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The verification of category and property statements

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Two experiments compared the speed with which category and property statements of matched associative production frequency could be verified. The verification of category statements was consistently faster than that of property statements, for both true and false judgments. The category advantage did not interact with the level of production frequency for the true sentences. Implications for models of decision processes in semantic memory are discussed.

Experimental studies of semantic memory frequently have investigated the retrieval and verification of two kinds of proposition. The first kind, which is generally called a category proposition, specifies the class of things to which a concept belongs, as, for example, in "An apple is a fruit." The second kind, called a property proposition, describes attributes that are characteristics of the concept. An example of this kind would be "An apple has a peel." Although this distinction has been widely used, its theoretical basis is not well understood. Smith (1978) pointed out that there are no good logical criteria for differentiating category from property propositions. The two kinds of proposition are in fact intertranslatable. "An apple is a fruit" can be rephrased as "An apple has the property of fruitness," and "An apple has a peel" can be phrased as "An apple is in the class of peel-covered objects." It can thus be argued that the two types of proposition differ only in their syntactic form, and not in the form of their representation in memory. Therefore, other things being equal, whether or not the verification times for the two types of proposition differ is an interesting empirical question. Perhaps surprisingly, no direct comparison of the speed of verification of category and property statements under controlled conditions has been undertaken. The first aim of the present experiments was therefore to answer this simple empirical question.

Consideration of current models of semantic memory suggests that it is not easy to derive direct predictions for the outcome of this comparison. Network models (Glass & Holyoak, 1975; Collins & Loftus, 1975; Collins & Quillian, 1969, 1972) assume that the major determinant of verification time for true semantic propositions is the ease of retrieving the information from the network, and that the most direct measure of this associative strength is production frequency in a generation task. As Johnson-Laird (1975) pointed out, this principle, originally known as Marbe's law of associations, accounts for a considerable number of experimental studies in which generation frequency later predicts retrieval speed (Conrad, 1972; Glass, Holyoak, & O'Dell, 1974; Holyoak & Glass, 1975; Wilkins, 1971). Thus, if associative frequency is held constant, then retrieval models in general would predict no difference in verification times for category and property predicates. Any such difference would therefore constitute an important departure from the generality of Marbe's law as an account of semantic memory processing times and would entail modifications to network models.

The alternative approach to semantic memory is the featural approach (Hampton, 1979, 1981; McCloskey & Glucksberg, 1979; Schaeffer & Wallace, 1970; Smith, Shoben, & Rips, 1974). Rather than emphasizing retrieval processes, this approach assumes that category propositions are verified by a process of feature comparison. As with network models, it is not easy to derive a direct and obvious prediction from the models concerning the relative speed of verifying category and property information. On the one hand, one may suppose that, since property information generally consists of a single feature [e.g., COLOR (RED)], whereas category propositions depend on the evaluation of several features, property statements should be more rapidly verified. This proposal is consistent with Smith's (1978) suggestion that property statements are semantically more primitive than category statements (Wierzbicka, 1972). On the other hand, if features can be checked in parallel, or holistically (Smith et al., 1974), then with several features tending to confirm or contradict a category statement, but only one specific feature confirming or contradicting a property statement, category statements may be verified more quickly.

Network models might also be able to account for a difference in category and property verification times by adopting one of two suggestions contained in Collins

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and Quillian's (1969) early model. They found that category statements were verified faster than property statements (when nonnormative materials were used), which they explained by the suggestion that some properties must be retrieved via a category node. They proposed a principle of cognitive economy, whereby any property generally true of a class (such as "Birds can fly") would be stored at the category node for that class. Hence, "Canary can fly" would take longer to verify than "Canary is a bird," the latter being used to infer the former. On this particular account, category predicates should only be faster than properties that are also true of a superordinate class.

The second suggestion was that category nodes may be searched in series, whereas property nodes may be searched in parallel. This difference could obviously give rise to a difference in the overall speed of retrieving the two types of information. However, if one process is slower than the other, then, by this account, the effects of associative strength (as measured by production frequency–PF) should be magnified for the slower process. Thus, if there is a difference between category and property retrieval times, we should expect the difference to interact with PF, such that there is a greater difference for low-PF predicates. Featural theories would not make this prediction. A significant difference that did not interact with PF would therefore not be readily explainable in terms of search-and-retrieval mechanisms.

