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Pictures and Names: Making the Connection

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In order to identify an object sensory input must somehow access stored information. A series of results supports two general assertions about this process: First, objects are identified first at a particular level of abstraction which is neither the most general nor the most specific possible. Time to provide names more general than "entry point" names is predicted by the degree of association between the "entry point" concept and the required name, not by perceptual factors. In contrast, providing more specific names than that corresponding to the "entry point" concept does require more detailed perceptual analysis. Second, the particular entry point for a given object covaries with its typicality, which affects whether or not the object will be identified at the "basic" level. Atypical objects have their entry point at a level subordinate to the basic level. The generality and usefulness of the notion of "basic level" is discussed in the face of these results.

The apparent ease with which people identify common objects belies the subtlety and complexity of the operations and structures involved in

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such identifications. Somehow, a visual stimulus must be consistently mapped into a single (or small set) of representations in memory. This mapping is dependent on both perceptual factors (such as an object's shape) and cognitive factors (such as context—see Biederman, 1972; Biederman, Glass, & Stacy, 1973; Palmer, 1975). The identification of objects stands at the interface between perception and semantic memory, and hence an understanding of perceptual identification will place broad constraints on more general aspects of human cognition.

There is a substantial body of research suggesting that objects are identified first at a particular level of abstraction. For example, an apple is named or matched with the name "apple" faster than with "Delicious apple" or with "fruit" (Brownell, 1978; Hutcheon, 1970; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Segui & Fraisse, 1968; Smith, Balzano, & Walker, 1978). This line of thinking has been elegantly studied by Rosch and her colleagues and has led to the concept of "basic level" (Rosch et al., 1976; Rosch, 1978).

The basic level was defined empirically by Rosch et al. (1976) by the convergence of four experimental procedures. First, subjects were asked to list as many attributes and properties of verbally specified categories (such as bird, robin) as they could think of during a brief period of time (between 1 and 2 min). More people list the same attributes (called common attributes) for different objects belonging to the same basic-level concept than for objects belonging to more abstract concepts. Second, subjects were asked to describe motor behaviors they would emit in the presence of specific objects. More common motor behaviors were listed for basic-level categories than for categories at other levels. Third, objects belonging to the same basic-level category have a greater degree of shape overlap (when considering cannonical depictions) than do objects belonging to the same superordinate category but not the same basic-level category; and objects belonging to the same basic-level category do not have significantly less overlap than do objects belonging to the same subordinate-level category. And fourth, subjects were presented with drawings created by averaging the outlines of two shapes. The task consisted of naming the category to which the object belonged. Category membership could be identified from the average of the shapes of two members of a basic-level category as well as when averaging shapes from a subordinate-level category, but people were much worse at identifying category membership when the shapes were drawn from different basic-level categories belonging to a given superordinate category. For example, people easily recognized the outline shape created by averaging a Golden Delicious apple and a MacIntosh apple as an apple and with equal ease recognized the outline formed by averaging two different MacIntosh apples. However, people had difficulty in identifying the average of an apple and of a banana as a member of the category fruit. All four experimental procedures converged in implicating a particular level of abstraction, which was called the "basic level." In the experiments we present in this paper we explore the role of the basic level and the role of typicality in determining the level of abstraction at which objects are identified.

There are several empirical findings that demonstrate that people can name objects or match names with pictures faster at the basic level than at other levels (Brownell, 1978; Hutcheon, 1970; Rosch et al., 1976; Segui & Fraisse, 1968; Smith et al., 1978). One interpretation of these results is that objects are first identified at the basic level, and that this initial identification causes speedy naming and matching at this level. The basic-level advantage has been found also when using artificial tool-like objects paired with arbitrary names (Murphy & Smith, 1982). This evidence suggests that the effects associated with basic level concepts were not confounded by factors such as word frequency, conjoint frequency of pictures and names, order of learning (i.e., whether one learns the basic-level name first or later, see Anglin, 1977), or by the length of the names at the different levels, which could have explained earlier results. Despite the ample demonstrations of the effects and importance of the basic level, there have been no experiments specifically designed to study the processing responsible for the basic-level advantage. Little is known about how objects are identified at this level or at more specific or more general levels.

