The objective of this research is to examine the representation of numerical versus verbal product information in consumer memory. Information about products in the marketing environment is often conveyed through numerical and verbal modes. However, consumers may either store the information that they are exposed to without modification or translate it into a different form. This match or mismatch between conveyed and stored information has important consequences for consumer behavior. A conceptual framework based on surface versus meaning level processing of information is developed to examine the representation of numerical versus verbal information in consumer memory. The basic proposition tested here is that numerical information may be represented in memory identical to its form at presentation in the external environment to a greater degree than verbal information. Research bearing on memory representations is discussed to bring out the methodological importance of using a recognition paradigm. This paradigm is adopted here, and hypotheses are developed about the recognition of numerical versus verbal product information following a learning task. The details of two experiments conducted to test the hypotheses are presented. Implications of this research for consumer behavior are discussed.

A consumer shopping for a new car finds a model at a dealership. She or he recalls that this model has a gas mileage of exactly 32 mpg on the basis of an article in Consumer Reports. Comparing this model to a second car with a similar price, she or he vaguely remembers the second car being described by an acquaintance as “moderately high” in gas mileage. However, not being certain of the exact verbal description, she or he eliminates this car from the consideration set. As suggested in this example, a key issue in consumer research relates to the representation of product information in memory. Is information stored in consumer memory in the form in which it is available externally, or in a different form? In the example above, the consumer had stored the numerical information in a form that was identical to its availability in the external environment but not the verbal information. Such storage may have enhanced the consumer’s memory for information, the likelihood of using the information in judging the product, the accuracy of judgment, as well as the certainty or confidence held in the judgment. The purpose of this study is to understand how consumers represent magnitude information about products in memory by studying two widely used modes of conveying such information in marketing communications; namely, numerical and verbal magnitudes. (Information such as 32 mpg and high mileage, are referred to in this paper as magnitudes; i.e., the location of a product on an attribute continuum.) Price, nutrition, and other types of information are frequently conveyed to consumers in marketing settings in numerical or verbal modes.

The broad theoretical issue of relevance here is the degree to which information conveyed to consumers in the marketing environment is stored in consumer memory in an identical form. A wide variety of modes are used in the marketing environment to convey information about products, such as pictorial, graphic, numerical, and verbal modes. Consumers may either store the information that they are exposed to as is or translate it to a different form. This match or mismatch between conveyed and stored information has important consequences for such variables as consumer memory for information, usage of information in decision making, accuracy of judgments, and confidence in making judgments. Knowledge of the representation of product and price information in memory has important implications for marketers and public policy makers in gearing their communications toward buyers.

An understanding of how and in what form consumers store information will perhaps allow for an identification of factors that may facilitate the retrieval of this information and, thus, enhance the likelihood of purchase of a particular brand. With such understanding of buyer behavior, marketers can...
customize their communications to maximize the match between information presented to consumers and its eventual storage in consumer memory. In an era of advertising clutter and information overload, such communication may be more likely to enhance consumer memory and subsequent usage of information. Similarly, public policy makers can gear regulations to enhance consumers’ memories and usage of nutrition, price, and other information disclosed by manufacturers by understanding how consumers represent different types of information in memory.

**Conceptual Background**

In this section, research bearing on memory representations is discussed that brings out methodological issues in terms of the importance of using a recognition paradigm and substantive issues in terms of different representations of numerical information. This is followed by the development of a conceptual framework in terms of surface versus meaning level processing to assess representations of numerical versus verbal information. Hypotheses about recognition of numerical versus verbal information are then developed.

**Research on Representation of Information**

The information-processing paradigm recognizes that individuals are capable of symbolic manipulation of information. These symbols may represent an object, event, or some abstract relationship (Snodgrass, 1984). For example, written language is a symbol system in which arbitrary symbols (alphabetic strings) are used to represent underlying concepts. Pictures are another form of external representation of information. An important theoretical issue with regard to memory representation is the degree to which external information and its representation in memory are identical.

**RELEVANT RESEARCH IN MARKETING.** The few studies that have addressed consumer responses to the structure of information presented to them have mainly focused on the persuasiveness and/or the comprehensibility of information rather than on the memory storage and retrieval of that information (Yalch and Elmore-Yalch, 1984; Dickson, 1982; Holbrook, 1978; Scammon, 1977; Borgida and Nisbett, 1977; Anderson and Jolson, 1980). These studies also have defined information structure in different ways: abstract versus concrete; case versus base rate; factual versus evaluative; and vivid versus pallid information. Although the definitional inconsistencies make it difficult to draw conclusions, these studies do share the commonality of employing numerical and verbal information in one form or another. Also, these studies employ judgment and retention measures based upon either verbal report techniques or self-administered scales. These techniques provide insights about what information is accessible from memory, but they fail to distinguish between the use of information based upon its storage versus its inference at either encoding or retrieval (Gardner, Mitchell, and Russo, 1978). Thus, although these studies do not address the issue of representation per se, their selective review provides some useful insights for guiding the current research.

