were male, and their ages were between 18 and 40 years (M = 21.73, SD = 5.24; Mode = 19). It was specified that any subjects who exhibited problems reading words or identifying pictures during the ten practice trials would be disqualified, but none did.

Apparatus and Procedure. Stimuli consisted of 25 pairs of nonsemantic associates (e.g., GLOVE-HAND), 22 pairs of semantic associates (e.g., DESK-TABLE), and 39 pairs of unrelated words (e.g., SHOE-EGG; i.e., as determined by the absence of such pairs from Postman & Keppel, 1970; Battig & Montague, 1969; and data collected
in Experiments 1 and 3 of the current series). All of those pairs are listed in Appendix A, List 2. There were approximately equal numbers of "yes" trials (i.e., associated pairs) and "no" trials (i.e., unrelated pairs) in each list (i.e., a block of 86 trials), and that was intended to prohibit subjects from developing a response bias.

Semantic associates were exemplars of categories normed in Experiment 1 and utilized in Experiment 2. Nonsemantic associates were selected from items normed in the third study, and they were pairs for which each item is a high-frequency associate of the other (i.e., items sharing a bidirectional association). In addition, care was taken to ensure that nonsemantic associates were not, also, semantically related (i.e., by consulting Battig & Montague, 1969, and Exp. 1 of the current series).

Ensuring that semantically-related items were not associatively-related was also important, and that was accomplished by checking that semantically-related pairs did not appear as frequent associates in Postman and Keppel's (1970) norms for word association. For some higher-order categories, exemplars often share additional, nonsemantic associations. For instance, CAT and MOUSE are
both members of the category ANIMAL, but one is also the predator of the other. Such pairs could not be included as stimuli, because it would be difficult to anticipate the manner in which activation of one type of association in permanent memory might influence activation of the other type of association. As a consequence, the influence of a "double association" on latencies and error rates would be difficult to predict.

Subjects viewed stimuli on an enhanced VGA monitor. Items were pairs of pictures (i.e., white line drawings) and pairs of words printed in white on a black computer screen. Stimulus pairs were displayed side-by-side, centered on the screen. Items in each pair were offset from the center by 1 cm in either direction (i.e., left or right).

The size of each picture or word was approximately 1037 square mm (i.e., horizontal visual angle = 4.58 for a single fixation centered on a single picture or word; vertical visual angle = 2.19 for all fixations; horizontal visual angle = 13.27 for a single fixation centered on the screen), as endorsed by the results of the second experiment (i.e., data endorsing the second smallest stimulus size from Exp. 2, but indicating that all sizes
except Size 1 might be appropriate for pictures and all sizes but Size 5 might be appropriate for words). It was posited that subjects required at least two fixations in order to apprehend the stimulus display (i.e., with at least one fixation per word/picture). In fact, subjects were directed specifically to study the display in that fashion from left to right (see "Instructions," listed below).

Subjects were given the following instructions:

In the following task, you will view pairs of words and pairs of pictures, presented on the computer screen in front of you. For each pair of items, it will be your job to decide whether the two things are related to one another. You should try to make this decision as quickly as possible and with few errors.

There are two basic ways in which items might be related. First, they might be members of a common category. For example, EAR and TOE are both types of HUMAN BODY PARTS. The second way in which two things might be related is not in terms of category membership, but in terms of whether they occur together often in
time and space, like FOOT and SOCK. Those items are not in the same category (i.e., FOOT is a BODY PART, but SOCK is not). However, they do often occur together.

If two items are related, they will be related in one of those two ways. Whenever such a relationship occurs, you should respond "yes" to the pair. Whenever the items are not related, you should respond "no." Do that by pressing the RIGHT (LEFT) button on the keypad for "yes" and the LEFT (RIGHT) button for "no."

You may be wondering about items that aren't related. How will you know they aren't? Well, these will be pairs of things for which there is no obvious link. In other words, you would have to make up a story to devise some relationship. For example, SHOE and EGG are not related, and one would have to make up a story--perhaps, about how a bird found an old shoe, and laid her eggs in it--in order to get the two items to be related. If you find yourself making up a wild story like that, you
can be fairly certain that the items are unrelated, and you should respond "no."

