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The Encoding of Numerical and Verbal Information on Product Attributes: Implications for Consumer Memory

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Abstract

The focus of this paper is on differences in consumer memory for numerical versus verbal attribute information. Drawing on past research about the encoding of numerical and verbal information as a function of processing goals, hypotheses are derived for differences in memory between these two modes of information. Predictions are assessed for a range of variables such as recognition, recall, and encoding time. Numerical information is found (i) to be recognized more accurately and with less response time, (ii) to be recalled more precisely, and (iii) to require less time to encode, when compared to verbal information following a learning task. However, several advantages for numerical information disappear following a judgment task. Explanations for differences in consumer memory for numerical versus verbal information were generated and assessed here. Numerical and verbal information may differ in terms of the exactness with which they are encoded in memory and also in terms of the uniqueness with which they are represented in memory.
Marketing communications about product attributes use several modes of presenting information such as pictorial, graphical, numerical, and verbal modes. The numerical and verbal modes of presenting attribute information or magnitudes along attributes are commonly found in marketing communications. Using the attribute, gas mileage, as an example, magnitudes refer to quantifiers such as '32' m.p.g. or 'high' mileage that indicate the degree to which an attribute is possessed by a product. Such magnitudes or values along product attributes are often conveyed numerically and verbally on packages as well as other forms of marketing communications. The focus of this paper is on assessing and explaining differences in consumer memory for these two widely used modes of information, namely numerical and verbal magnitude information.

In addition to the importance of understanding the differences between these two modes due to their prevalent use in marketing communications, researchers have pointed out the importance of studying differences between numerical and verbal information for understanding issues with respect to magnitudes presented in any mode (Viswanathan and Childers 1992). In particular, two basic dimensions on which these two modes differ, namely their degree of evaluativeness and their degree of precision in conveying magnitudes, have been suggested as being of importance to our understanding of issues about magnitudes in general. Therefore, insights gained from comparing numerical and verbal attribute information may be extendible to other modes of information as well. A focus on differences in consumer memory between these two modes of information is critical here since each mode provides a baseline with which to compare the other. Further, inferences can be drawn about issues relating to magnitudes in general from differences between numerical and verbal information. Drawing on past research about the encoding of numerical and verbal information in consumer memory, hypotheses are generated and tested for differences in consumer memory for numerical versus verbal magnitudes. Several explanations for memory differences between numerical and verbal information are evaluated here.

Review of Relevant Research and Hypotheses

A review of past research on the encoding of numerical and verbal information in consumer memory as well as research on the interrelated issue of differences between numerical versus verbal information is provided as a basis for inferring differences in memory across these two types of
information as a function of the encoding task.

Differences between Numerical and Verbal Information

At least two dimensions on which numerical and verbal information differ have been identified in past research, namely evaluativeness Huber (1980) and precision (Jaffe-Katz et al. 1989). Research suggesting differences along these two dimensions is included here in a review of possible differences between numerical and verbal information.

Evaluativeness of Numerical Versus Verbal Information

Verbal magnitudes have been argued to be relatively more evaluative than numerical magnitudes and, therefore, easier to use in making evaluations during decision making (Huber 1980). Verbal magnitudes, when compared to numerical magnitudes, make the inference or evaluation of highness or lowness along an attribute (for example, a key difference between '32' miles per gallon and 'high' mileage is that the verbal magnitude makes the inference of highness in gas mileage). Huber (1980) found that subjects made evaluations more frequently when using verbal information (since such information was similar to evaluative labels) whereas computations of differences and maximum values were performed more frequently on numerical information. Scammon (1977) found that adjectival rather than percentage descriptors of nutritional information led to more accurate identification of nutritious brands. Consistent with Scammon's study, research on nutritional information disclosure (Venkatesan et al. 1986) suggests that a number derives its meaning in comparison with other numerical information. Therefore, several researchers have suggested that verbal magnitudes are relatively more evaluative than numerical magnitudes and, as a result, easier to use in making evaluations during the course of decision making than numerical magnitudes. Given this difference in terms of evaluativeness, it is possible that verbal information may be more likely to be encoded in terms of its evaluative equivalent when compared to numerical information, which requires additional processing in order to derive an evaluation.