Dickson (1982) found that numerical information was perceived as more difficult to learn. However, recall of the numerically presented information was relatively high (80 and 86%, respectively, for two experimental contexts). Also, mistakes in recall indicated that there was some indication of statistical magnitude even when the reports were incorrect, suggesting that subjects may have coded in memory some representation of the numerical information. Olson (1978) has noted that there has generally been a lack of attention paid to the storage dimensions of memory versus their process-related facets, such as encoding and retrieval. Olson suggests that prices may be encoded and stored in a manner different than the numerical form in which price information is typically available in the environment. Thus, “...a given price might first be encoded at the sensory level as .79 and then re(coded) and stored as cheap or expensive, depending upon one’s frame of reference. If rather “broad” codes (categories of meaning) of this nature are used to represent price, one might expect little or no differences in overt response to prices that are encoded similarly” (Olson, p. 50). Zeithaml (1982) reported that subjects who typically noticed price information were able to recall specific prices paid better than subjects who typically made relative or comparative price evaluations.

The recall methodology used in the extant research is assumed to reflect the underlying representation of the information in memory. However, Lynch and Srull (1982) have disagreed with this premise. In essence, the use of a recall task to assess memory storage may relate to strategies affecting retrieval of information accessible in memory rather than the representation of the information available in memory. The appropriateness of using recall measures to infer the nature of information stored in memory has also been questioned by Hall (1983) and Tulving and Pearlstone (1966). Data regarding the information stored in memory are perhaps best generated by means of recognition rather than through recall tasks, because the former rely less on retrieval deficits (see Tulving and Pearlstone). Accordingly, and consistent with the recommendation of Gardner, Mitchell, and Russo (1978) and Chang (1986), we employ the recognition task in this research to examine memory representations.

**NUMBER REPRESENTATION RESEARCH IN COGNITIVE PSYCHOLOGY.** Researchers in cognitive psychology have examined the nature of representation of numerical information. McCloskey and Macaruso (1995) distinguish between written number-words (e.g., thirty-five), spoken number-words, and Arabic numerals (35). Each of these forms of available numerical information is argued to be represented in memory: Arabic numerals as graphemic digit representation, spoken number-words as phonological word representation, and written number-words as graphemic word representation. At the most
Numerical and Verbal Product Information

abstract level, a semantic representation is posited with intermediate syntactic digit frame and syntactic word frame representations serving to translate between semantic representation and the three forms mentioned above.

As suggested above, McCloskey, Sokol, Goodman-Schulman, and Caramazza (1990) are arguing for a modular theory where translation from one form to another (e.g., visual Arabic to phonological number-word) involves access to a semantic representation. In contrast, Dehaene, Bossini, and Giraux (1993) present a triple code theory that argues that numerical representations can be translated from one form to another (e.g., visual Arabic to phonological number-word) without accessing a semantic representation. Noel and Seron (1993) suggest that individuals translate numerals to a preferred entry code (e.g., Arabic numerals to number-words) before representation and calculation. Evidence in support of each of these views has been presented in past literature largely through the study of patients with deficiencies in brain functioning (McCloskey, Sokol, Goodman-Schulman, and Caramazza, 1990). Another model is the encoding complex view, which argues for a network of connections between alternate numerical representations (Campbell and Clark, 1988).

Several conclusions of relevance can be drawn from the number-representation literature in cognitive psychology for the present study. First, the literature distinguishes between several forms in which numerical information is represented externally with implications for internal representation, such as visual Arabic numerals, spoken number-words, and written number-words. In the present study, we use the term, numerical information, to refer to product information presented in the form of Arabic numerals in the context of a unit of measurement (e.g., “32” calories) and verbal information to refer to the use of adjective quantifiers to convey product information (e.g., “low” calories). The choice of numerical and verbal information is driven by the widespread availability of information in these two forms in the marketing environment. Although number-words in spoken and written form are also used to describe product information, the Arabic numeral format was chosen as a starting point given its widespread use in advertising as well as in regulated package information.

A second conclusion that can be drawn from the numerical representation literature is the complexity involved in understanding numerical representation in memory as reflected by competing models. Given our motivation to compare two widespread forms of product information; that is, numerical (e.g., 125 calories) versus verbal (e.g., low calories) information, we focus on the degree to which these two forms are encoded and represented in consumer memory identical to their form at presentation. As suggested by the example at the beginning of the paper, the representation of these two forms of information has important implications for marketing. Hence, our focus is not at the level of inter-relationships between internal representations at deeper levels of abstraction, as much as in studying the degree of correspondence between the surface features of external information and their representation in memory. As such, our findings could be consistent with alternate representational systems that are beyond the scope of this paper.