I would like to make a final request of you, and that concerns the manner in which you study items on the computer screen. When the two items appear on the screen, please, look at the one on the left first, and then look at the one on the right. This will, of course, be what you do naturally for the word displays, but I would also like you to do the same thing for the pictures. Is that okay?

Do you have any questions?

Subjects were asked to determine whether two stimuli, projected side-by-side on the screen were related in any way, and they responded by pressing one of two buttons on a keypad. This was the same keypad that had been utilized in the categorization task of the second experiment, and it was linked to an XT-compatible computer so that latencies could be measured and recorded. The keys designated as "yes" and "no" were switched for half the subjects, as in Experiment 2. Errors were recorded by the experimenter. Reported data are for trials involving associated pairs (i.e., "yes" trials), and descriptions of average latencies
are provided only for trials in which subjects responded correctly.

Results

Latency Data

Mean latencies by subjects are listed in Table 3 (i.e., by stimulus type and type of association). Outliers were removed at 3 standard deviations from the mean latency and beyond. The overall analysis of variance (i.e., subjects X order of presentations X left/right arrangement of stimulus pairs X pictures/words first X type of association X stimulus type) yielded a marginal advantage for pictures over words, $F (1,32) = 3.45$, $p = .07$, but in the analysis by item, that effect was reliable, $F (1,48) = 4.33$, $p = .04$. The analysis of latencies revealed that subjects made decisions about semantic associations significantly faster than about nonsemantic associations, $F (1,32) = 25.28$, $p < .001$, but that effect was marginal in the analysis by items, $F (1,48) = 3.98$, $p = .07$. The critical two-way interaction between type-of-item (i.e., picture or word) and type-of-association was also significant in the subject analysis, $F (1,32) = 57.10$, $p < .001$, and in the analysis by item, $F (1,48) = 15.82$, $p < .001$. 
In the analysis of latencies by subjects (i.e., design described above), latencies for semantically-related pictures were significantly faster than for semantically-related words, $F(1, 32) = 22.81, \ p < .01$, and that was also true for the analysis by items, $F(1, 48) = 75.17, \ p < .01$. On the other hand, associatively-related words were not reliably faster than associatively-related pictures in the analysis by subjects, $F(1, 32) = 1.32, \ p = .26$, but the difference was in the predicted direction. Furthermore, that effect was significant in the analysis by items, $F(1, 48) = 14.54, \ p < .01$.

In an attempt to separate the effects of extraneous variables (e.g., which of two random orders of presentation of stimuli a subject received), from the critical effects (e.g., stimulus type and type of association), an additional analysis of latencies by subject was executed by collapsing across between-subjects conditions to create 8 super-subjects. Data from all subjects who viewed items in a particular order were combined to create 1 super-subject, and, because there were 8 different orders of presentation, that yielded 8 super-subjects. An additional goal of the analysis was to create super-subjects for whom there were no missing data. Since any single subject was bound to have
made an error on at least one item, it was inevitable that there were missing data in the original analysis. By collapsing across subjects to create super-subjects, the problem of missing data was alleviated. Analysis by super-subject revealed a significant advantage for associatively-related words over associatively-related pictures, $F(1, 7) = 14.54, p < .01$. In addition, just as in the foregoing analyses, that effect was reversed for semantic pairs, with a significant advantage for semantically-related pictures over semantically-related words, $F(1, 7) = 75.17, p < .01$.

Additional support for the results of the analysis of latencies by super-subject is provided by the error analyses. The effects detailed above were also significant in the error analysis by subject and the error analysis by item, $p < .05$. However, in the error analyses, semantically-related pictures were not significantly different from semantically-related words, $F(1, 39) = 2.18, p = .15$ (i.e., in the error analysis by subject), although the difference was in the predicted direction.

Finally, with respect to the latency data, there were no significant main effects of, or interactions between, counterbalancing factors. That is, there were no
significant main effects for the order of presentation of items, the arrangement of items on the computer screen (i.e., which item was on the right or left), or whether subjects viewed pictures or words first, with $F < 1.00$ for each test, and there were no significant interactions between those variables, with $F < 1.00$ for each test. The analysis of latencies by item (i.e., collapsed across subjects) revealed the same results.