Precision of Numerical Versus Verbal Information

Another dimension on which numerical and verbal information differ is in the degree of precision or fine-grainedness with which they convey magnitude information (Jaffe-Katz et al. 1989). Jaffe-Katz et al. (1989) argued and found that numerical information is more precise than verbal information by using comparisons of probability expressions. A number of studies in
decision making on the translation of verbal probability expressions to numerical form have found a high variation in the magnitude values assigned to verbal expressions as well as a high degree of overlap (cf., Beyth-Marom 1982). In a decision making context, Bell (1984) studied evaluations made by financial analysts and found that numerical information (operationalized as anchors on a rating scale) was given greater importance when companies were in stable environments and verbal information (due to its vague nature) was given greater importance for companies in volatile or uncertain environments.

Numerical and verbal information also differ in the context that is used to convey magnitudes. Numerical magnitudes are associated with an objective unit of measurement such as miles per gallon. This unit of measurement provides a context to interpret the numerical value. Kaplan (1964) points out that the standardization of numbers allow for their use in mathematical calculations. Standardization is a dimension on which numerical and verbal attribute information also vary since numerical information is presented on a standardized unit of measurement while verbal information is subjective in its usage. Verbal magnitudes provide a context for an attribute with the use of attribute specific verbal labels (such as "lengthy" for warranty length). Such an anchor may not match the way in which consumers typically encode information on the attribute in question, thereby requiring some degree of translation during encoding (such as, say, a translation to 'long' warranty).

Numerical information may also be associated with a higher degree of credibility since it represents raw or unprocessed information (as suggested by Scammon (1977)) in a relatively precise form. Verbal labels, due to their inherently imprecise nature and due to their subjective usage in marketing communications, may be associated with lower levels of credibility. Scammon (1977) found that people were more satisfied when judgments were made using percentage rather than adjectival descriptors. This finding is suggested to occur because adjectival information is preprocessed by the communicators while percentage information allows exposure to actual data. To the extent that consumers are allowed to process information, they may attribute a higher level of credibility with such information. Holbrook finds such a result in studying factualness/evaluativeness of messages. Finally, Yalch and Yalch (1984) have suggested that consumers may have less motivation or ability to process quantitative information. Hence, various
factors could affect the nature of encoding of numerical versus verbal information. To summarize, differences between numerical and verbal information in terms of precision, evaluativeness, use of a unit of measurement/a verbal anchor, and credibility may exist.

Encoding of Numerical and Verbal Information

Past research has focused on the encoding of numerical and verbal information as a function of processing goals at exposure to information. Hinrichs and Novick (1982) studied memory for numbers and argued that numbers could be used in either a nominal sense (such as a telephone number) or a magnitude sense (e.g., price information). They argued that since approximate information is often sufficient in dealing with magnitude information but that exact digits are of importance in nominal information, memory representations may reflect this by encoding different types of numbers differently. The authors investigate this possibility by studying the serial position effect. They found that the serial position occurred only when exact recall of digits were emphasized in the task instructions. The results are interpreted as suggesting two types of representations of numbers in memory.

The notion of nominal versus magnitude encoding suggested by Hinrichs and Novick (1982) points to a distinction of importance here. Magnitude encoding refers to the meaning of a magnitude label being encoded while nominal encoding refers to the surface features of a label being encoded in memory. The authors argue that when magnitudes (i.e., the meaning of a label) are encoded, only approximate numbers are recalled. However, when surface features are encoded, the exact information is more likely to be recalled. Further, the authors relate the nature of encoding to the task instructions provided such that when recall of exact digits were emphasized, nominal encoding occurred while emphasis on the magnitude conveyed by a label led to nominal encoding. Based on this research, an important distinction in memory representations of numbers is in terms of the level of precision with which information is encoded (i.e., either exact or approximate encoding).

Viswanathan and Childers (1992) conceptualize the nature of encoding of magnitudes in memory by arguing for dual forms of encoding, a form of encoding without modification and a form of encoding which is relatively coarse-grained and evaluative and, therefore, easy to use in decision making. They argue that numerical information will be recoded during a task involving decision making such as choice or judgment and the coarse-grained, evaluative equivalent of it may be
encoded in memory. During a learning task, numerical information is argued to be encoded without modification. The form of encoding of numerical information suggested during tasks involving decision making (i.e., a coarse-grained, evaluative form which is comparable to other magnitudes) involves the extraction of the meaning of a magnitude from numerical information whereas encoding without modification is similar to nominal encoding. Verbal information is argued to be encoded without modification following a learning task and less likely to be recoded during a choice task due to its coarse-grained, evaluative nature. The authors provide evidence to support their conceptualization by looking at interactions between processing goals (i.e., learning and choice) and mode for a range of tasks tapping memory and judgment. Their results suggest that numerical information may be encoded similar to a verbal form (i.e., at a magnitude level) during a choice task and without modification during a learning task (i.e., at a nominal level).