The logic of this argument is directly comparable to that of Sternberg's (1969) methodology. A major issue (Smith, 1978) between network and featural models is the relative importance of the retrieval of prestored information (as in network-search models) and the computation of new decisions (as in feature-comparison models). If there is any difference in verification time for category and property information, then it may be possible to use Sternberg's methodology to assess whether that difference is occurring at a retrieval stage or at some other stage. Sternberg argued that, when two independent variables affect the same stage of an information-processing sequence, then their effects on overall time will interact (generally speaking), whereas if they affect separate stages, their effects will be additive. [Recent treatments of this method (McClelland, 1979; Schweickert, 1983) have concurred that additivity is a sign of separate stages, although an interaction need not always imply that the variables are affecting the same stage.] Now, since associative PF is a direct measure of the retrievability of the information, we may assume that retrieval-based models should predict an interaction between predicate type and PF. On the other hand, discovery of a predicate-type effect that was independent of PF would argue against any retrieval-based explanation of the predicate-type difference, and consequently argue against the central importance of retrieval processes in determining verification time.

The aim of the experiments, therefore, was, first, to determine which (if either) type of predicate was more rapidly verified and, second, to discover whether any difference between predicate types interacted with PF. The experiments aimed to provide an answer to an empirical question, the answer to which should constrain the development of models of semantic memory. Although neither approach to modeling semantic memory provides a clear prediction of a difference between predicate types, the discovery of such a difference could nevertheless be used to partially discriminate between classes of models.

EXPERIMENT 1

Method

Subjects. Twenty-four student volunteers (10 males and 14 females) at The City University, London, acted as paid subjects; all were native speakers of English and were right-handed.

Design. A two-factor repeated-measure design was employed, the factors were predicate type (category vs. property) and truth (true vs. false). Nested within the true sentences, there was an additional factor of PF (high, medium, or low).

Materials. Four predicates were selected for each of 64 subject nouns. These predicates were two category statements (one true and one false) and two property statements (one true and one false). True predicates were selected for each subject noun so that category and property statements were matched for PF within one of three levels–high (PF = 33% to 94%), medium (PF = 15% to 33%), and low (PF = 4% to 15%). There were approximately the same number of subject nouns for each level of PF. The predicates themselves were chosen from three sets of property norms [Ashcraft, 1976a, 1976b (also published in shorter form–Ashcraft, 1978b) and two additional sets of unpublished data collected by the author (based on 24 and 16 subjects, respectively)]. PF was balanced for category and property statements within each set of norms. [The subjects generating these norms simply listed any information that came to mind to describe and define the concepts named by each noun, with no constraint being placed on the type of information produced. Production was not time constrained in the author's data, but Ashcraft (1978b) allowed 40 sec per word. Subjects typically produced between 4 and 10 different predicates to each noun. Production order of predicates was not controlled, but has been shown to correlate well with PF (Hampton, 1976). Only 3 predicates that had PFs greater than 80% were used, so differences in associative strength were not concealed by ceiling effects.] The lengths of the two predicates were also matched. Each predicate (category or property) occurred only once as a true sentence and once as a false sentence. Each subject noun occurred four times, once under each truth x predicate type condition. False sentences were constructed by reassigning predicates to subject nouns to produce unambiguously false statements. The resulting 256 sentences were divided randomly into four blocks so that each subject noun occurred once in each block, no predicate occurred twice in the same block, and there were equal numbers of the four sentence types in each block. Each subject received a different random sequence of the sentences in each block, and the order of blocks was balanced across subjects. A list of the sentences used is given in the Appendix.

Apparatus. A Commodore 3016 microcomputer was programmed to display the sentences one at a time on its VDU screen and to record the subject's responses and reaction times in milliseconds. The subject was seated in front of the display screen and had two response keys to press, one by each of his or her hands.

Procedure. A warning signal (an asterisk) appeared in the center of the screen for 1.5 sec before the display of the subject noun above the predicate, both in uppercase characters. These were displayed until a key was pressed. There was then a 3-sec blank interval before the warning signal appeared for the next trial. If the noun plus predicate made a sentence that was "generally true," the subject was to press the right-hand key, and if false, the left-hand key. The subject was told that all the sentences were obviously true or false. If the subject thought a sentence meaningless, he or she was to respond "false." The subject was instructed to respond as fast as possible while making as few errors as he or she could. The first 10 trials were practice materials and were not recorded. Between each of the four blocks of 64 trials, the subject was allowed to rest for as long as he or she wished; the subject started the next block by pressing either response key. Experiment 1 lasted about 25 min.

Results

Before mean response times were calculated, erroneous responses (6% of the data) were removed. In addition, 26 latencies of over 3 sec and five machine errors were removed from the data. The mean and standard deviation for correct reaction times for each condition are shown in Table 1, together with error rates. For both true and false statements, category predicates were responded to faster than property predicates. The differences were 121 msec for true and 110 msec for false predicates.