**Summary of the latency data.** Overall, then, the latency data are consistent with the notion that pictures have privileged access to information in semantic memory. Subjects required less time to respond to semantically-related pairs when they were pictures than when they were words. On the other hand, words seem to have privileged access to information in permanent memory concerning nonsemantic associations, and that is supported by data indicating that subjects required less time to respond to nonsemantic associates when they were words than when they were pictures.

**Error Data**

Error data are listed by type-of-stimulus and type-of-association in Table 4. Analyses of the between-subjects factors revealed no significant main effects of, or
interactions between those variables at the .05 level. No speed-accuracy trade-off was evident, since subjects generally made fewer errors on items that yielded faster performance, and the correlation between latencies and errors was .50.

The interaction between type-of-stimulus and type-of-association was significant, $F(1, 32) = 14.80, p < .001$, in the error analysis by subject, and it was also significant in the error analysis by item at the .01 level. Errors for associatively-related pictures were significantly higher than for associatively-related words in the subject analysis, $F(1, 39) = 16.80, p < .01$, and in the analysis by items, $F(1, 24) = 6.78, p = .016$, and that effect was reversed for semantic pairs (i.e., with semantically-related words yielding more errors than semantically-related pictures, but, as was mentioned previously, it was not significant $F(1, 39) = 2.18, p > .10$ (for the analysis by subjects).

Discussion

The results of Experiment 4 indicate that pictures have privileged access to information about category membership in semantic memory, and that privilege does not depend upon the perceptibility of the stimulus. In fact,
when optimally-sized words and optimally-sized pictures are employed (i.e., as prescribed by the results of the second experiment), subjects still make faster, more accurate judgments about semantic associations between pictures than between words. That observation is particularly important, because it contradicts the assertions of Theios and Amrhein (1989). Moreover, it does so in the context of an investigation that employed pictures which are non-arbitrary representations of real-world objects, rather than employing pseudo-symbolic geometric shapes (Theios & Amrhein) or logos (Haase & Theios, 1992).

The advantage for pictures over words with respect to making semantic judgments suggests that pictures have a more direct way of activating information in semantic memory, and that is consistent with Glaser and Glaser's (1989) conceptualization of permanent memory and with the generic model set forth by Seifert and Johnson (in press). That observation is inconsistent with Theios and Amrhein's (1989) model of memory which supposes that pictures and words activate information in semantic memory (i.e., the abstract conceptual processor; Theios & Amrhein, 1989) through mediational processes in auxiliary memory.
structures (i.e., the surface linguistic processor and the surface pictorial processor).

In that Theios and Amrhein (1989) have accounted for activation of semantic memory through mediational processes for both pictures and words, and because they assume that mediation requires the same amount of time for both types of stimuli, then no difference in latencies is expected in categorization. Overall, the current data suggest that activation of semantic information may be more direct for pictures than for words, with the semantic processing of words requiring lexical mediation, and that is inconsistent with the prediction of Theios and Amrhein.

The Glaser and Glaser (1989) model, as well as the generic model of Seifert and Johnson (in press), predicts an advantage for pictures over words with respect to semantic judgments. Those models demand that effect, because in both cases activation of information in semantic memory is assumed to be mediated by access to lexical entries for word stimuli, but not for picture stimuli. In conceptualizing permanent memory, Glaser and Glaser proposed that nonlinguistic stimuli like pictures and colors have direct access to information in semantic memory, without the requirement of lexical access. Thus,
pictures should have an advantage over words when tasks require semantic judgements, without demanding lexical access (i.e., requiring a keypress response rather than a verbal one).

The observed advantage in Experiment 4 for words over pictures, with respect to associatively-related pairs, supports the notion that nonsemantic associations may be stored as links between entries in the lexicon, as suggested by the data Pattee (1982) reported. Furthermore, the data from Experiment 4 provide an insight into the manner in which those types of associations might develop (e.g., through experience with two items that occur together often). As mentioned previously, that effect was significant in the analysis of latencies by item, in the analysis of errors by item, in the analysis of errors by subject, and in the additional analysis of latencies by super-subjects. It was not significant in the original subject analysis of latencies ($p = .259$), but in that case the difference was in the predicted direction.