Based on past research, it appears that numerical and verbal information may be encoded in consumer memory in different ways as a function of processing goals. Past research provides a basis for assessing consumer memory for numerical versus verbal information as a function of processing goals.

Consumer Memory for Numerical Versus Verbal Information

As suggested earlier, numerical and verbal information may be encoded at nominal or magnitude levels in memory. These two types of encoding have implications for differences in the encoding of numerical and verbal information. Based on the review of differences between numerical and verbal information, several explanations can be generated for suggesting differences in consumer memory for numerical versus verbal information depending on encoding at the magnitude level and at the nominal level, respectively.

Differences between Numerical and Verbal Information Encoded at the Magnitude Level

Considering encoding at the magnitude level, to the extent that numerical information is more finely distinguished than verbal information, it could be argued that the representation of the corresponding magnitude in memory is less likely to overlap with other magnitude values. The rationale here is that a more precise representation of magnitude in memory is less likely to overlap with other magnitude representations. However, evidence from past research suggests that encoding at the magnitude level such that the original precision of numerical information is maintained does not
occur. In order to maintain the same level of precision in memory as in the externally presented information, several levels of magnitudes would have to be used (for example, if 32 mpg is inferred as being precise to 1 mpg, then several labels will have to be employed for each increment of 1 mpg.). Viswanathan and Childers (1992) argue that it is more likely that numerical information is compared to some reference point in order to infer a relatively coarse-grained magnitude from it. They provide evidence that numerical information is recoded into a form similar to verbal information during choice, a task which requires the extraction of the meaning of a magnitude label. Results presented by Hinrichs and Novick (1982) also point to a similar conclusion that approximate information is encoded when the magnitude of a number is emphasized. However, possible differences due to encoding at the magnitude level will be assessed in the research to be reported.

**Differences between Numerical and Verbal Information Encoded at the Nominal Level**

Two sets of explanations for possible differences in memory for numerical versus verbal information will be discussed which relate to differences at encoding and differences in memory representation after encoding. One explanation relates to the extent to which encoding of information is exact or identical to the presented information. Hence, this explanation, referred to as ‘exactness of encoding’ explanation, relates to the extent to which information is encoded in exactly the form in which it is presented. It should be noted that the term exact is used to refer to similarity with presented information whereas the word precise is used to describe the level of fine-grainedness of information. Another explanation is based on differences in memory representations of numerical and verbal information as a result of encoding. It will be argued that numerical and verbal information may differ in terms of the uniqueness of their memory representations, hence this explanation is referred to as the ‘uniqueness of representation’ explanation.

Nominal encoding may lead to the exact encoding of digits for numerical information and words for verbal information. However, several arguments could be made for the relatively inexact encoding of verbal information when compared to numerical information. As discussed earlier, numerical information involves a unique combination of digits presented in the context of a specific unit of measurement. Using the analogy of memorizing a telephone number versus a verbal description, the exact content of the number is emphasized whereas an approximate equivalent of a verbal descriptor may be sufficient to retain the meaning of conveyed information. Unique
combinations of digits may, therefore, be encoded in memory more exactly than verbal labels. In fact, a means of avoiding the expenditure of effort in extracting the meaning equivalent of numerical information may be to encode it without modification.

Based on past research, several factors suggest the relatively inexact encoding of verbal information when compared to numerical information. One possibility is that, given the imprecise usage and interpretation of verbal labels when compared to numerical labels (Jaffe-Katz 1989), they are encoded in an even more approximate form (for, e.g., a label such as 'very lengthy' may be encoded as 'lengthy'). Such encoding may be the result of the perceived credibility and/or imprecision of verbal information. Another possibility is that verbal information is encoded in memory in terms of its equivalent evaluative meaning due to the evaluative nature of verbal labels (for e.g., a label such as 'very high' mileage may be encoded as 'good' mileage, with the exact label not being encoded in memory). Due to its evaluative nature (cf. Huber 1980), verbal information may trigger an evaluative equivalent during encoding. Numerical information is relatively non-evaluative in nature and therefore, may not trigger an evaluative equivalent. A third possibility is that, since, numerical information involves the use of an objective unit of measurement and verbal information involves the use of an idiosyncratic verbal anchor (such as, say, 'lengthy' for warranty), such an anchor may not match the way in which consumers typically encode information on the attribute in question, thereby requiring some degree of translation (such as, say, 'long' warranty).