A two-way analysis of variance with repeated-measures factors of truth and predicate type showed a significant main effect of predicate type [min $F'(1,50) = 36.2$, $p < .001$]. There was no main effect of truth and no interaction ($F < 1$ in both cases). Across materials, the size of the category advantage did not correlate with mean PF ($r = .08$, $n = 64$). An analysis of error rates gave significant factors of truth [min $F'(1,54) = 10.47$, $p < .01$] and predicate type [min $F'(1,40) = 4.4$, $p < .05$], but no significant interaction (min $F' < 1$). True sentences had more errors than false, and property predicates had more errors than category predicates. (A closer analysis of the error distribution revealed that certain sentences had significantly higher error rates than would be expected from a random distribution of errors across materials. There were eight category and eight property statements involved. Reanalysis of the reaction time and error rate data excluding these sentences showed no change in the size or significance of the effects reported above.)

Finally, mean response times for true sentences were analyzed to discover whether the observed significant factor of predicate type interacted with the PF of the predicates. Mean reaction times for the three levels of PF for each predicate type are also shown in Table 1, in which it can be seen that the category advantage was present at all three levels. Analysis of variance across materials confirmed the main effect of predicate type [$F(1,61) = 27.3$, $p < .001$]. There was a slight attenuation of the effect at low PF, but the interaction did not approach significance [$F(2,61) < 1$]. The main effect of PF itself was significant [$F(2,61) = 7.21$, $p < .01$]. As would be expected, high-PF sentences (1,037 msec) were faster than medium-PF sentences (1,110 msec), which were faster than low-PF sentences (1,165 msec). A corresponding analysis of false sentences, treating PF of the predicate as a pseudovariable, showed no increase in verification speed as PF dropped (mean times were: high PF–1,106 msec, medium PF–1,083 msec, low PF–1,093 msec). The PF effect was therefore due to the relation between subject noun and predicate, and not to the predicate alone.

Discussion

The experiment provided clear results. Whether true or false, the category statements were responded to over 100 msec faster than the property statements. There was a difference in the error rate in the same direction (therefore ruling out any explanation in terms of speed-accuracy tradeoffs). There was also a tendency to make more false-negative than false-positive errors. Most importantly for discriminating between semantic memory models, the category advantage did not interact with PF. Indeed it appeared to be less strong with lower PF.

The existence of equivalent-sized effects for true and false sentences (interaction $F < 1$) suggests that the result for true sentences cannot be attributed to any hidden imbalance in associative strength of category and property predicates, since such an imbalance would not affect the false sentences, except indirectly.

Before any strong conclusions were drawn from this result, it was deemed advisable to replicate the experiment to ensure that the result was not an artifact of the materials used. Specifically, there was an obvious im-

Table 1
Means and Standard Deviations for Reaction Times (RTs, in Milliseconds) and Error Rates (in Percent) for Sentences in Experiment 1

PF	Category Mean RT	Category SD	Category ER	Property Mean RT	Property SD	Property ER	Number of Words	Category Advantage
				True Sentences				
High	967	125	3	1107	141	7	20	140
Medium	1040	112	10	1181	170	7	16	141
Low	1119	155	11	1211	163	11	28	92
Total	1048	189	8	1169	222	9	64	121
				False Sentences				
	1043	181	2	1153	228	6	64	110

balance in the two types of predicate in terms of the variety of syntactic form used. Category predicates had the standard form "is (a) [NOUN]," whereas property predicates could be of three types– "is [ADJECTIVE]," "has a [NOUN]," or one containing some specific verb (e.g., "grows in summer"). Although post hoc analysis showed the category advantage to be strongest for the words with the "is [ADJECTIVE]" type of property, it was felt that the subjects may have been sensitive to the different frequencies of syntactic forms. There were also more adjective-noun combinations in the property predicates. Experiment 2, therefore, used only one form of property predicate, namely, "has a [NOUN]." Using this form also enabled the word frequency of the predicate noun to be controlled.

EXPERIMENT 2

Method

Subjects. Twenty-four student volunteers at The City University, London, acted as paid subjects. There were roughly equal numbers of males and females, and they were all right-handed native speakers of English.

Design and Materials. The same design was used that had been used in Experiment 1, with the two factors of truth and predicate type, and with PF nested within true sentences. The sentences were constructed as follows. Fifty-two subject nouns were used (45 of which were used in Experiment 1), and a category and a property predicate were selected for each word from the same norms used previously, so that associative PF, length, and word frequency (Kučera & Francis, 1967) were all matched. PF was matched at three levels, as in Experiment 1. All the property predicates contained the auxiliary verb "has," and all category predicates had the verb "is." In addition, no predicates were used that had given rise to a significant number of errors in Experiment 1. As before, each predicate occurred once only as a true sentence. False sentences were created in the same way as before. Three judges read through the false sentences, picking out any that contained related concepts. On average, only 6 of the 104 were selected as related, and these were evenly distributed between category and property statements. Since agreement between judges was poor, no items were rejected. Randomization and balancing followed the same design as Experiment 1, with four blocks of 52 trials, presented in random sequence. The materials used are shown in the Appendix.