Overall, analyses support the notion that processing of nonsemantic associations is faster and more accurate for words than pictures. Taken together, the analyses indicate that information in permanent memory concerning nonsemantic
associations is activated more directly for words than for pictures, and in the current experiment faster performance for associatively-related words cannot be ascribed to faster processing at the output stage of performance, because the required response was manual, rather than verbal.

Perhaps, nonsemantic associations are represented as links between lexical entries, and, as such, can be activated directly by word stimuli. If that were true, then one would expect that pictures would not have that privilege and that activation of those associations by pictures would require mediation. Pictures would activate information in semantic memory first, and then, only afterward, would information in the lexicon concerning nonsemantic associations become available.
CHAPTER VI
GENERAL DISCUSSION

The critical results of the current experiments reside in data from Experiments 2 and 4. Although, the norming studies (i.e., Experiments 1 and 3) were invaluable in providing a basis for selecting the appropriate stimuli for the second and fourth studies, they add little to a conceptual understanding of picture and word processing. For that reason, the following discussion will focus on the results of Experiments 2 and 4.

Experiment 2 of the current series demonstrated that words have an advantage over pictures in a naming task, regardless of the size of stimuli utilized. That result is not in direct conflict with either Glaser and Glaser's (1989; see also Glaser, 1992) or Theios and Amrhein's (1989) theory, because both sets of researchers maintain that words have privileged access to information in the lexicon. Furthermore, it is assumed that privilege allows word naming to be so rapid as to preclude any detriment
from using words that are less perceptible, than pictures. However, considering the results of Experiment 2 and the previous discussion of theories set forth by Theios and Amrhein and by Glaser and Glaser, overall, the data (i.e., from Experiment 2) are far more consistent with Glaser and Glaser's predictions than with Theios and Amrhein's.

Specifically, with respect to categorization, the results of Experiment 2 are inconsistent with Theios and Amrhein's (1989) theory of picture and word processing. The key result is that even when one compares the slowest mean latency for picture categorization (i.e., for size 1 pictures) to the fastest mean latency for word categorization (i.e., for size 2 words), pictures still have an advantage of 21 ms (see Table 1). Furthermore, when one compares the optimal (i.e., fastest) performance for picture categorization (i.e., for size 2) to the optimal (i.e., fastest) performance for word categorization (i.e., size 2), pictures have an advantage of 57 ms.

Those results are inconsistent with Theios and Amrhein's (1989) theory. In fact, they contradict one of the most important tenets of their model, which contends that equating pictures and words with respect to perceptibility should, by necessity, abolish any apparent
advantage that pictures have over words in a categorization task. Theios and Amrhein suggested that pictures appear to have privileged access to information in semantic memory merely because all previous investigations have employed large pictures and smaller words, thereby making the pictures more perceptible.

Theios and Amrhein (1989) proposed that semantic memory is, in fact, accessed indirectly by both pictures and words through specialized "surface" processors, and employing pictures and words that are of equivalent perceptibility should make that indirect access evident. As was mentioned previously, they investigated their claim by employing a conceptual classification task. They required subjects to view two items in succession (e.g., two words, two pictures, or a word and a picture) and to judge whether the second item represented the same thing as the first. They observed that subjects required no more time to make such a decision about a word than about a picture, provided all items subtended a visual angle of at least 3 degrees (see Theios and Amrhein, 1989).

However, as was mentioned previously, Theios and Amrhein (1989) utilized pictures that are not realistic 2-dimensional representations of real-world objects. Instead,
they employed rows of shapes (e.g., "o000000"), and those are abstract representations of features of real-world objects. For that reason, shapes may be called pseudo-symbolic. They are abstractions, and they may be more like words than like realistic, 2-dimensional representations of real-world objects (e.g., a line drawing of a dog). Thus, Theios and Amrhein's second experiment may indicate that pseudo-symbolic pictures are classified in about the same amount of time as words, but that observation may not generalize to comparisons between categorizing realistic pictures of real-world objects and categorizing words.