Conceptual Framework

The objective of this research is to assess the degree to which numerical versus verbal product information is represented in memory identical to its form at presentation. The processing of magnitude information can be distinguished in terms of surface-level processing and meaning-level processing. Surface-level processing refers to the processing of the surface features of a magnitude rather than its meaning. Hence, surface-level processing refers to processing a numerical label such as “32” mpg as a number or processing a verbal label such as “high” as a word (i.e., treating a magnitude as a nominal label). A useful analogy that illustrates surface-level processing is the processing of a phone number as a nominal label rather than in terms of meaning. In contrast, meaning-level processing refers to the processing of the meaning of a numerical label (such as whether it is “high” or “low”) or a verbal label. Such a distinction between surface- and meaning-level processing is particularly relevant for the presentation of magnitudes, because it pertains to whether magnitude information is represented in terms of its surface features or in terms of its meaning (i.e., the location of a brand along an attribute).

A study in psychology that examined memory for numbers (Hinrichs and Novick, 1982) is relevant here. Hinrichs and Novick argued that numbers could be used in either a “nominal” sense (such as a telephone number) or a “magnitude” sense (such as price information). They argued that approximate information is often sufficient in using magnitude information, but that exact digits are of importance in nominal information. Therefore, memory representations may reflect this by encoding these types of numbers differently. The authors investigated this possibility by studying the occurrence of the “serial position effect” for 4-digit numbers. The serial position effect in this study referred to a finding that digits at the beginning or the end of a 4-digit number are recalled better than the digits in the middle. The authors used a paired associate learning task where a word and a 4-digit number were presented to subjects in a learning task. In a subsequent recall task, subjects were provided with each word and were required to recall the corresponding 4-digit number. Although the authors conducted multiple experiments with mixed results, one experiment is particularly relevant here. In this experiment, the instructions were varied between two groups of subjects. One group was told in the learning task that the numbers represented a portion of a telephone number and should be recalled exactly. Another group was told that the numbers were the price of a car. The authors found the serial position effect when numbers were used as digits of a phone.
number (i.e., when numbers were used in a nominal sense). However, the effect was not found when numbers were used as digits in the price of a car (i.e., when numbers were used in a magnitude sense). Rather, when numbers were used as digits in the price of a car, the earlier digits were recalled better. Such a finding is consistent with using numbers in a magnitude sense where the earlier digits are more important to the price of a car. The results are interpreted as suggesting that numbers may be represented in memory either at a nominal level or in terms of the magnitude that they convey. However, the effect was not found when numbers were used as digits in the price of a car, the earlier digits were recalled better. Such a finding is consistent with using numbers in a magnitude sense where the earlier digits are more important

Hypotheses

Hypotheses were developed to examine memory representations of numerical versus verbal information following a learning task. During a learning task, the processing goal is to acquire or memorize information rather than use it in making a choice or judgment. Therefore, information may be processed and represented at the surface level. However, although numerical information may be processed at the surface level, there may be a tendency for verbal information to be processed and represented at the meaning level. Due to the ready availability of its meaning, verbal information may tend to be processed in terms of its meaning (i.e., the magnitude conveyed) rather than in exact terms (i.e., surface features) to a greater extent than numerical information. Because numerical information does not readily convey the location of a brand along an attribute, such information may tend to be processed at a surface level. Therefore, these two types of information may differ in the degree to which they are represented in memory identical to their form at presentation (i.e., the degree to which information is represented in a form that is identical to the surface features of the presented information). The rationale is illustrated in Figure 1A with differences in encoding of numerical versus verbal information being polarized for expository purposes. Again, using the analogy of learning or memorizing a telephone number, the exact content (i.e., surface features) of the numerical information may be represented, because the immediate goal is to learn information and not to use the information in a choice or judgment. On the other hand, verbal information may be processed at the meaning level to a greater extent because of the ready availability of its meaning, leading to a lesser degree of representation of such information identical to its form at presentation.

Faster recognition of stimuli similar to their representation in memory has been hypothesized in past research (cf., Chang, 1986). Consider a learning task followed by a recognition task where numerical or verbal information presented during learning is shown in an identical form during recognition. As suggested earlier, numerical information is expected to be represented in memory identical to its form at presentation to a greater extent than verbal information. Therefore, faster recognition of numerical information is predicted wherein the information is presented in the same form at presentation and at recognition. The rationale is illustrated in Figure 1B for the arrows labeled exact matching. Because the numerical information is encoded at a surface level in memory, exact matching with identical information at recognition is facilitated.
**Figure 1.** Rationale for hypotheses.

*The diagram illustrates surface level encoding for numerical information and meaning level encoding for verbal information.*

**H1:** Numerical information will be recognized faster than verbal information following a learning task.

The hypothesis stated above relates to situations where information is presented at recognition in an identical form as it was presented during learning. Consider a recognition task where the mode of information is different from its mode at learning, although the meaning or semantic content is similar. If numerical and verbal information provided at learning is equated in semantic content (e.g., a “long” battery life or “400” hours of battery life for a calculator) but presented in a different mode at recognition, an additional hypothesis can be generated from the proposed framework.