Procedure and Apparatus. The details of procedure and apparatus were identical to those for Experiment 1, with the exception that slightly fewer sentences were used, so that the duration of the experiment was approximately 20 min.

Results

Error response times and 38 latencies of over 3 sec were removed from the data. The average error rate was 6%. Table 2 shows the mean correct reaction times with standard deviations and error rates for the four types of sentence. Category predicates were again responded to faster than property predicates. The difference was 73 msec for true and 53 msec for false sentences. A two-way repeated-measures analysis of variance confirmed the main effect of predicate type [min $F'(1,40) = 12.48$, $p < .01$], with no effect of truth and no interaction ($F < 1$ in both cases). Error rates were also subjected to analysis of variance. There was a significant main effect of truth [min $F'(1,39) = 16.72$, $p < .001$], but no significant effect of predicate type [min $F'(1,41) = 1.83$, $p > .20$], unlike in Experiment 1. There was no interaction ($F < 1$). As before, true sentences were more prone to errors than false ones.

Analysis of the response times for true sentences with respect to predicate type and PF revealed a pattern similar to that in Experiment 1. There were significant main effects of predicate type [min $F'(1,34) = 6.85$, $p < .05$] and of PF [min $F'(2,56) = 4.6$, $p < .05$], but no significant interaction [across subjects, $F(2,46) = 2.16$; across materials, $F(2,49) = 0.14$]. The category advantage was strongest at medium PF (103 msec), and less strong at high or at low PF (71 and 45 msec, respectively). The means are shown in Table 2. The size of the category advantage did not correlate at all with PF ($r = -0.05$, $n = 52$).

As found in Experiment 1, mean decision times for false sentences were equivalent across PF levels (high PF–1,085 msec, medium PF–1,087 msec, and low PF–1,089 msec), so that the PF effect for true sentences was due to the relation between subject and predicate, and not to the predicate alone.

As an additional control for confounding variables associated with predicate retrieval, a condition was run in which 20 new subjects from the same population read

Table 2
Means and Standard Deviations for Reaction Times (RTs, in Milliseconds) and Error Rates (in Percent) for Sentences in Experiment 2

	Category			Property				
PF	Mean RT	SD	ER	Mean RT	SD	ER	Number of Words	Category Advantage
				True Sentences				
High	1010	211	10	1081	261	9	20	71
Medium	1005	218	4	1108	252	8	15	103
Low	1135	260	11	1180	286	14	17	45
Total	1050	224	8	1123	262	11	52	73
				False Sentences				
	1062	210	3	1115	226	4	52	53

through the full list of true and false sentences. Sentence presentation began with display of the subject noun. When the subject pressed a key with his or her left hand, the predicate was then displayed. The subject pressed a second key with the right hand as soon as he or she had read and understood the predicate. Thus, no decision was required; the subject merely had to read the sentence subject and predicate. The two inspection times were recorded separately, and time to read the predicate was analyzed across materials in a 2 x 2 x 3 analysis of variance with factors of truth, predicate type, and PF (as a true sentence). There was a significant effect of truth [$F(1,49) = 17.2$, $MSe = 2{,}575$, $p < .0001$], with true predicates being read faster (583 msec) than false (612 msec), but no other main effects or interactions were significant. Mean reading times are shown in Table 3. Overall, category predicates (598 msec) were read no faster than property predicates (598 msec). The power of the test for this comparison was .75 for obtaining a difference of 45 msec or more, and .99 for a difference of as much as 75 msec. It can therefore be safely concluded that observed differences in verification time were not attributable to differences in reading time for the predicates, even in the context of their subject nouns. The significant effect of truth confirmed that subjects were in fact reading the sentences for their meaning. There was a small effect of PF on an analysis of the true sentences only; the effect was significant across subjects but not across materials. (Low-PF sentences were read, on average, 26 msec slower than medium- or high-PF sentences.) The reading control condition therefore supported the major conclusions of Experiment 2.

A final question concerns the absence of an interaction between predicate type and PF for the true sentences. The interpretation of this null effect must be treated with some caution in the light of the low power of the test. The error variance across materials was such that several hundred sentences would be required to provide an adequate demonstration of additivity in a single experiment. In order to examine the possible interaction more carefully, an analysis of covariance was conducted across materials for the true sentences, with factors of PF and predicate type, and with covariates for each predicate (nested within predicate type) of PF, length, word frequency, and reading time. Removing these extraneous sources of variance should have the effect of rendering a clearer picture of any underlying interaction between PF and predicate type. The results showed again a strong effect of predicate type [$F(1,45) = 11.58$, $MSe = 18{,}516$, $p < .002$] but no hint of an interaction [$F(2,45) = 0.04$, $MSe = 18{,}516$, $p = .96$]. As can be seen in Figure 1, the slightly greater category advantage obtained for medium-PF sentences was attenuated by the control of the covariates, and the data appear to demonstrate additivity. (There was a residual effect of the factor of PF, which was due to a nonlinear relation between verification time and PF level as defined in the present sample.) It may also be noted that the test for a correlation between category advantage and mean PF across predicate pairs reported previously had a power of .75 to reveal an association of .32 or greater ($r = -0.05$). Although the interaction test had low power, the absence of any sign of an increase in the advantage to category predicates with lower PF can be taken as a failure to support a retrieval-based account of the effect. This issue is discussed further in the final section.