A different explanation for memory differences between numerical and verbal information is based on differences in memory representations after encoding. Even with exact encoding of verbal information, a verbal label may be more likely overlap with other labels that may be used to describe the same or different attributes in memory (for example, the label, 'high', may be more likely to overlap with information for the same or different attributes). This may not be the case for a unique combination of digits, particularly when these digits are provided within the context of a unit of measurement. Therefore, the retrieval of verbal information may be more difficult due to potential interference with other labels in memory. Since this argument is made for nominal encoding of information, it does not relate to the precise versus imprecise magnitudes conveyed by numerical and verbal information but possible differences in the uniqueness of representation of numerical and verbal information at the nominal level. Therefore, this explanation is referred to as the uniqueness
of representations explanation (rather than the precision of representations explanation). It should be noted that both explanations in terms of exactness of encoding and uniqueness of memory representations are not mutually exclusive. It is possible that inexact encoding of verbal information may lead to a greater degree of overlap with other information and, hence, a disadvantage in terms of memory.

Hypotheses for Recognition, Recall, and Encoding Time

Magnitude versus nominal encoding may be related to tasks involving learning and decision-making. In a learning task, the nominal encoding of information would be emphasized since the goal at exposure to information is to memorize it. In a task involving decision-making such as a judgment task, an overall evaluation is required which would necessitate an understanding of the meaning of the labels involved (i.e., their magnitudes along product attributes). Combining the arguments suggested above for differences in the encoding of numerical and verbal information as a function the processing goal at exposure to information, several hypotheses can be generated for consumer memory for numerical and verbal information.

Using a setting where both numerical and verbal information are provided with the single goal of either (i) learning information or (ii) making judgments about brands, operational hypotheses can be generated for a variety of tasks which follow these processing goals such as recognition and recall.

Recognition

Recognition tests have been used in the context of tests of models of semantic memory, with faster recognition of test stimuli similar to their representation in memory generally hypothesized (Chang 1986). Bettman (1979) points out that “to recognize a stimulus from among a set of distracting stimuli, information allowing one to differentiate or discriminate the previously encountered stimulus is necessary” (p. 45). As suggested earlier, more exact encoding and/or more unique representation of numerical information when compared to verbal information is possible during a learning task. To the extent that original information is more finely distinguished, easier recognition of information would be predicted since it would be easier to differentiate or discriminate information that is finely distinguished. Also, to the extent that numerical information is encoded more exactly than verbal information, better recognition of the original information is expected.
Therefore, both the exactness of encoding and the uniqueness of representation explanations suggest superior recognition for numerical information. Following a judgment task, such an advantage for numerical information is not predicted since numerical information may be encoded such that the meaning of the magnitude conveyed by it is encoded rather than the exact numerical value. The ease of recognition of numerical information is expected to translate into faster as well as more accurate recognition of such information.

H1a: Numerical attribute information will be recognized faster than verbal attribute information following a learning task.

H1b: Numerical attribute information will not be recognized faster than verbal attribute information following a judgment task.

H1c: Numerical attribute information will be recognized more accurately than verbal attribute information following a learning task.

H1d: Numerical attribute information will not be recognized more accurately than verbal attribute information following a judgment task.

Recall

Recall tasks have been used to assess the nature of storage of information in long term memory (cf., Biehal and Chakravarti 1982). Bettman (1979) points out that recall tasks require the reconstruction of a stimulus. To the extent that exact information is encoded in memory, more accurate recall of such information in its exact form would be expected since reconstruction of information in its exact form is likely. Given the encoding of numerical information in an exact form following learning when compared to verbal information, more exact recall (i.e., recall of the exact information presented) of numerical information than verbal information is predicted. However, such a relationship is not predicted following a judgment task. It should be noted that a similar prediction can be made based on the uniqueness of memory representations of numerical information when compared to verbal information. A more unique memory representation may facilitate the retrieval of exact information when compared to a representation that overlaps with other representations.