**H2:** Numerical information at learning that is presented verbally at recognition will be recognized faster than verbal information at learning that is presented numerically at recognition.

The rationale for H2 is represented in Figure 1B by arrows labeled approximate matching. If information presented in a numerical mode at learning must be subsequently recognized in a verbal mode, then some form of matching must take place from the memory representation of numerical information for a particular brand to the verbal information presented at recognition. This matching is approximate rather than exact in nature, because the surface features of information are different between learning and recognition. Numerical information is argued to be represented in a form that is identical to its form at presentation to a greater degree than verbal information. Therefore, during recognition, faster access is afforded to the original information when it was numerical rather than verbal at learning. Because such access is required to perform a match and provide a recognition decision, faster recognition of numerical when compared to verbal information is predicted when such information is presented in a
different form at recognition. The hypotheses were tested in two experiments.

**Experiment 1**

The experiment involved presentation of numerical versus verbal information for a learning task followed by a distractor task to remove the effects of short-term memory. This was followed by criterion test(s) to assess learning and then the recognition task. A 2 (information mode at learning; numerical versus verbal; within subjects) by 2 (information mode at recognition; numerical versus verbal; within subjects) factorial design was used. (Additional factors were manipulated in this study to assess issues beyond the scope of this paper. These factors were the format of information presentation during learning and during recognition; i.e., either a brand-based format or an attribute-based format. Format of information presentation during learning was manipulated between subjects. However, for purposes of analyses, means averaged across these two conditions of information format are presented.)

**Stimulus Materials**

**PRODUCT CATEGORY AND ATTRIBUTES.** Two criteria used in choosing a product category were that product attributes for the category should be easy to manipulate in terms of meaning and verbal modes and that subjects (students) should have sufficient knowledge to be able to process information in terms of meaning. Although several product categories, such as televisions, calculators, and automobiles, partially fulfill these criteria, calculators seemed to be a suitable product category because students are familiar with and own calculators (Bihañ and Chakravarti, 1983). Fictitious brand names were used to prevent the use of prior knowledge of existing brands, which might not be possessed at comparable levels across subjects. Brand names with similar normed ratings on concreteness, imagery value, and meaningfulness were chosen from the nouns tested by Paivio, Yuille, and Madigan (1968).

**PRETEST TO DETERMINE ATTRIBUTE MAGNITUDES.** To equate numerical and verbal labels in terms of meaning or semantic content, the following pretest was conducted. The “levels” subjects associated with the extreme points for each attribute were determined. For example, subjects’ apriori perceptions of “long” and “short” battery life for a rechargeable calculator was determined. To accomplish this the following approach was used: (1) open-ended elicitations were obtained for the extreme points along each attribute; (2) different levels obtained from the open-ended elicitations (a minimum of five levels per attribute) were each rated on a seven-point scale as either descriptive of one or the other end of the continuum by separate groups of subjects; and (3) the extreme points obtained for this pretest were then rated along semantic differential scales in a double translation approach. For example, one group of subjects rated a battery life of “840 hours” along a scale anchored by the verbal descriptors of “long” and “short.” A second group of subjects rated the statement, “A long battery life for a calculator would be?” along the scale anchored by the statistical descriptors “12 hours” and “840 hours.” The direction of the ratings (high versus low values) for different attributes were mixed within the different groups of subjects. Based upon the results of these pretests, values were obtained that mirrored the extreme end of their appropriate descriptors. The “high” versus “low” mean scores (on the seven-point scale) for each of the attributes are as follows: battery life (5.1 vs. 1.9, p < 0.05), warranty duration (5.1 vs. 1.9, p < 0.05), weight (5.3 vs. 1.4, p < 0.05), arithmetic functions (6.6 vs. 1.9, p < 0.05), and digital display (6.7 vs. 1.8, p < 0.05). The brand information used in the experiment is presented in Table 1.

**Procedures**

A total of 75 subjects participated in the study. All were undergraduate students in marketing courses at a midwestern university. The experiment was administered to four subjects at a time, each with a private booth equipped with a personal computer. The booths were separated by dividers to minimize exposure to other participants as well as distraction by others. When all four subjects were present in the room, there were at least two researchers present to coordinate the different stages of the experiment. After the learning phase and a distractor task, subjects completed a criterion test to assess whether they had learned the brand information. Those who did not pass the criterion test were given a second criterion test. Subjects who passed either of the tests completed the subsequent recognition task. Subjects received $5 apiece for their participation and in addition a lottery was held with two participants drawn at random receiving $100 and $50.