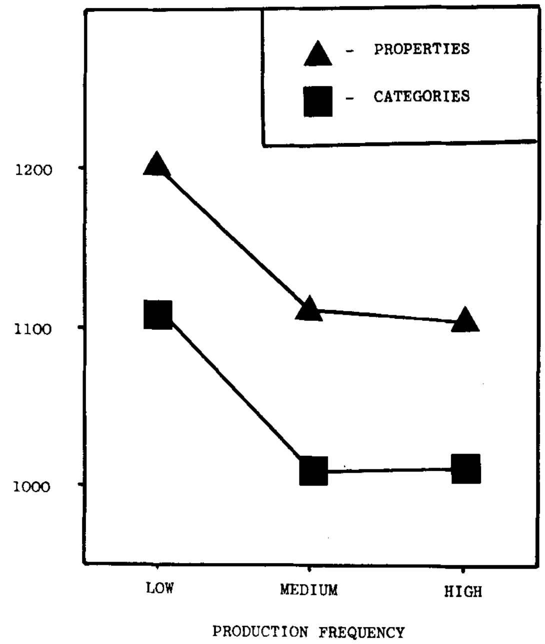

Figure 1. Corrected mean reaction times for Experiment 2, controlling for the effects of four covariates: PF, length, reading time, and word frequency.

Table 3
Means and Standard Deviations for Reading Times (in Milliseconds) for the Control Condition in Experiment 2

PF	Category: Mean Reading Time	SD	Property: Mean Reading Time	SD
	True Sentences			
High	578	61	574	44
Medium	581	39	567	40
Low	599	44	603	49
Total	586	50	581	46
	False Sentences			
	609	56	615	44

Discussion

Experiment 2 replicated the results of Experiment 1 in almost every respect. In addition, the stimulus frequency of sentence forms and the word frequency of predicate nouns were controlled, and a measure of reading time showed no effect of predicate type.[1] The relative advantage of category predicates in both true and false sentences was found in the response times but, unlike Experiment 1, did not reach significance in the analysis of error rates. The bias toward false-negative rather than false-positive errors was also replicated.

It may be concluded from the successful replication that the category advantage obtained in Experiment 1 was not attributable to uncontrolled stimulus-frequency effects. In both experiments, there was a reliable advantage for the verification of category information that did not interact with PF. The following section discusses the implications of this result.

GENERAL DISCUSSION

A consistent pattern of results was obtained from these two experiments, the first of which used a broad range of properties, and the second a more constrained set. The results showed category information to be verified more quickly than property information of the same associative and word frequency. This advantage was found for both true and false sentences, and for true sentences it was apparently independent of PF. No current model of semantic memory would readily predict this result. How then may it best be interpreted?

Essentially, all models of semantic memory recognize that information must first be retrieved and then decided upon, but, as Smith (1978) argued, a critical difference between models lies in the amount of work and time assumed to be involved in either retrieval or decision processes. Most network models (e.g., Glass & Holyoak, 1975) emphasize the role of retrieval in verification. If retrieval is the key factor, then, when PF is equated, one would not expect there to be any substantial residual reliable difference in verification times. Indeed, Conrad (1972) showed that, for a property verification task, with PF held constant, there was no residual effect of number of links traversed in the network on response time. For the data reported here, a post hoc division of the true property sentences into those specific to the subject noun (e.g., "Croquet has hoops") and those that might be inferred from membership of some higher level category (e.g., "Owl has feathers") likewise showed no difference in the size of the category advantage for the two types of property—in either experiment. This result confirms Conrad's conclusion that Collins and Quillian's (1969) principle of cognitive economy is unsupported. It could certainly not explain the observed differences in verification times. Although often cited as a failure of network theory, it could in fact be argued that Conrad's result is exactly what would be expected if verification depends largely on retrieval (since distance in the network should determine both retrieval time *and* PF). A similar result reported by Smith et al. (1974), in which categorization was faster in a more distant category ("A chicken is an animal") than in a closer category ("A chicken is a bird"), could also be accounted for by the general principle of associative frequency, operating in a retrieval model (e.g., Glass & Holyoak, 1975). "Animal" is a more frequently produced superordinate to "chicken" than is "bird." Hence, Marbe's law still predicts the result.