Clearly, the results of Experiment 2 are inconsistent with the notion that pictures and words access semantic memory in the same amount of time, provided an optimally-sized stimulus is employed. Those data are much more consistent with Glaser and Glaser's (1989; see also Glaser, 1992) view. Glaser and Glaser proposed that pictures and other nonlinguistic stimuli (e.g., objects, colors) have more direct access to semantic memory than do words. On the other hand, they suggested that words can only access semantic memory through mediation by the lexicon. That would explain the advantage for pictures over words in tasks requiring access to semantic memory, but not
requiring lexical access (e.g., a categorization task employing a keypress response), because direct access (i.e., for pictures) should be faster than mediated access (i.e., mediation via the lexicon for words).

With respect to the results of Experiment 4, another set of questions arises beyond the issue of privileged access to semantic memory for pictures. In Experiment 4, another issue took precedence, and that is whether words or pictures may have an advantage when speeded judgments about associational relationships are required. A response-time advantage of that sort might indicate where such associations are stored in permanent memory (i.e., in the lexicon or in semantic memory) since words presumably have privileged access to the lexicon and pictures have privileged access to semantic memory.

First, the results of Experiment 4 support the conclusions from Experiment 2 that pictures have privileged access to information in semantic memory. When subjects in Experiment 4 made speeded judgments about items being related, pictures enjoyed a considerable advantage over words when items were semantically related (see Tables 3 and 4). However, when subjects made the same type of judgment about associated items (i.e., items that are
associated, but not in the same category; e.g., MOUSE-CHEESE), words had an advantage over pictures.

It would be reasonable to suggest, then, that information about nonsemantic associations is stored as lexical-lexical links in permanent memory. That is, since words had an advantage over pictures when judgments about nonsemantic associations were required, it indicates that such information is more directly available for words than for pictures. That also would suggest that the information is stored in the lexicon, rather than in semantic memory, and it supports the observations of Pattee (1982).

Despite the fact that the observations about nonsemantic associations from Experiment 4 do not fit neatly into a pre-existing theory of permanent memory, it would not be difficult to incorporate them into Glaser and Glaser’s (1989) model. That would entail simply stipulating that nonsemantic associations are stored in the lexicon, as opposed to semantic memory. The predictions that would follow from that assumption would be consistent with the current data, because they would presuppose privileged access to the lexicon for words.

In conclusion, the data from Experiment 2 seem to strongly support the notion that words have privileged
access to the lexicon and that pictures have privileged access to semantic memory. Furthermore, the observations from Experiment 4 strongly suggest that information concerning nonsemantic, spatial-temporal associations is stored in the lexicon, while information about meaning-based, semantic associations is stored in semantic memory.
APPENDIX A

Stimulus Lists
### List of Categories Derived in Experiment 1

<table>
<thead>
<tr>
<th>Animals</th>
<th>Words*</th>
<th>Pictures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel</td>
<td>w = 37</td>
<td>p = 39</td>
</tr>
<tr>
<td>Cat</td>
<td>w = 37</td>
<td>p = 31</td>
</tr>
<tr>
<td>Cow</td>
<td>w = 39</td>
<td>p = 33</td>
</tr>
<tr>
<td>Dog</td>
<td>w = 39</td>
<td>p = 28</td>
</tr>
<tr>
<td>Elephant</td>
<td>w = 40</td>
<td>p = 32</td>
</tr>
<tr>
<td>Fish</td>
<td>w = 36</td>
<td>p = 25</td>
</tr>
<tr>
<td>Fox</td>
<td>w = 46</td>
<td>p = 37</td>
</tr>
<tr>
<td>Frog</td>
<td>w = 31</td>
<td>p = 25</td>
</tr>
<tr>
<td>Horse</td>
<td>w = 41</td>
<td>p = 36</td>
</tr>
<tr>
<td>Lion</td>
<td>w = 39</td>
<td>p = 35</td>
</tr>
<tr>
<td>Pig</td>
<td>w = 46</td>
<td>p = 37</td>
</tr>
<tr>
<td>Rabbit</td>
<td>w = 44</td>
<td>p = 42</td>
</tr>
<tr>
<td>Squirrel</td>
<td>w = 48</td>
<td>p = 37</td>
</tr>
<tr>
<td>Tiger</td>
<td>w = 35</td>
<td>p = 35</td>
</tr>
</tbody>
</table>