For the learning task, subjects were presented with information in booklets with the order of the brands and of the attributes across the pages as well as the sequence of the information within a given page being randomized to minimize contamination caused by primacy and recency effects. The 30-page booklet used each attribute name (brand name) as a page header followed by one page for each of the five brands (attributes) and the values associated with that attribute (brand). (As mentioned earlier, the format of information presentation was manipulated between subjects to examine issues beyond the scope of this paper.) Subjects in the brand condition were given a similar booklet using each brand name as a page header followed by the five attribute values associated with that brand. Initially, each subject was directed to learn information about calculators contained in a booklet. They were explicitly informed that they would be answering questions concerning this information later in the study. After completing the directed learning task, subjects completed a distractor task where they were given 20 anagrams to be solved in 20 seconds. To assess whether learning had successfully
Table 1. Brand-Attribute Information

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Battery Life</th>
<th>Arithmetic Functions</th>
<th>Warranty Duration</th>
<th>Display Width</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand Profile</td>
<td>Short</td>
<td>Many</td>
<td>36 Months</td>
<td>Small</td>
<td>2 Ounces</td>
</tr>
<tr>
<td>Brand Baron</td>
<td>840 Hours</td>
<td>4</td>
<td>Lengthy</td>
<td>14</td>
<td>Light</td>
</tr>
<tr>
<td>Brand Angle</td>
<td>Short</td>
<td>Many</td>
<td>2 Months</td>
<td>Large</td>
<td>3 Pounds</td>
</tr>
<tr>
<td>Brand Galaxy</td>
<td>12 Hours</td>
<td>96</td>
<td>Brief</td>
<td>6</td>
<td>Heavy</td>
</tr>
<tr>
<td>Brand Colony</td>
<td>Long</td>
<td>Few</td>
<td>2 Months</td>
<td>Large</td>
<td>3 Pounds</td>
</tr>
<tr>
<td>Experiment 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand Baron</td>
<td>40 Hours</td>
<td>E.high</td>
<td>E.brief</td>
<td>12 Digits</td>
<td></td>
</tr>
<tr>
<td>Brand Colony</td>
<td>Long</td>
<td>3 Functions</td>
<td>5 Months</td>
<td>E.wide</td>
<td></td>
</tr>
<tr>
<td>Brand Profile</td>
<td>380 Hours</td>
<td>Low</td>
<td>Lengthy</td>
<td>3 Digits</td>
<td></td>
</tr>
<tr>
<td>Brand Angle</td>
<td>E.short</td>
<td>38 Functions</td>
<td>72 Months</td>
<td>Narrow</td>
<td></td>
</tr>
</tbody>
</table>

occurred, subjects were administered a criterion test designed to evaluate the subject’s mastery of the information acquired during directed learning.

The order of the brands and attributes in the booklet were randomized except for the brand and attribute used in the criterion test, which were always positioned in the middle. The fixed position for the information used in the criterion test was desired to prevent the results of the criterion test being influenced by an order effect or position bias. This procedure resulted in four different booklets. The four booklets were randomly distributed to subjects. In the criterion test, subjects were given two sheets of paper, each containing brand-attribute information placed in a rectangle in the middle of the page with “yes” and “no” shown as the two possible responses at the bottom of each rectangle. The subjects were instructed to circle the “yes” response if the information on the sheet was the same as they had previously learned, otherwise they were asked to circle the “no” response. The brand name “Angle” and the attribute “Display Width” were used in the criterion test (Table 1). Two brand names and their values for Display Width and two attributes and their values for Angle were chosen randomly to be used in the first criterion test. The remaining three values were reserved for the second criterion test (Table 1). Of the 75 subjects who participated in the second experiment, 46 passed the first criterion test by correctly recognizing the information presented on both sheets. The remaining 29 subjects took the second criterion test and 15 passed the second test.

Information on the four remaining brands and attributes were used for the recognition task. The recognition task was administered on a Macintosh computer. Upon successfully completing either the first or the second criterion test, subjects were given the recognition task instructions and were familiarized with the Macintosh computer and the keys to use for Yes and No responses.

Each of the events within a trial was positioned in a rectangle displayed in the middle of the computer screen. The first event in each trial contained the brand or the attribute name and served as a prime for the remaining three stimuli in each trial corresponding to either the attribute or the brand values associated with the prime (i.e., attribute prime followed by the values of the three additional brands for that attribute or brand prime followed by the values of the three additional attributes for that brand). Each trial was followed by a blank rectangle intertrial field lasting for 2,000 milliseconds to indicate the end of a given set of brand or attribute information.

A total of 32 trials were required. The content of the events within trials as well as the trial sequence were developed using a Latin square design, which enabled the within-subject factors to be fully crossed. Hence, within each trial, subjects were exposed to each of four possible combinations based on information mode and true items/fillers (i.e., numerical true; numerical false; verbal true; and verbal false, see Table 2). Furthermore, the position of the correct recognition event was counterbalanced across trials so that it never occupied the same position across trials; therefore, correct responses occurred an equal number of times in each of the four serial positions within a trial. This was deemed necessary to prevent subjects from detecting and using a constant response pattern across trials. Subjects were exposed to a total of 128 stimuli containing brand-attribute information. On average, the experimental session lasted approximately 1 hour.