The present result is therefore a more serious finding for retrieval models in general than these often quoted critiques. Unlike Conrad's (1972) and Smith et al.'s (1974) results, Marbe's law fails to account for the observed difference between category and property information verification. Furthermore, it would be hard to modify a retrieval model to account for the difference, given that the result occurs equally at high and at low PF, and as strongly for true as for false sentences.

The lack of interaction between the category advantage and PF in these two experiments was confirmed in an independent study (Hampton & Port, 1983) recently conducted in our laboratory. Thirty-two words were divided into two groups matched for familiarity, and a group of subjects each generated several category and "has"-property predicates to each word in both groups. Matched pairs of predicates (one category and one property) were selected at high and low PF from this task (one group of words had high-PF predicates, and the other had low-PF predicates). A second group of 32 subjects then performed a timed verification task on these sentences. The advantage to category predicates was replicated (72 msec for true and 86 msec for false), and the advantage was slightly lower at low PF (80 msec for high PF and 63 msec for low PF). There were significant main effects of predicate type and PF, but no significant interaction [across materials, $F(1,28) = 0.08$; across subjects, $F(1,31) = 0.66$]. There are therefore now three studies in which the category advantage has been replicated, and in no case was there any sign of an increase in the effect at low PF. Taken together, this repeated failure to find the predicted interaction suggests that the retrieval-based account is inadequate. Following Sternberg's (1969) logic, it appears likely that PF effects and the bases of the category advantage are located at different stages in the verification process.

Given that the difference is unlikely to lie in the retrieval of prestored information, the alternative locus for the effect would be in a decision stage. Feature-comparison models of categorization (Hampton, 1979; McCloskey & Glucksberg, 1979; Smith et al., 1974) concentrate on the decision stage as the source of observed differences in verification time. In support of locating the category advantage at a decision stage, there is the fact that the advantage is independent of PF and occurs equally strongly for true and for false sentences.[2] Possible accounts of the effect might then be framed along the following lines.

It is recognized, largely from the work of Rosch and her colleagues (Rosch & Mervis, 1975), that categories are formed to maximize the family resemblances of items within a single category and to minimize the similarity between items that fall in different categories.

For any category decision, there are therefore a number of correlated features or dimensions that can be used for making the judgment, and because of their positive correlation, the probability is high that most items in a domain will fall clearly in or clearly out of a particular category. This is because the features constituting the prototype representation of a category will be weighted in order to maximize the cohesiveness of the group of category members. There are, of course, notable exceptions to the clear-cut boundaries of categories (see Hampton, 1979, 1982, and McCloskey & Glucksberg, 1978). However, their number is necessarily small compared with the large cluster of items that are clear examples.

If we consider property predicates, there is much less evidence for any such structure. Usually, some single specific physical or functional piece of information about the concept must be retrieved and used. There will be few correlated features that could make the decision easier, and thus true sentences will be harder to verify. A first explanation of the category advantage therefore lies in the degree of specificity and lack of redundancy in the information needed to verify properties as opposed to category statements.

A second account concerns the ease with which sentences can be rejected as false, through the discovery of directly contradicting information. Category information is frequently (although not always) taxonomic in structure. That is to say, a domain (such as creatures) will be divided up into mutually exclusive sets of items (such as fish, birds, insects, and so on). As represented psychologically, such knowledge is frequently incomplete and less exact than is sometimes supposed (for examples, see Hampton, 1982), but nonetheless there are still many examples of mutually exclusive sets. Obviously, if an item belongs in such a set, then this fact can be used to infer rapidly that it is not in any other of the sets in the domain. (For evidence of this contradiction strategy, see Anderson & Reder, 1974, and Holyoak & Glass, 1975.) For property statements, however, there appears again to be less structure. Properties do not form mutually exclusive subdivisions of a domain to the same extent. Overlap between the classes defined by possession of a particular property is usually high (consider, e.g., the sets of creatures having tails, wings, legs, or eyes). Thus, the contradiction strategy that can be used for some category judgments is unlikely to be of use in falsifying properties.

These accounts must of course be speculative, and further study of property verification is clearly called for. It would, for example, be interesting to compare category predicates with false property predicates that either did or did not directly contradict a true property. Recently, studies (Ashcraft, 1978a; Barsalou, 1982) have indicated some of the variety of properties involved in concept representations. Whatever the fate of the suggestions made here, the main significance of the present experiments lies in the demonstration of a strong and reliable effect on sentence verification time that cannot be explained in terms of Marbe's law of associations. Future developments in semantic memory must consider how the decision processes involved in verifying category and property information operate, in order to produce this difference in their ease of verification.

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NOTES

1. It should be noted that although syntactic form was controlled, there may still be a confounding effect of semantic variety, in that the "has" sentences included a wider range of semantic relations (such as part-whole vs. alienable possession).