**Clothing**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot</td>
<td>w = 20</td>
<td>p = 23</td>
</tr>
<tr>
<td>Coat</td>
<td>w = 36</td>
<td>p = 41</td>
</tr>
<tr>
<td>Dress</td>
<td>w = 43</td>
<td>p = 46</td>
</tr>
<tr>
<td>Glove</td>
<td>w = 31</td>
<td>p = 33</td>
</tr>
<tr>
<td>Hat</td>
<td>w = 28</td>
<td>p = 32</td>
</tr>
<tr>
<td>Mitten</td>
<td>w = 31</td>
<td>p = 31</td>
</tr>
<tr>
<td>Pants</td>
<td>w = 42</td>
<td>p = 49</td>
</tr>
<tr>
<td>Shirt</td>
<td>w = 46</td>
<td>p = 47</td>
</tr>
<tr>
<td>Shoe</td>
<td>w = 27</td>
<td>p = 25</td>
</tr>
<tr>
<td>Skirt</td>
<td>w = 42</td>
<td>p = 49</td>
</tr>
<tr>
<td>Sock</td>
<td>w = 34</td>
<td>p = 44</td>
</tr>
<tr>
<td>Vest</td>
<td>w = 37</td>
<td>p = 45</td>
</tr>
</tbody>
</table>

*The number listed is the number of subjects out of 52 who generated the specified superordinate category label for a particular word or picture.*
LIST I (continued)

Additional Categories Derived in Experiment 1

<table>
<thead>
<tr>
<th>Body Parts</th>
<th>Words</th>
<th>Pictures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>Ear</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Eye</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>Finger</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Foot</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td>Hand</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>Leg</td>
<td>41</td>
<td>36</td>
</tr>
<tr>
<td>Nose</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>Thumb</td>
<td>18</td>
<td>23</td>
</tr>
</tbody>
</table>

1. Bed    | 40    | 38       |
2. Chair  | 43    | 46       |
3. Couch  | 42    | 49       |
4. Desk   | 42    | 43       |
5. Lamp   | 30    | 26       |
6. Stool  | 29    | 24       |
7. Table  | 46    | 48       |

<table>
<thead>
<tr>
<th>Transportation/vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane</td>
</tr>
<tr>
<td>Bicycle</td>
</tr>
<tr>
<td>Bus</td>
</tr>
<tr>
<td>Car</td>
</tr>
<tr>
<td>Motorcycle</td>
</tr>
<tr>
<td>Train</td>
</tr>
<tr>
<td>Truck</td>
</tr>
</tbody>
</table>

*The number listed is the number of subjects out of 52 who generated the specified superordinate category label for a particular word or picture.*
LIST I (continued)

Additional Categories Derived in Experiment 1

<table>
<thead>
<tr>
<th>Kitchen Utensils</th>
<th>Words*</th>
<th>Pictures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fork</td>
<td>v = 39</td>
<td>p = 30</td>
</tr>
<tr>
<td>2. Knife</td>
<td>v = 27</td>
<td>p = 31</td>
</tr>
<tr>
<td>3. Spoon</td>
<td>v = 34</td>
<td>p = 29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appliances</th>
<th>Words*</th>
<th>Pictures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stove</td>
<td>v = 30</td>
<td>p = 40</td>
</tr>
<tr>
<td>2. Toaster</td>
<td>v = 28</td>
<td>p = 40</td>
</tr>
</tbody>
</table>

*The number listed is the number of subjects out of 52 who generated the specified superordinate category label for a particular word or picture.
LIST I (continued)

Pictures Normed in Experiment 1 and
Not Appearing in Snodgrass and Vandervart (1980)*

1. Cheese
2. Egg(s)
3. Head
4. Hive
5. Nest
6. Net
7. Rake
8. Street
9. Web
10. Witch

*All other pictures for Experiment 1 can be found in Snodgrass and Vandervart (1980). Copyright laws prohibit them from being printed here.
## LIST II