Results and Discussion
Preliminary analysis was conducted to assess the degree to which variation in accuracy rates was related to the variation in response times by correlating the two variables. The correlation between accuracy and response time was not significant ($r = -0.21; p > 0.05$).

The comparison to test $H1$ examined response times of recognition when information was identical at presentation and at recognition (i.e., “True” trials in recognition when information was presented in the same form at learning and at recognition; see Table 2). Numerical information was recog-


### Table 2. Details of Stimuli and Hypotheses Tests in Experiment 1

<table>
<thead>
<tr>
<th>Information Mode at Learning</th>
<th>Information Mode at Recognition</th>
<th>Correct Response</th>
<th>Examples of Information*</th>
<th>At Learning</th>
<th>At Recognition</th>
<th>Tests of Hs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical</td>
<td>Numerical</td>
<td>True</td>
<td></td>
<td>840</td>
<td>840</td>
<td>H1</td>
</tr>
<tr>
<td>Numerical</td>
<td>Numerical</td>
<td>False</td>
<td></td>
<td>12</td>
<td>840</td>
<td></td>
</tr>
<tr>
<td>Numerical</td>
<td>Numerical</td>
<td>False</td>
<td></td>
<td>840</td>
<td>12</td>
<td>H1</td>
</tr>
<tr>
<td>Numerical</td>
<td>Numerical</td>
<td>True</td>
<td></td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>Verbal</td>
<td>True</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>Verbal</td>
<td>False</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>Verbal</td>
<td>False</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>Verbal</td>
<td>True</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical</td>
<td>Verbal</td>
<td>True</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical</td>
<td>Verbal</td>
<td>False</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical</td>
<td>Verbal</td>
<td>False</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical</td>
<td>Verbal</td>
<td>True</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The attribute, battery life, is used to illustrate stimuli used with the numerical values presented as hours of battery life.

The recognition decision would likely involve exact matching of surface features of information at recognition with encoded information as a means of distinguishing it from other information. However, when information is presented in a different mode at recognition, the task may involve approximate matching. The essence of this task is not so much to determine whether information at learning versus recognition is identical in terms of surface features, but to determine whether they are approximately similar in meaning. As discussed earlier, information that was numerical at learning would have been encoded exactly and consequently accessed faster than information that was verbal at learning. But the recognition decision itself may then involve approximate matching to determine if information at recognition and encoded information are similar in meaning. Because these two pieces of information are different in mode, it may not be necessary to distinguish information at recognition from all other information in terms of their exact surface features, hence the faster response times.

The results of Experiment 1 provided support for the hypotheses in terms of faster recognition of numerical information presented in the same mode at recognition (H1) as well as in a different mode at recognition (H2). To conceptually replicate the findings in terms of H1, another experiment was conducted. Experiment 1 employed procedures, such as criterion tests, to ensure that learning had occurred among subjects. Experiment 2 used a learning task without criterion tests to study memory representation following learning tasks that are more akin to learning in the real world. Moreover, brands in Experiment 2 were described along attributes using a range of different magnitudes rather than just the extremes. The recognition task in Experiment 2 only involved presenta-
tion of information in the same mode as at learning, to provide a test of H1.

**Experiment 2**

In Experiment 2, the initial learning task was followed by a distractor task and a recognition task.

**Stimulus Materials**

The number of brands on which to present information was an issue of importance in order to avoid ceiling or floor effects for memory. Research in the past has usually involved the use of two to eight brands (e.g., Huber, 1980). The number of brands used was set at four on the basis of pilot tests. Six attributes used were “warranty length,” “battery life,” “weight,” “number of arithmetic functions,” “display width,” and “memory.” The number of attributes to be used in the experiments was trimmed from six to four on the basis of pilot tests.

**PRETEST TO ASSESS ATTRIBUTE MAGNITUDES.** A pretest was conducted to provide a basis for the manipulation of attribute magnitudes in numerical and verbal forms using a cross-model magnitude scaling procedure (cf., Lodge, 1981). The aim of the pretest was to generate a set of equivalent verbal and numerical labels that covered the range of possible magnitudes for each of several attributes of a calculator and to determine the number of magnitude levels to be used for each attribute. Groups of subjects (three in all) estimated the magnitudes represented by 13 verbal labels and 13 numerical labels for each of two attributes. Subjects provided their impressions of magnitudes by drawing lines (or producing numbers) so that the length of the line (or the magnitude of the number) varied with the magnitude represented by each label. Thirteen verbal labels were chosen for each attribute by attaching a range of descriptors studied in past research (Wildt and Mazis, 1978) such as “extremely,” to the anchors used to describe each attribute. Based on the pretest, five verbal labels and five equivalent numerical labels were chosen for each attribute, representing a five-point scale that covered each attribute continuum (Table 1).