EXPERIMENT 1

If people really do identify objects first at the basic level, how is superordinate-level identification achieved? Two straightforward possibilities immediately come to mind. The first involves a process of "semantic mediation": Objects are first identified at the basic level, and then are categorized into superordinate classes using information in semantic memory. A second possible mechanism involves no semantic mediation. Rather, identification at the basic level and at the superordinate level proceed by "purely perceptual processes," but these processes are slower for superordinate-level concepts than for basic-level concepts.

Anderson and Reder (1974) suggested something like the "semantic-mediation" hypothesis for semantic decisions about category membership using words as input. Anderson and Reder (1974), using multiple regression techniques, provided evidence that subjects decide that an object does not belong to a specified class of objects by retrieving the superordinate concept to which the objects belong and comparing this concept with the one specified. In contrast, a model similar to the "purely perceptual" point of view has been proposed by Murphy and Smith (1982).

In their view, superordinate-level categorization is slower than basic-level categorization because superordinate concepts are more perceptually disjoint, and thus require more features to be extracted from the stimulus and matched to stored memory representations.

The two notions make different predictions about the necessity of activating the basic level when making superordinate-level decisions using pictures as input. On the semantic-mediation hypothesis, the activation of basic-level concepts is a necessary step to achieve superordinate-level categorization, whereas on the purely peceptual hypothesis, the basic level is normally activated first, but this activation is not necessary in order to achieve superordinate-level categorization.

On the face of things, it seems unlikely that people routinely identify objects directly at levels more abstract than the basic level. What set of perceptual attributes distinguishes fruits from vegetables, or vehicles from weapons? Furthermore, as Rosch et al. (1976) have shown, the basic level is the most abstract level at which people are able to form an integrated perceptual representation of a category. However, it is possible that people can match the incoming image with a disjoint set of visual features that together represent the superordinate category (perhaps by combining some representative exemplars). Thus, this process may allow one to access superordinate-level concepts directly without prior access of basic-level representations. Furthermore, because the set of features is disjoint (i.e., one set of features does not represent the whole category), more time would be required to make the match between the perceptual input and a superordinate concept. This would explain why more time is required to name an object using a superordinate name, or to make a positive match between an object and a superordinate word.

Consider a simple task: A person sees a written word or sees a picture, for example the word "apple" or a picture of an apple, and says the superordinate name corresponding to the word or picture (in this case, "fruit"). In order to say "fruit" when the word "apple" is presented, it seems that one must activate the concept corresponding to the word (i.e., the concept of "apple"). Then, one activates the appropriate superordinate via one's knowledge of class membership. Thus, when a word is to be categorized at a superordinate level, one cannot proceed directly from the word to the superordinate concept. Rather, processing proceeds via the activation of a concept associated with the word (which is at the basic level in our example), followed by a search of semantic memory.

The important issue here concerns the kind of processing involved when a picture must be named at a level superordinate to the basic level. Suppose that the time to provide a superordinate after reading a basic-level name is positively correlated with the time to name the corresponding picture using its superordinate-category name. This is exactly what we would expect if both tasks, naming the picture and providing the word's superordinate, involve the activation of the basic-level concept. Models positing direct perceptual access to superordinates do not make this prediction; in these models there is no a priori reason to expect that the processes invoked when the word "apple" is to be named "fruit" should have anything in common with the "direct perceptual processes" required to encode a picture of an apple as a member of the category "fruit." Thus, if there is a positive correlation between naming a picture and naming a word at a level superordinate to the basic level, we will have evidence that the process of naming a picture at the superordinate level involves the activation of the basic level followed by a search of semantic memory.

Method

Subjects

Eight Harvard undergraduates, all native speakers of English, volunteered to participate as paid subjects. No subject in this experiment participated in any other experiment reported in this paper.

Materials

The stimuli were 24 slides (35 mm) of watercolor pictures drawn by a professional artist. The pictures consisted of six exemplars from four categories. The four categories were fruit, vegetable, clothing, and furniture. According to earlier research these categories are at the superordinate level and their members are at the basic level (Rosch et al., 1976; Smith et al., 1978). For each category, three exemplars were typical and three exemplars were atypical members of the category. Typicality was determined by mean ratings obtained in a prior ratings experiment. A list of 28 words that included the basic-level names of the objects and the four category names was also used. The names of the exemplars used are included in Appendix 1. Two different random orders of these items were prepared. Four additional words and pictures were used in practice trials.