**Stimulus Pairs for Experiment 4**

<table>
<thead>
<tr>
<th>Unrelated</th>
<th>Semantic</th>
<th>Associational</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. couch-eggs</td>
<td>1. eye-arm</td>
<td>1. toaster-bread</td>
</tr>
<tr>
<td>2. spoon-hive</td>
<td>2. bicycle-motorcycle</td>
<td>2. anchor-boat</td>
</tr>
<tr>
<td>3. camel-flower</td>
<td>3. cat-elephant</td>
<td>3. street-car</td>
</tr>
<tr>
<td>4. bowl-fox</td>
<td>4. finger-foot</td>
<td>4. ashtray-cigarette</td>
</tr>
<tr>
<td>5. coat-fish</td>
<td>5. car-train</td>
<td>5. hat-head</td>
</tr>
<tr>
<td>6. banana-hat</td>
<td>6. bed-table</td>
<td>6. hair-comb</td>
</tr>
<tr>
<td>7. ring-rake</td>
<td>7. cow-dog</td>
<td>7. rabbit-carrot</td>
</tr>
<tr>
<td>8. witch-elephant</td>
<td>8. vest-pants</td>
<td>8. tree-apple</td>
</tr>
<tr>
<td>9. carrot-foot</td>
<td>9. arm-nose</td>
<td>9. witch-broom</td>
</tr>
<tr>
<td>10. dress-lion</td>
<td>10. lion-frog</td>
<td>10. bee-hive</td>
</tr>
<tr>
<td>11. rake-bed</td>
<td>11. hand-leg</td>
<td>11. banana-monkey</td>
</tr>
<tr>
<td>12. ashtray-cheese</td>
<td>12. fox-horse</td>
<td>12. rake-leaf</td>
</tr>
<tr>
<td>13. hair-anchor</td>
<td>13. ear-hand</td>
<td>13. eye-glasses</td>
</tr>
<tr>
<td>15. vase-cheese</td>
<td>15. rabbit-squirrel</td>
<td>15. coat-hanger</td>
</tr>
<tr>
<td>16. hive-anchor</td>
<td>16. shirt-coat</td>
<td>16. web-spider</td>
</tr>
<tr>
<td>17. bicycle-ashtray</td>
<td>17. desk-table</td>
<td>17. mouse-cheese</td>
</tr>
<tr>
<td>18. knife-nest</td>
<td>18. foot-ear</td>
<td>18. fish-net</td>
</tr>
<tr>
<td>19. cigarette-squirrel</td>
<td>19. tiger-camel</td>
<td>19. vase-flower</td>
</tr>
<tr>
<td>20. bird-shirt</td>
<td>20. knife-spoon</td>
<td>20. glove-hand</td>
</tr>
</tbody>
</table>
LIST II (continued)

Stimulus Pairs for Experiment 2

<table>
<thead>
<tr>
<th>Unrelated</th>
<th>Semantic</th>
<th>Associational</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. bread-train</td>
<td>22. spoon-fork</td>
<td>22. hair-brush</td>
</tr>
<tr>
<td>23. spoon-motorcycle</td>
<td>23. ring-finger</td>
<td>24. chicken-eggs</td>
</tr>
<tr>
<td>24. toaster-cow</td>
<td>24. chicken-eggs</td>
<td>25. foot-boot</td>
</tr>
<tr>
<td>25. eggs-lamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. couch-toaster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. cigarette-dog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. vase-hair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. banana-bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. witch-camel</td>
<td></td>
<td></td>
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<tr>
<td>31. toaster-motorcycle</td>
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<td>32. arm-train</td>
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<tr>
<td>33. carrot-hat</td>
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<tr>
<td>34. web-train</td>
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<td></td>
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<tr>
<td>35. hair-knife</td>
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<tr>
<td>36. vase-rake</td>
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<td>37. tiger-anchor</td>
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<td>38. ashtray-lion</td>
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<tr>
<td>39. comb-frog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Items</td>
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<tr>
<td>------------</td>
<td></td>
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</tr>
<tr>
<td>1. Cheese</td>
<td></td>
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<tr>
<td>2. Cowboy</td>
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<tr>
<td>3. Earthworm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Egg(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Hive</td>
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<td></td>
</tr>
<tr>
<td>8. Honey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Hunter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Lady</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Net</td>
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</tr>
<tr>
<td>12. Nest</td>
<td></td>
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</tr>
<tr>
<td>13. Pail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Rake</td>
<td></td>
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</tr>
<tr>
<td>15. School</td>
<td></td>
<td></td>
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<tr>
<td>16. Stamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Street</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Witch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Web</td>
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<td></td>
</tr>
</tbody>
</table>