H2a: Exact recall of numerical information will be higher than exact recall of verbal information following a learning task.

H2b: Exact recall of numerical information will not be higher than exact recall of
verbal information following a judgment task.

Encoding Time

A further test of explanations developed here would be provided by examining the encoding time required for numerical versus verbal information as a function of task. Encoding time has been used in past research as a proxy for processing effort (Stone and Schadke 1992). To the extent that numerical information is argued to be encoded in an exact form without modification whereas verbal information is argued to be encoded in terms of its meaning equivalent, easier encoding of numerical information is suggested. Similarly, to the extent that numerical information is easily distinguishable based on its uniqueness, easier encoding (i.e., lesser learning time) of numerical information is predicted.

H3a: Numerical information will require less encoding time than verbal information during a learning task.

H3b: Numerical information will not require less encoding time than verbal information during a judgment task.

Pretest

A previous study (Viswanathan and Childers 1992) involved a methodology that was used to assess the processing of numerical and verbal information under learning versus choice conditions. The focus there was to assess interactions between task and mode for assessing a conceptualization of the encoding of magnitudes by consumers. The data from this study was reanalyzed for purposes of evaluating the hypotheses presented here in terms of differences in memory between numerical and verbal information. It should be noted that a choice task has several similarities with a judgment task in that it does not involve the learning of information but requires the extraction of the meaning or magnitude conveyed by a label. The results are presented here as a pretest. This is followed by a description of two other studies that were conducted to evaluate the explanations presented earlier. The methodology employed in the pretest is described in some detail due to the high degree of overlap with the methodology used in the two studies conducted here.

Overview of Design

The methodology involved a task manipulation between subjects with two levels (i.e.,
directed learning and on-line choice (cf. Biehal and Chakravarti 1983). A within subjects manipulation of information mode was employed, since all hypotheses were at the level of individual attribute information for a brand. This initial choice or learning task was followed by a distracter task involving pictorial information (to avoid use of verbal or numerical information) to remove the effects of short term memory and provide tests of long term memory. The task manipulation followed previous research (Biehal and Chakravarti 1983) where the learning instructions informed the subjects that they would be tested on memory for the information while the choice instructions stressed that subjects were not required to learn information, but to use it in making a choice. The distracter task was followed by either a recognition task or a recall task.

Stimulus materials

Calculators were chosen as the product category to be used in the experiments since students are familiar with this category and own calculators (Biehal and Chakravarti 1983). Four fictitious brands and four attributes were used in the experiments on the basis of pilot tests conducted to assess several aspects of the experimental procedures. The pilot tests were designed to test and calibrate the experimental procedure to prevent ceiling or floor effects for memory. Several aspects of the procedure including comparable levels of credibility of numerical and verbal information, processing of both modes to comparable levels and adherence to task instructions to process all pieces of information were also assessed and found to be satisfactory (please see Viswanathan and Childers (1992) for details of the pilot test).

The manipulation of attribute magnitudes in numerical and verbal forms was determined on the basis of a pretest using a cross-modal magnitude scaling procedure (see Viswanathan and Childers 1992). Since the focus here is on translation from one mode to the other, it was important to generate a set of equivalent verbal and numerical labels for each of several attributes of a calculator which covered the range of possible magnitudes for each of the attributes. Further, it was important to determine the number of magnitude levels to be used for each attribute. A range of magnitude labels (i.e., 13 verbal and 13 numerical labels) for each of several attributes of calculators were estimated by subjects by using numbers (or drawing lines) such that the size of numbers (or the length of lines) indicated their subjective impressions of the magnitudes conveyed by these labels. Clusters of verbal labels were identified to determine the number of levels of magnitudes to use for
each attribute. Based on this analysis, five verbal labels and five equivalent numerical labels were chosen for each attribute.

Four brands with four attributes were employed with the middle points for the four attributes being excluded and the other points assigned to the four brands. Magnitudes were assigned to brands and attributes such that (i) the proportion of numerical versus verbal information was constant across brands and attributes, (ii) both modes were used to convey an equal number of scale-points along a five point continuum (therefore, the valence of information is not confounded with mode of information), and (iii) no magnitude value was repeated for any brand to eliminate differential levels of interference for different pieces of information.