Procedure

Subjects were first familiarized with the four category names and with the six exemplar names associated with each category. Subjects heard the complete list of names and attempted to recall it after each of two successive presentations. After the second recall attempt, the experimenter read any words on the list that were omitted by the subject on the final trial. Every subject performed every one of four subtasks, as quickly as possible while keeping errors to a minimum. These subtasks were (1) reading a word presented on a cathode ray tube, (2) saying the superordinate name of a word presented on a cathode ray tube, (3) naming a picture using a basic-level name, and (4) naming a picture using a superordinate-level name.

For half the subjects, the first two tasks were those involving words, whereas for the other subjects the first two tasks were those involving pictures. The order of the different word-naming and picture-naming tasks was counterbalanced within each of these groups. The two word-naming and picture-naming blocks used two different random orderings of the complete set of stimuli. These orders were counterbalanced with the order in which the subjects performed the various subtasks. Every subject performed the entire sequence of

TABLE 1
Correlation Matrix for Naming Times in the Four Tasks of Experiment 1

	W_{basic}	W_{super}	P_{basic}	P_{super}
W_{basic}	1	−.08	.34**	−.04
W_{super}		1	−.04	.52**
P_{basic}			1	.14*
P_{super}				1

Note. The cases in the correlation are the means of the four replications of a task for each subject (8), item (24), and condition. Thus, there were 192 cases (8 × 24). W_{basic} = name a word at the basic level (reading); W_{super} = name a word at the superordinate level; P_{basic} = name a picture at the basic level; P_{super} = name a picture at the superordinate level (* = .05, ** = .0001, two tailed). N = 192; all subjects and all four categories are presented.

four tasks a total of four times. The subjects were randomly assigned to counterbalancing conditions that differed in the order in which the four subtasks were performed. Each new task was preceded by a set of four practice trials.

Reaction time for each verbal response was measured from the onset of the stimulus to the onset of the verbal response, by means of a voice-activated relay. Once a block of trials was initiated, the interstimulus interval was 2 sec. The entire experiment required approximately 45 min per subject.

Results

Average verbal reaction times for each naming task and item (pooled over the four replications of each task) were computed for each subject. As a correction for obvious outliers, reaction times greater than twice the mean of the other replications were discarded, which resulted in the loss of less than 1% of the observations. When an observation was discarded a mean based on the remaining replications for that item, condition, and that subject was substituted for the rejected value.

The mean picture-naming time at the basic level was 736 msec (SE = 8.9), while it was 895 msec (SE = 12.9) at the superordinate level, $t(190) = 10.98$, $p < .0001$. This result replicates the finding that pictures are named faster at the basic level than at the superordinate level, and supports the claim that these objects are identified first at the basic level. The mean word naming time (i.e., reading) was 493 msec (SE = 4.2) at the basic level and 921 msec (SE = 11.9) at the superordinate level, $t(190) = 33.10$, $p < .0001$.

The correlations between the naming latencies for corresponding items in the four experimental tasks are presented in Table 1 (the individual cases going into these correlations are means over replications for different items in each task for each subject). As is evident in Table 1, the correlation between naming a picture at the category level and naming a written word at the category level is positive and highly significant.

TABLE 2
Correlation Matrices for Naming Times in the Four Naming Tasks in Experiment 1

	W_{basic}	W_{super}	P_{basic}	P_{super}
Fruit				
W_{basic}	1	−.09	.21	−.05
W_{super}		1	.34*	.57****
P_{basic}			1	.16
P_{super}				1
Clothing				
W_{basic}	1	−.18	.42**	−.05
W_{super}		1	−.20	.43**
P_{basic}			1	−.01
P_{super}				1
Vegetable				
W_{basic}	1	.01	.22	.01
W_{super}		1	.01	.57****
P_{basic}			1	.22
P_{super}				1
Furniture				
W_{basic}	1	−.19	.52****	−.07
W_{super}		1	−.08	.49***
P_{basic}			1	.20
P_{super}				1

Note. The cases going into the correlations are the mean times (over the four replications in each task) for subjects and items, within each of the four superordinate categories. Thus, there were 48 cases in each correlation (six items per category for each of eight subjects). W_{basic}, W_{super}, P_{basic}, & P_{super} have the same meaning as in Table 1 (* = .02, ** = .003, *** = .001, **** = .0001, two tailed). $N = 48$ for each category.