2. The nearly equal size of the predicate-type effect for true and false sentences (121 vs. 110 msec, and 73 vs. 53 msec in each experiment) need not be taken to imply that predicate-type differences affect a stage distinct from the stage in which the correct response is selected. Given that predicate type affects the ease of discriminating true from false sentences (for whatever reason), one would expect such an effect to appear in the response times for both true and false responses—as indeed was the case in the present experiments.

APPENDIX
Materials Used in the Experiments

Word	True Category	True Property	False Category	False Property
		Experiment 1		
High PF				
Oak	Is a tree	Has green leaves	Is a creature	Eats mice
Sparrow	Is a bird	Has wings	Is a tree	Is used for stockings
Rose	Is a flower	Has sharp thorns	Is a mammal	Has wings
Grape	Is a fruit	Contains small seeds	Is a building	Is used for sheets
Violin	Is a musical instrument	Is made of wood	Is a grain	Lives in forests
Tea	Is a drink	Is made from leaves	Is a construction	Is often dirty
Ant	Is an insect	Is black	Is a flower	Is made from leaves
Hammer	Is a tool	Is metal	Is a bug	Contains small seeds
Linen	Is a cloth	Is used for sheets	Is a beverage	Has a mouth
Hotel	Is a building	Has many beds	Is a musical instrument	Has pockets
Garlic	Is a food flavouring	Is used in cooking	Is a hobby	Is strongly built
Octopus	Is a creature	Has long tentacles	Is poultry	Is for carrying goods
Van	Is transport	Is for carrying goods	Is a delicacy	Uses sharp hooks
Football	Is a sport	Has two teams	Is a plant	Is used in cooking
Croquet	Is a game	Uses wooden mallets	Is a citrus fruit	Has small white pips
Onion	Is a vegetable	Makes you cry	Is a primate	Stands against a wall
Eel	Is a fish	Is very slimy	Is an act	Is vertical
Potato	Is a staple food	Has a skin	Is a rodent	Makes you cry
Ship	Is a vessel	Floats on water	Is a staple food	Is found in parks
Lemon	Is a citrus fruit	Has small white pips	Is a fowl	Uses wooden mallets
Medium PF				
Sword	Is a weapon	Has a blade	Is a fruit	Is drunk with cream
Cabin	Is a house	Has a window	Is food	Is very crisp
Rice	Is a grain	Contains starch	Is transport	Opens up boxes
Pine	Is a wood	Has a smell	Is a game	Has sharp thorns
Sofa	Is furniture	Is for sitting on	Is a parasite	Is hard to control
Nylon	Is a synthetic fibre	Is used for stockings	Is seafood	Eats through wool
Coffee	Is a beverage	Is drunk with cream	Is a tool	Is used for sails
Celery	Is a plant	Is very crisp	Is a predator	Has pink legs
Trout	Is food	Has a mouth	Is a wood	Has green leaves
Angling	Is a hobby	Uses sharp hooks	Is an object	Is battery bred
Rug	Is a floor covering	Is for comfort	Is a sport	Has a skin
Arrow	Is a projectile	Has feathered flights	Is a food-flavouring	Is very slimy
Coughing	Is an act	Is hard to control	Is a kitchen object	Floats on water
Lamb	Is a kind of meat	Has four legs	Is a device	Has a blade
Ladder	Is a device	Is strongly built	Is a vessel	Is for comfort
Sunbathing	Is an activity	Can cause sunburn	Is a container	Is kept sharp
Low PF				
Coat	Is clothing	Has pockets	Is a vehicle	Is driven
Shrimp	Is seafood	Has pink legs	Is furniture	Is for sitting on