Experimental Procedures

The experiments were conducted using Macintosh computers. The sample consisted of 80 undergraduate students at a midwestern university. 40 subjects were assigned to each task (i.e., learning versus choice) with 20 subjects assigned to each dependent variable (i.e., recognition versus recall) within each task condition. Subjects were provided with a short exercise on the use of the Macintosh computer, familiarized with the product category and attributes on which information would be presented, provided instructions for either directed learning or on-line choice tasks, and familiarized with the brand names. Subjects then performed either the directed learning or the on-line choice task. They were exposed to one piece of information at a time (i.e., a brand name, an attribute, 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 randomized across all subjects. Subjects had the option of exiting the task or viewing the information again only at the end of a cycle of sixteen pieces of information (to prevent differential exposure between pieces of information).

The initial task was followed by a distracter task for one minute where subjects were required to complete a partial line drawing of an object. The distracter was followed by either the recognition task or the recall task for different groups of subjects. 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 (with an equal number of trials in each mode, the use of magnitudes which balance the valence of information in each mode, and no repetition of
magnitudes which appeared in the ‘true’ trials or other fillers). Each trial consisted of exposure to a screen containing a brand name, an attribute label, and a magnitude. Subjects were required to provide a True/False response by clicking a mouse on the Macintosh 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 information 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 subjects from performing the task at different points along the speed-accuracy curve, both within and across task 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.

The recall task consisted of 16 trials (with 3 second masks between trials). Subjects were provided with a brand name and an attribute label and instructed to type in the attribute value they could recall. The sequence of cues was brand based (on the basis of pilot tests) with the order of attributes for each brand being randomized.

Results

Analysis of recognition data

Data on the recognition task was analyzed by computing the average response times of accurate responses for each subject for numerical and verbal information under each condition.\(^3\) The mean response times were analyzed using an analysis of variance procedure with a 2 (task; between subjects) by 2 (information mode; within subjects) factorial design. A significant main effect for mode (F(1,38) = 18.99; p < 0.001) and a significant interaction between task and mode (F(1,38) = 5.99; p < 0.05) were obtained. An examination of the specific contrasts suggested that numerical information was recognized significantly faster than verbal information following learning (F(1,38) = 23.16; p < 0.001) but not following choice (F(1,38) = 1.82). The mean response times for the recognition of numerical information and verbal information following learning and choice respectively was 7.42s, 8.97s, 7.30s, and 7.73s. These results provide support for H1a and H1b.

In terms of accuracy of recognition, a similar ANOVA led to a significant main effect for mode such that numerical information was recognized significantly better than verbal information (F
(1,44) = 20.14; p < .001). This effect appeared to hold for learning (F (1,38) = 11.26; p < .01) and for choice (F (1,38) = 8.95; p < .01). Therefore, even though encoding at the magnitude level was argued for numerical information following a choice task, an advantage in terms of recognition appears to persist, thereby providing support for H1c but not for H1d.

**Analysis of recall accuracy**

Subjects in the recall task were instructed to retrieve information in any form they preferred leading to four possible combinations; numerical recall of information that was numerical at exposure (referred to as NN), NV, VV, and VN where the first letter refers to mode at exposure and the second letter refers to mode at recall). The number of accurately recalled times for each of these cells was computed for each subject. The accuracy of recall was computed twice using a strict and a lenient criterion, respectively. Using the strict criterion, a response was considered accurate if a subject recalled the equivalent of the exact scale point that a brand-attribute was associated with (on a five point scale based upon the pretest). In the case of numerical information, this referred to recall of the exact digits. For verbal information, accurate recall was based on the meaning conveyed by a recalled word (for e.g., a label such as 'high' warranty length, while being different from 'lengthy' warranty length, conveys the same meaning). This was with a view to assessing the various reasons that were suggested for inexact encoding of verbal information by including recall of items that were equivalent in terms of meaning. It should be noted that H2a & H2b relate to the use of a strict criterion since exact recall of information is emphasized. However, such a criterion does not allow for individual differences in assessing magnitudes (i.e., a warranty length of 72 months may be "very lengthy" for some individuals but "lengthy" for others). Therefore, the accuracy of responses were also identified using a lenient criterion wherein a response was accurate if it was within one scale point on either side of the "strict" response (for e.g., if battery life for a brand was "long", then recall of this item as "very long" or "neither long nor short" was considered accurate using the lenient criterion). This was with a view to assessing approximate recall of information as well.