A correlational analysis was also performed on the data from each category considered separately. The main reason for this analysis is to eliminate the possibility that the observed correlations listed in Table 1 were due to response factors. That is, due to differences in the time to say the actual words in the different categories. In the data from a given category, the same name was the correct response (at the superordinate level) for all stimuli in the category. Thus, there should be no systematic variance associated with response factors in the data from a given category. The correlational results for each of the four categories are presented in Table 2. Again, in each of the categories, the correlation between naming a picture with a superordinate name and naming a word with the same superordinate name was positive and significant.

Separate correlations were computed for data from individual subjects using all the items. For every subject the correlation between word and picture superordinate naming was significantly greater than zero. This result demonstrates generality over subjects.

As a further precaution against possible artifacts produced by pooling, we computed 32 separate correlations between mean superordinate naming time for words and pictures using the data from each subject and each category. Six cases went into each correlation. Of these 32 correlations 25 were positive and 7 were negative ($p < .001$, by sign test), indicating that the positive correlations shown in Tables 1 and 2 are not an artifact of our pooling data over subjects or over response categories.

The correlation between reading a word and naming the corresponding picture using the same word was also significant in most cases (see Tables 1 and 2). These correlations are probably due to response factors, given that different responses were given to the different items when they were named at the basic level. In the aggregated data (Table 1) the correlation between the time to name a picture at the basic level and the time to name it at the superordinate level was marginally significant. This relation is not surprising if basic-level concepts must be activated in both cases. However, due to quite different semantic-memory and motor-output requirements in the two cases, the correlation is quite small. Only one other correlation of the 24 presented in Table 2 reached a significant magnitude: the correlation between the time to say the superordinate name of a written word and the time to name a picture at the basic level, for the category fruit. However, this result may well be due to chance given that this correlation was obtained in only one of the four categories, and it will not be discussed further.

Discussion

The results were as expected if two steps are required to identify visually presented objects as members of categories superordinate to the basic level: First, the basic-level concept is activated, and then one proceeds to search semantic memory—just as one would if the basic-level concept had been activated by a word. The significant positive correlations between naming pictures and words at the superordinate level suggest that the same processes are used to name words and pictures at the category level. For words, it seems virtually impossible to verbalize the category name without first reading the word itself and activating the concept associated with the word (which was the basic-level concept for the corresponding picture). Thus, it seems that the only reasonable explanation of our correlations between word and picture naming at the superordinate level is that pictures also required the activation of the basic-level concept before they could be named at this level. Also, the primacy of basic-level activation is supported by the shorter naming times at this level than at the superordinate level.

Our correlations are not an artifact of aggregating data from different subjects or from different response categories. First, if aggregating over subjects caused our correlations, then we would expect not just three significant positive correlations in Table 1; rather, all six would be positive and significant. Clearly this is not so. Also, correlations computed for each subject were significant in every case. Thus, we can be confident that the correlations are not due to some subjects responding quickly to all stimuli and other subjects responding more slowly to all stimuli. Another possible artifact could result from the fact that four different superordinate-level words were used in the experiment. Thus, if preparing to say and saying some of these words is slower than for some other words, then we would observe positive correlations between naming a word and the corresponding picture. However, this counterinterpretation does not apply to analyses performed on data from separate categories. In these data, the superordinate name was the same for all superordinate responses and thus could not contribute to the correlation. Finally, correlations computed on data for each category using data from each subject separately also showed a positive relation between superordinate naming for words and pictures. Thus, we can be confident that the observed relations are not due to aggregating artifacts.