Word	True Category	True Property	False Category	False Property
Flea	Is a parasite	Sucks animal's blood	Is a woven fabric	Is metal
Hut	Is a shelter	Has a roof	Is clothing	Grows in summer
Moth	Is a bug	Eats through wood	Is a cylinder	Has a window
Cotton	Is a material	Is made into clothes	Is a bird	Has two hands
Crowbar	Is a lever	Opens up boxes	Is a house	Has whiskers
Car	Is a vehicle	Is driven	Is an animal	Is nutritious
Drum	Is a cylinder	Is hollow inside	Is a root crop	Has a tail
Parsnip	Is a root crop	Is nutritious	Is a material	Is black
Bear	Is a mammal	Lives in forests	Is a weed	Is made of wood
Robin	Is an animal	Has a tail	Is a cloth	Is for individuals
Daisy	Is a weed	Grows in summer	Is a drink	Has a smell
Owl	Is a predator	Eats mice	Is a synthetic fibre	Has many beds
Canvas	Is a woven fabric	Is used for sails	Is an insect	Is hollow inside
Lion	Is a carnivore	Is very powerful	Is a lever	Has long tentacles
Salmon	Is a delicacy	Is eaten smoked	Is a weapon	Is square
Raft	Is a primitive craft	Is square	Is a carnivore	Is eaten smoked
Chicken	Is poultry	Is battery bred	Is a primitive craft	Is very powerful
Chair	Is an object	Is for individuals	Is a shelter	Has two teams
Otter	Is a rodent	Has whiskers	Is a path	Has feathered flights
Bookcase	Is a container	Stands against a wall	Is a kind of meat	Contains starch
Man	Is a primate	Has two hands	Is a floor-covering	Has a roof
Knife	Is cutlery	Is kept sharp	Is a fish	Has four legs
Duck	Is a fowl	Is found in parks	Is a projectile	Is useful
Corkscrew	Is a kitchen object	Is useful	Is an activity	Can cause sunburn
Door	Is a construction	Is vertical	Is a vegetable	Sucks animal's blood
Pavement	Is a path	Is often dirty	Is cutlery	Is made into clothes
		Experiment 2		
High PF				
Oak	Is a tree	Has leaves	Is a vehicle	Has wings
Celery	Is a vegetable	Has stalks	Is a pastime	Has beds
Owl	Is a bird	Has feathers	Is a construction	Has petals
Grape	Is a fruit	Has seeds	Is a game	Has a collar
Spider	Is an insect	Has a web	Is an automobile	Has posts
Hammer	Is a tool	Has a head	Is a vessel	Has a scent
Hotel	Is a building	Has beds	Is a citrus fruit	Has hoops
Garlic	Is a flavouring	Has a smell	Is a dessert	Has arms
Octopus	Is a creature	Has tentacles	Is an instrument	Has fur
Van	Is transport	Has an engine	Is a fowl	Has seeds
Croquet	Is a game	Has hoops	Is a building	Has a mouth
Daisy	Is a flower	Has petals	Is transport	Has a brain
Dustbin	Is a cylinder	Has a lid	Is seafood	Has legs
Eel	Is a fish	Has slime	Is a grain	Has leaves
Otter	Is an animal	Has fur	Is an appetiser	Has an edge
Rose	Is a bush	Has a scent	Is a weapon	Has a pitch
Arrow	Is a projectile	Has flights	Is a bird	Has a smell
Onion	Is a tuber	Has layers	Is a path	Has tentacles
Lemon	Is a citrus fruit	Has white pips	Is a tool	Has a catch
Ship	Is a vessel	Has a funnel	Is a tree	Has starch
Medium PF				
Drum	Is an instrument	Has a skin	Is a delicacy	Has shoots
Sword	Is a weapon	Has a point	Is a house	Has gills
Cabin	Is a house	Has a window	Is a fruit	Has a beak
Rice	Is a grain	Has starch	Is cutlery	Has a shaft
Shrimp	Is seafood	Has a tail	Is a bush	Has a window
Sofa	Is furniture	Has springs	Is a flavouring	Has slime
Coat	Is clothing	Has a collar	Is a projectile	Has a heart
Trout	Is food	Has a mouth	Is a shelter	Has a funnel
Bamboo	Is a plant	Has shoots	Is an animal	Has a nose
Truck	Is a vehicle	Has a driver	Is food	Has vitamins
Football	Is a sport	Has a pitch	Is a cylinder	Has an engine
Chicken	Is a fowl	Has a beak	Is a device	Has a driver
Angling	Is a pastime	Has competitions	Is an object	Has stalks
Man	Is a primate	Has a brain	Is a flower	Has a tail
Fence	Is a barrier	Has posts	Is a plant	Has a web
Low PF				
Hut	Is a shelter	Has a roof	Is meat	Has a skin
Moth	Is a bug	Has legs	Is a primate	Has a kerb
Crowbar	Is a lever	Has a bend	Is a mammal	Has flights
Car	Is an automobile	Has a horn	Is a vegetable	Has white pips

Word	True Category	True Property	False Category	False Property
Bear	Is a mammal	Has arms	Is poultry	Has a stone
Parsnip	Is a root	Has vitamins	Is an insect	Has a lid
Lion	Is a carnivore	Has a heart	Is a lever	Has a sail
Salmon	Is a delicacy	Has gills	Is furniture	Has a horn
Pear	Is a dessert	Has a core	Is clothing	Has a bend
Olive	Is an appetiser	Has a stone	Is a barrier	Has springs
Raft	Is an object	Has a sail	Is a tuber	Has a point
Lamb	Is meat	Has a nose	Is a fish	Has feathers
Duck	Is poultry	Has wings	Is a root	Has competitions
Knife	Is cutlery	Has an edge	Is a carnivore	Has a core
Pavement	Is a path	Has a kerb	Is a bug	Has a head
Corkscrew	Is a device	Has a shaft	Is a sport	Has layers
Door	Is a construction	Has a catch	Is a creature	Has a roof

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