*As noted in the text, some of the above items were excluded from use in Experiment 4, because they had no single high-frequency associate.*
APPENDIX B

Tables
Table 1

**Mean Latencies (in msec) for Experiment 2**

### Naming

**Stimulus Size**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture</td>
<td>630</td>
<td>597</td>
<td>595</td>
<td>583</td>
<td>580</td>
</tr>
<tr>
<td>Word</td>
<td>376</td>
<td>376</td>
<td>378</td>
<td>382</td>
<td>407</td>
</tr>
<tr>
<td>Means</td>
<td>503</td>
<td>487</td>
<td>487</td>
<td>483</td>
<td>494</td>
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</tbody>
</table>

### Categorization

**Stimulus Size**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture</td>
<td>689</td>
<td>653</td>
<td>669</td>
<td>651</td>
<td>659</td>
</tr>
<tr>
<td>Word</td>
<td>725</td>
<td>710</td>
<td>716</td>
<td>736</td>
<td>749</td>
</tr>
<tr>
<td>Means</td>
<td>707</td>
<td>682</td>
<td>693</td>
<td>699</td>
<td>704</td>
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</table>
Table 2

Mean Percent Errors for Experiment 2

**Naming**

<table>
<thead>
<tr>
<th>Stimulus Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Picture</strong></td>
<td>2.50</td>
<td>1.76</td>
<td>2.22</td>
<td>1.94</td>
<td>1.20</td>
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<tr>
<td><strong>Word</strong></td>
<td>0.28</td>
<td>0.28</td>
<td>0.09</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td>1.39</td>
<td>1.02</td>
<td>1.16</td>
<td>1.20</td>
<td>0.83</td>
</tr>
</tbody>
</table>

**Categorization**

<table>
<thead>
<tr>
<th>Stimulus Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Picture</strong></td>
<td>2.27</td>
<td>1.80</td>
<td>1.53</td>
<td>1.76</td>
<td>1.94</td>
</tr>
<tr>
<td><strong>Word</strong></td>
<td>2.22</td>
<td>2.22</td>
<td>1.34</td>
<td>1.94</td>
<td>1.85</td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td>2.25</td>
<td>2.01</td>
<td>1.44</td>
<td>1.85</td>
<td>1.90</td>
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</table>
Table 3

Mean Latencies (in msec) for Experiment 4

<table>
<thead>
<tr>
<th>Type of Association</th>
<th>Means</th>
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</thead>
<tbody>
<tr>
<td>Semantic</td>
<td>associative</td>
</tr>
<tr>
<td>Type of Stimulus</td>
<td></td>
</tr>
<tr>
<td>Picture</td>
<td>946</td>
</tr>
<tr>
<td>Word</td>
<td>1034</td>
</tr>
<tr>
<td>Means</td>
<td>990</td>
</tr>
</tbody>
</table>
Table 4

Mean Percent Errors for Experiment 4

<table>
<thead>
<tr>
<th>Type of Association</th>
<th>Type of Stimulus</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Picture</td>
<td>0.638</td>
</tr>
<tr>
<td></td>
<td>Word</td>
<td>0.986</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>0.812</td>
</tr>
</tbody>
</table>
LIST OF REFERENCES


Cattell, J.M. (1886). The time it takes to see and name objects. Mind, 11, 63-65.


Pattee, J. J. (1982). A study of the associational responses to equivalent stimuli in English and Spanish of college students at three different levels of instruction in beginning Spanish courses. Unpublished dissertation at The Ohio State University.