Data from an experiment by Potter and Faulconer (1975) provide additional evidence that our correlations are not confined to our particular stimuli or subjects. Their subjects named 96 pictures and words using basic-level words. The correlation between the time to name each item using a word or a picture as input was .25 ($p < .02$, two tail), which is similar in magnitude to the correlation in this experiment (.34). In the same experiment, subjects also named the items using superordinate-level names (these results were not published in the original report),[1] and the correlation was .51 ($p < .0001$, two tail), which is also very similar in magnitude to the correlation in this experiment (.52).

Potter and Faulconer (1975) also report data in which subjects were provided with the name of a superordinate category before the presentation of one of their 96 pictures or one of the 96 corresponding basic-level words. The task consisted of pressing one button, as rapidly as possible, if the picture or word designated an object belonging to the category, and of pressing another button if the object did not belong to the category. In this task the correlation between picture and word superordinate categorization was much smaller than in the naming experiment, $r = .19$, $p > .06$, two tail, when the picture or word belonged to the category. Also, the correlation was near zero when the picture or word did not belong to the category, $r = .11$, $p > .28$, two tail. Thus,

[1] We thank Molly Potter for providing us with these results.

Potter and Faulconer obtained a correlation between pictures and words in the time to provide a superordinate category name, but not in the time to match a picture and a word to a superordinate category.

At first blush, these data could appear damaging to the notion that the correlation between picture and word categorization times in the *naming* case is due to the common activation of a basic-level concept followed by a search of long-term memory. If so, why should the correlation become so small or vanish when superordinate *matching* is required? The answer stems from the fact that subjects can prepare for particular exemplars when matching is involved, but they cannot prepare in the naming paradigm. When the category label is given before presenting a picture, subjects presumably can activate or prime the exemplars of the category (and/or their names—see Collins & Loftus, 1975). Upon seeing the picture (or the word), a match at the level of primed exemplars (or names) may often be sufficient to initiate a response. Thus, we would expect a reduced correlation (or no correlation) because the semantic-memory search may only occur on a fraction of the trials, and perhaps not at all.

The fact that the time to name a picture and the corresponding word at the superordinate level share a significant amount of variance strongly suggests that common mechanisms are involved in the two cases. Why then is the correlation not larger? A simple answer to this question is that the encoding processes for these two tasks are quite different. There is no reason to expect that the time to read a word and the time to encode the corresponding picture would have much in common. However, these processes should take some time to execute and contribute to the variance in the naming data, and thus attenuate the correlation between picture and word naming times.

EXPERIMENT 2

The results of Experiment 1 suggest that superordinate-level categorization of objects occurs after the necessary activation of its corresponding basic-level concept. Furthermore, we argued that the activation of the superordinate concept proceeds via semantic memory. In this experiment we provide further evidence for these claims and we examine how people identify objects as members of categories subordinate to the basic level.

On logical grounds, the semantic-memory search mechanism used for superordinate-level categorization cannot underlie how we identify members of superordinate-level concepts. Consider again the superordinate case. Suppose we have identified an object at the basic level and that we need a more general characterization. For example, we may know that an object is an apple but we wonder if it is a fruit. This decision can be made without the need for further perceptual analysis—one can infer the superordinate category name using only semantic information. In contrast, suppose that we have identified an object as a bird, but we wish to know if it is a robin. In this case we cannot unambiguously infer which of the several possible subordinates may have activated the basic-level concept. Thus, more information is required before one can decide whether the bird is a robin.

Rosch et al. (1976) suggested that basic-level concepts are activated faster than subordinate concepts because they are more perceptually distinctive (see also Seymour, 1973). On this view basic-level concepts have associated shapes that are quite different compared to that of other basic-level concepts, and thus are easy to discriminate. Subordinate concepts have more similar shapes and thus would be activated after a search for distinguishing features. Murphy and Smith (1982) suggest similar process but do not assume that basic concepts are privileged in any way with respect to subordinate concepts. In their *preparation model,* categorization at the basic level and at the subordinate level uses identical processes. However, subordinate categorization requires the extraction of additional features and results in longer response times (categorizing an object as a Delicious apple, for example, requires all the features of apple and then some). Current explanations of the superiority of categorization at the basic level over categorization at the subordinate level agree that the advantage results from the need for additional perceptual processing when categorizing object at levels subordinate to the basic level. However, there have been no experiments showing directly that additional perceptual processing is required for subordinate-level categorization. The purpose of this experiment is to demonstrate the presence of additional perceptual processes when people decide that an object belongs to a subordinate-level concept compared to decisions about category membership in a basic-level category. Also, we wish to provide converging evidence that assigning membership into superordinate-level categories does not involve additional perceptual processing, but rather proceeds via stored semantic information.