**PILOT TESTS.** The pilot tests were designed to test and calibrate the experimental procedure in order to prevent ceiling or floor effects for memory. Furthermore, several issues were emphasized in the instructions and assessed in these pilot tests including credibility of information, which was facilitated by informing subjects that the information was extracted from Consumer Reports, processing of both modes to comparable levels, and adherence to task instructions to process all pieces of information. To encourage processing of all pieces of information, each of the four brands was first, second, third, and fourth, respectively, in its ranking based on magnitude on each of the four attributes.

The learning goal manipulation followed previous research (Biehal and Chakravarti, 1983), where the learning instructions asked subjects to learn information and informed them that they would be tested on memory for the information. Protocols after completion of the pilot tests suggested adherence to instructions. On the basis of the pretest and pilot tests, the set of brand-attribute information to be used in the experiment was determined (see Table 1). Because four brands with four attributes seemed to be appropriate based on the pilot tests, the magnitudes representing the middle points on the five-point continuum for each of the four attributes based on the pretest were excluded. Magnitudes were assigned to brands and attributes so that: (1) the proportion of numerical versus verbal information was identical across brands and attributes; (2) both modes were used to convey an equal number of scale-points along the five-point continuum based on the pretest, and therefore, the valence of information is not confounded with mode of information; and (3) no magnitude was repeated for any brand to eliminate differential levels of exposure and potential interference for different pieces of information (Table 1).

**Experimental Procedures**

The experiment was administered using Macintosh computers. The sample consisted of 20 undergraduate students at a midwestern university. Subjects were provided with a short exercise on the use of the computer, familiarized with the product category and attributes on which information would be presented, provided instructions for the learning task, and familiarized with the brand names. They were exposed to one piece of information at a time (i.e., a brand name, an attribute name, and a magnitude) and self-paced their exposure to each piece of information. The sequence of information was brand-based on the basis of the pilot tests with the order of attributes within each brand counterbalanced across all subjects. Furthermore, the order of brands was randomized to create four different versions of the basic information sequence to prevent primacy or recency effects for any brands, and an equal number of subjects was assigned to each version. Subjects had the option of exiting or viewing the information again only at the end of a cycle of 16 pieces of information to prevent differential exposure between pieces of information. This initial phase was followed by a distractor task for 1 minute where subjects completed a partial line drawing of an object using paper and pencil. Such a pictorial task was chosen, because it does not require the use of numerical or verbal information and should prevent differential interference/facilitation of numerical or verbal magnitudes in memory.

The distractor task was followed by the recognition task. The recognition task consisted of 32 trials, the 16 pieces of information originally shown, and 16 fillers. These fillers were false information about each of the four brands along each of the attributes. The fillers were in the same mode as the original information and consisted of an equal number of trials in each mode, the use of magnitudes that balance the valence of information in each mode, and no repetition of magnitudes...
that appeared in the “true” trials or as other fillers. Each trial consisted of exposure to a screen containing a brand name, an attribute name, and a magnitude. Subjects were required to provide a response (i.e., True or False) by clicking the mouse on the computer on the appropriate button on the screen. Such a response mode does not require the use of numbers or letters and should prevent differential interference/facilitation of numerical or verbal magnitudes in memory. The sequence of trials was randomized across all subjects with the constraint that no successive trials were for the same brand or attribute to prevent differential priming of information across trials. Subjects were instructed to provide as fast a response as possible without compromising on accuracy in order to prevent them from performing the task at different points along the speed–accuracy curve within and across conditions. Each trial was followed by a masked screen for 3 seconds to mark the end of the trial and alert subjects to the beginning of the next trial.

Results and Discussion

Preliminary analysis was conducted to assess the degree to which variation in accuracy rates is related to the variation in response times by correlating the two variables. The correlation between accuracy and response time was not significant ($r = 0.13; p > 0.05$).

The comparison to test $H1$ examined response times of recognition for all “True” trials, because all information at recognition was presented in the same mode as at learning. Numerical information was recognized significantly faster than verbal information ($mean = 7.62$ versus $8.85$ seconds; $p < 0.05$), providing support for $H1$. Consistent with the framework in terms of surface- versus meaning-level processing and the findings of Experiment 1, this result suggests that numerical information is represented in memory identical to its form at presentation to a greater degree than verbal information and is subsequently recognized faster.