In this experiment subjects had either a relatively long period of time (the long-exposure condition) or only a short period of time (the short-exposure condition) to encode a picture. This difference in exposure duration was intended to create two conditions that differed in level of perceptual difficulty. Thus, differences in performance between the two conditions would be diagnostic of the involvement of perceptual processes. The task required subjects to decide whether a word named a picture seen previously. The word to be matched was either subordinate, at the same level as, or superordinate to the basic-level concept of the picture.

In the long-exposure condition we expected longer verification times whenever the word was at a level other than the basic level. Such results would provide a straightforward replication of the basic-level advantage. However, we expect the exposure time to have different effects on categorization at different levels. If additional perceptual processing is necessary for subordinate-level categorization, then verification should be more difficult when a subordinate name is used in the short-exposure condition than in the long-exposure condition. In the short-exposure condition the brief exposure of the picture should make it more difficult to extract the additional perceptual information required to categorize the object more specifically than at the basic level. Thus, subjects should make more errors and take more time to make their decisions.

In contrast to the large expected effect of exposure duration on subordinate-level categorization, the effects on superordinate-level categorization should be much smaller. Suppose that the activation of concepts superordinate to the basic level proceeds by activating the basic-level concept, and then solely via semantic memory, as suggested in Experiment 1. Then, the exposure duration of the picture should have little or no effect on the difference in the time to verify words that match the basic-level concept and the time to verify words that match the superordinate-level concept of the picture. If, on the other hand, perceptual processing is involved in superordinate categorization, then we expect to observe an effect of the degree of perceptual difficulty. If the results show an effect of exposure duration for subordinate concepts and no effect for superordinate concepts, we will have strong converging evidence that pictures are spontaneously identified first at a particular level of abstraction in memory. Furthermore, we will have additional evidence for the notion that superordinate concepts are activated via semantic memory rather than via slow "direct" perceptual processes.

Method

Subjects

Sixteen volunteer Harvard University summer school students and local high school students participated as paid subjects. All were native speakers of English and no subject in this experiment participated in any other experiment reported in this paper.

Materials

Twenty-four pictures were used in this experiment. Half of these picture were the 12 typical basic-level objects used in Experiment 1. The other half were 12 new typical objects; these were three member of the categories "bird," "boat," "car," and "dog" (see Appendix 1 for a complete list of the items). Note that the four new category names are at the basic level and that the item names for these categories are at the subordinate level, whereas for the four old categories (used in Experiment 1) the category names are at the superordinate level and the item names are at the basic level. In this paper, we will call the new categories Basic High categories and we will call the old categories Basic Low categories. Basic High categories are tested at the subordinate level and at the basic level and Basic Low categories are tested at the basic level and at the superordinate level. Thus, by comparing performance between these two sets of categories we can look at differences between basic and superordinate categorization (using the categories used in Experiment 1; i.e., Basic Low categories), and we can also look at differences between basic and subordinate categorization (using the four new categories; i.e., Basic High categories).

Procedure

Subjects saw a picture and 1 sec later they heard a word. The task was to decide whether the word correctly named the picture (at any level of categorization). If subjects heard a word that correctly named the picture they were to respond, as quickly as possible, by pressing the "true" key; otherwise they were to respond, as quickly as possible, by pressing the "false" key. Each picture was followed by a visual mask. The mask consisted of lines and patches of color drawn in watercolor (using the same tones as in the drawings of the stimulus objects) and lines drawn in felt-tip pen. The purpose of the mask was to eliminate afterimages or icons left by the presentation of the pictures and thus to terminate perceptual encoding of the pictures. The picture was in view for either 1000 msec (in the long-exposure condition) or 75 msec (in the short-exposure condition) before the onset of the mask, and the word was always presented 1000 msec after the onset of the picture. Subjects received eight practice trials before proceeding with the actual experiment.

Each of the 24 pictures was shown four times for a total of 96 trials. Of the 96 test trials, 48 were "true" and 48 were "false." In both the "true" and the "false" trials, 24 trials used exemplars from the categories "bird," "boat," "car," and "dog," and 24 trials used exemplars from "clothing," "fruit," "furniture," and "vegetable." All subjects saw the same sequence of 96 pictures; however, four different audio tapes of the words accompanied these pictures, allowing each individual picture to be paired once with a "true" or "false," exemplar or category word. For a given subject, each picture appeared either briefly on all four presentations (in the short-exposure condition), or for a long time on all four presentations (in the long-exposure condition). This constraint on presentation duration was to prevent a subject from using information about a picture garnered during a long-exposure presentation in a later trial involving only a brief presentation of the same picture. In each of the four tape sequences, half of the pictures were in the short-exposure condition and the other half were in the long-exposure condition. Two versions of the sequence were used for each tape, varying only in which pictures were presented at the two durations. Each picture occurred equally often in all eight different counterbalancing conditions in the experiment (two exposure durations, two word levels, and two truth values).

Two subjects were tested in each of the eight counterbalancing versions of the experiment. For each of the eight counterbalancing groups, one subject used his or her dominant hand for "true" responses and one used his or her dominant hand for "false" responses. The experiment was conducted in two consecutive blocks of 48 trials separated by a brief rest period.

Results

Reaction Times

The data from "true" trials were submitted to an analysis of variance in which we considered the effects of the level of the word (exemplar or category), type of category (categories with the basic level at the level of the items, Basic Low = "clothing," "fruit," "furniture," and "vegetables"; categories with the basic level at the level of the category name, "Basic High" = "bird," "boat," "car," and "dog"), exposure duration (75 or 1000 msec), subjects, and items.[2] (Exemplar names were at the subordinate level for Basic Low categories and at the basic level for Basic High categories.)

The mean verification time and percent error rate (in parentheses) for each condition are illustrated in Fig. 1. As can be seen in Fig. 1, we replicated the basic-level advantage reported in the literature while using a different paradigm than previously used (i.e., picture followed by a word): More time was required when the level of the word did not correspond to the level of the basic name of the picture, $F(1,15) = 60.0$, $p < .001$. However, this interaction between the level of the word and the level of the basic name was mitigated by the amount of time the picture was exposed. The interaction was exactly as predicted by the notion that additional perceptual information is necessary to activate the appropriate subordinate concept once an object has been identified at the basic level: When a short exposure duration was used, it was especially difficult to evaluate names subordinate to the basic level. This pattern of means resulted in a significant three-way interaction between word level, type of category (Basic High/Basic Low), and exposure duration, $F(1,15) = 12.6$, $p < .005$.

This pattern of times contributed to various other significant differences when the data contributing to the means illustrated in Fig. 1 were pooled. First, less time was required in Basic Low categories than in Basic High categories, $F(1,15) = 20.8$, $p < .001$. Second, responses were slower with exemplar-level words than with category-level words, $F(1,15) = 5.16$, $p < .05$. Third, responses were slower for categories with the basic level at the category level (Basic High), but this difference was greater in the short-exposure condition than in the long-exposure condition, $F(1,15) = 6.5$, $p < .05$. And fourth, although response times were about equal for exemplar and category level words in the long-exposure condition, responses for exemplar-level words were longer than for category-level words in the short-exposure conditon, $F(1,15) = 17.0$, $p < .001$.

In addition, to ensure that our results were not confined to only a few of our stimuli, we performed separate analyses on each of the items in

[2] In the analysis reported here, times from trials in which errors were committed were replaced by the mean of the other data points in its cell for that subject. Some concern may arise from this procedure because of the very high error rate in the short-exposure condition. For this reason we also performed an unweighted means analysis of variance in which we considered subjects, exposure duration, type of category, and level of word as factors. The results were identical in all important respects to those reported here. In particular, none of the probability values in the reported analysis need to be changed in light of the unweighted means analysis.