It should be noted that the response times reported in both studies are in the order of seconds; whereas, typical response times in cognitive psychology are in the order of hundreds of milliseconds. Our results seem to be consistent with other work in marketing as well (e.g., Boush and Loken, 1991; Viswanathan and Narayanan, 1994). A key difference with research on cognitive psychology is the greater complexity of stimuli; that is, not a number or a word but one describing a brand on an attribute. Therefore, there is more information to process in terms of a number or a word, a unit of measurement, and the product category. Moreover, studies in cognitive psychology involve psychological dimensions that are universally used, such as size; whereas, product attributes often have a much narrower context. For example, display width of calculators is an attribute of a specific product category to which memory representations are identical to the form of the stimuli; that is, not a number or a word but one describing a brand on an attribute. Therefore, there is more information to process in terms of a number or a word, a unit of measurement, and the product category. Moreover, studies in cognitive psychology involve psychological dimensions that are universally used, such as size; whereas, product attributes often have a much narrower context. For example, display width of calculators is an attribute of a specific product category to which memory representations are identical to the form of the stimuli; that is, not a number or a word but one describing a brand on an attribute. Therefore, there is more information to process in terms of a number or a word, a unit of measurement, and the product category. 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Discussion

The objective of this research was to assess the degree to which numerical versus verbal product information is represented in memory identical to its form at presentation. A conceptual framework based on surface- versus meaning-level processing of information was developed to examine the representation of numerical versus verbal information in consumer memory. The basic proposition tested in this research was that numerical information may be represented in memory identical to its form at presentation in the external environment to a greater degree than verbal information. Research bearing on memory representations was discussed to bring out the methodological importance of using a recognition paradigm. Using this paradigm, hypotheses were developed about the recognition of numerical versus verbal product information following a learning task. The results of two experiments provided support for the hypotheses.

This study addressed an important question concerning representations in consumer memory of product information available externally in different modes. Symbolic manipulation of externally structured information in the form of numbers versus words can result in memory representations that may or may not be reflective of this external symbol. Theoretical implications of this research relate to how consumers process and represent numerical and verbal magnitude information in particular and magnitude information in general. Important implications include effects of memory representations on important variables in consumer research such as product judgments. These implications can be viewed within the framework developed here, which relates to the extent to which magnitude information is processed in terms of its meaning (i.e., the magnitude conveyed) versus its surface features. This framework leads to predictions about the degree to which memory representations are identical to the form of information at presentation as a function of factors such as information mode and processing goals. It should be noted that surface- versus meaning-level representations may occur
in many situations that are not captured in the set of studies presented here. This study used subjects who were knowledgeable about the product category; thereby, enabling meaning-level processing of numerical information during choice or judgment. However, surface-level representations of numerical information may occur even during a choice or a judgment task when consumers have a low level of knowledge or are not willing to expend the additional effort to process numerical information at a meaning level.

In terms of practical implications to marketers and public policy makers, identical representations lead to subsequent advantages in terms of memory and perhaps usage. Practitioners should focus on identifying conditions under which numerical versus verbal information will be processed and stored identical to its form at presentation. Such understanding would be very beneficial in enhancing the effectiveness of their communications. Public policy makers need to pay particular attention to how consumers derive meaning from numerical information, given its representation in memory identical to its form at presentation and consequent memory advantage. Consumers with low knowledge may process such information at a “surface” level and use it inappropriately without understanding the meaning conveyed. For example, consumers may store the sodium content of two brands of pretzels identical to its form at presentation as 500 mg and 600 mg, subsequently remember it accurately, and infer that the brand with 500 mg of sodium has “low” sodium when in fact it has “high” sodium, even for pretzels. Options for public policy include providing some form of reference information, such as the average sodium content of all pretzels, that facilitates meaning-level processing. On the other hand, advertisers would benefit from representation in memory of some magnitude information identical to its form at presentation where the meaning is obvious (such as the “1 calorie” Cola). It should be noted that generic numerical ratings, such as ratings on a five-point scale where meaning can be inferred from the end points of the scale, may be stored similar to verbal information; whereas, numerical information such as % of Daily Values may be stored similar to raw numerical information (i.e., identical to its form at presentation). With verbal information, marketers and public policy makers need to identify conditions under which identical representation is facilitated, such as through using verbal information with corresponding numerical labels when possible (e.g., Low fat-1 gram). Similar issues are relevant for price information as for product attribute information, such as whether availability of a reference price or a comparison price may encourage meaning-level processing (e.g., was $89, is $59); whereas, raw price information may encourage surface-level processing.

Several avenues for future research are suggested by this research. In broad terms, the key issue for future research is to develop an understanding of how consumers process and represent magnitude information, such as product attribute information and price information. Further research is needed on how numerical and verbal information is represented in consumer memory and what factors trigger surface- versus meaning-level processing. The effect of various factors, such as knowledge, motivation, and the availability of external reference information, needs to be researched. Although this study employed a high-knowledge setting, research should also focus on consumers with low levels of knowledge. Research should also focus on different presentations of numerical information that would facilitate its processing at the meaning level, such as a study of types of reference information that would facilitate the interpretation of numerical information. Research should also examine memory representations of other modes of presenting magnitude information, such as pictorial and graphic information. The effects of memory representations on ad processing as well as on product choice and judgment should also be examined.

Limitations of this research include the artificiality of the experimental setting in terms of fictitious brand names and information presentation in a structured sequence to enhance control. These procedures may have reduced the ecological validity of the findings. These issues should be considered in future research. In conclusion, this paper provides a set of findings about the representation of magnitude information in memory, the basic input to decision making, that have important implications for consumer research.

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