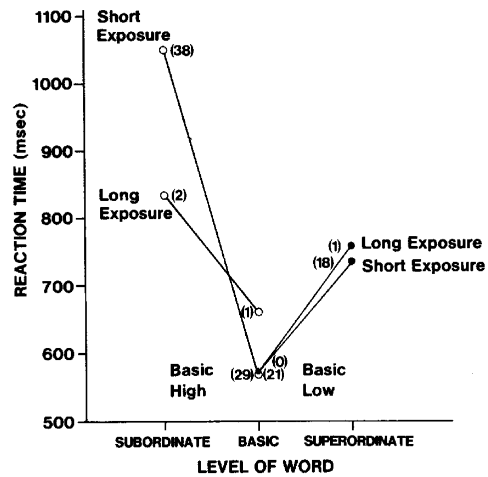

FIG. 1. Mean reaction time and percent error (in parentheses) in each condition of Experiment 2.

the experiment. First, consider the categories in which categorization was required at the basic level and at the superordinate level (Basic Low categories; fruit, vegetable, clothing, and furniture). Of these 12 items 11 required more time for superordinate verification than for basic verification, as expected, $p < .0032$ by sign test. Furthermore, for 11 of the items, the difference between basic and superordinate verification did not change depending on the exposure duration of the picture, $p < .0032$ by sign test. The story is quite different, however, when we consider items requiring basic and subordinate verification (Basic High categories; bird, dog, car, and boat). For all of these items, basic-level verification was faster than subordinate-level verification, $p < .0003$ by sign test. In addition, the magnitude of the difference between mean-subordinate-level and mean-basic-level categorization time was larger in the short-exposure condition than in the long-exposure condition for all items except one, $p < .0032$ by sign test. Thus, the aggregated data presented in Fig. 1 are not the results of only a few unusual items; rather, they represent an effect that seems quite general over the stimuli we used.

Errors

The error rates associated with each condition (see Fig. 1) were compared with their respective mean response times. In the comparisons of interest there were no speed–accuracy trade-offs, with the exception of one case: pictures from Basic Low categories matched with either basic-level or superordinate-level words in the short-exposure condition. In this case, there is a small tendency for the error rate to decrease as mean response time increases. However, the difference in error rates was relatively small (21 versus 18%), and the difference did not even approach statistical significance, $\chi^2(1) = 1.50$, $p > .20$. Furthermore, on a speed–accuracy trade-off interpretation of this difference, the interaction for Basic Low categories and exposure duration would be in the direction opposite that for Basic High categories. Therefore, the observed interaction between exposure duration, name level, and basic level of the category would be even greater than currently observed. Thus, there was no indication that the results were due to speed–accuracy trade-offs.

Discussion

The results were exactly as expected if objects are identified first at the basic level and concepts subordinate to the basic level are activated only after additional perceptual processing. When subjects are asked to verify a word subordinate to the basic-level concept, reaction times were much longer when the perceptual task was more difficult than when the task was easier. This strong interaction implies that the identification of objects at levels subordinate to the basic level requires perceptual information that is not necessary for the identification of the object as a member of a basic-level category. Thus, people do not immediately identify objects at the most specific level possible. Rather, objects are identified first at the basic-level and more specific identifications are made only later, via additional perceptual processing.

When verification requires the activation of a concept that is superordinate to the basic-level, no additional perceptual processing is logically necessary. And, in fact, no additional perceptual processing occurs: The degree of difficulty of the perceptual task had no effect on the time difference between verifying a basic-level and a superordinate-level word with a picture (see the response times for Basic Low categories in Fig. 1). If the difference in time between verifying a basic-level and a superordinate-level name was due to additional perceptual processing, we should have observed the effect of the difficulty of the perceptual task as we did in the case when the nonbasic word was a subordinate. This result supports the notion that at least part of the basic-level advantage over superordinate terms is due to an effect of subjects' cognitive structure. Superordinate-level categorization appears to be mediated by the prior identification of objects at the basic level, rather than by a slow perceptual feature-matching process.

EXPERIMENT 3

The previous results provide additional evidence for the advantage of the "basic level" of categorization and implicate specific processing mechanisms to account for the advantage. In the next two experiments, as in the first two, we are concerned with the notion that objects make