A 2 (task) by 2 (mode) factorial ANOVA was performed on the data based on the strict criterion. A significant effect was obtained for task (F(1,38) = 4.84; p <.05) and mode (F(1,38) = 9.42; p < .01). An examination of the specific contrasts suggested that precise recall of numerical information was significantly greater than of verbal information following learning (F(1,38) = 9.09;
p < .01) but not following choice (F(1,38) = 1.76). The mean recall for numerical and verbal information at learning and choice respectively was 4.05, 2.80, 2.75, and 2.20. These results provide support for H2a and H2b.

A similar analysis using a lenient criterion required the inclusion of the recall of numerical information in a verbal form and verbal information in a numerical form as well. Therefore a 2 (task; learning versus choice) by 2 (mode at presentation; numerical versus verbal) by 2 (mode at recall; numerical versus verbal) factorial ANOVA was conducted on the recall data. A significant main effect was found for mode at presentation such that numerical information was recalled more accurately than verbal information (F (1,38) = 22.77; p < .001) with significant effects for both learning and choice (Mean recall = 5.95, 4.45, 5.50, and 4.35, for numerical and verbal information at learning and choice, respectively). Based on the results, an advantage for numerical information also occurs in terms of approximate recall.

**Analysis of Encoding time**

A 2 (task) by 2 (mode) factorial ANOVA was performed on the encoding times. Significant effects were obtained for task (F(43.58; p < .001) and mode (6.90; p < .05). Numerical information required significantly less encoding time than verbal information following learning (F(1,78) = 8.01; p < .01) but not following choice (F(1,78) = 0.78). The mean encoding times for numerical and verbal information at learning and choice respectively were 261.3s, 288.2s, 97.3s, and 105.7s, respectively. These results provide support for H3a and H3b, suggesting that it is easier to encode numerical information when compared to verbal information during a learning task. These results are particularly interesting, in light of the faster recognition and superior recall of numerical information following a learning task.

Based on the results of the pretest using a learning and choice task, support was obtained for several hypotheses. However, H1d, which predicted that numerical information following a choice task will not be recognized more accurately than verbal information was not supported. It appears that numerical information is easier to encode than verbal information during a learning task, is subsequently recognized faster and more accurately, is recalled more exactly, and also has an advantage in terms of approximate recall. Numerical information also appears to be recognized more accurately following both learning and choice tasks. Further tests of the hypotheses were conducted
in Study 1 using three tasks with differing degrees of learning and judgment.

STUDY 1

This study was similar to the study described in the pretest in terms of the stimulus materials and procedures. Therefore, only differences between this study and the pretest are discussed here. The tasks used here were a learning task, a judgment task, and learning & judgment task. The learning and judgment task was used in order to examine the pattern of results for varying degrees of judgment and learning. The instructions for the judgment task followed previous research in that subjects were instructed to make a judgment or an evaluation based on their liking for each brand (Lichtenstein and Srull, 1985). The learning & judgment task instructed subjects to both learn information and judge brands. Each task was followed by a pictorial distracter task for one minute which was followed by the recall task or the recognition task. One difference in terms of the recall task was that free recall was used rather than cued recall. The cued recall task was used in the previous study to address issues unique to that study. Here, a free recall task was used to assess differences between numerical and verbal information using traditional measures of recognition and recall. Another difference in the recognition task was that each True/False trial was followed by a screen where subjects provided confidence ratings for their responses.

97 students at a midwestern university participated in this study. An approximately equal number of students were assigned to each task condition. Further, approximately 16 subjects within each task condition were assigned to a condition based on each dependent variable (i.e., recognition and recall).

Results

Analysis of recognition data

Data on the recognition task was analyzed by computing the average response times of accurate responses for each subject for numerical and verbal information under each condition. The mean response times were analyzed using an analysis of variance procedure with a 3 (task; learning, learning & judgment, and judgment; between subjects) by 2 (information mode; numerical versus verbal; within subjects) factorial design. A significant main effect for mode (F (2,44) = 31.91; p < 0.001) was obtained with the interaction between task and mode not reaching significance. An
examination of the specific contrasts suggested that numerical information was recognized significantly faster than verbal information following learning (F(1,44) = 15.38; p < 0.001) and following learning & judgment (F(1,44) = 17.73; p < 0.001) but not following judgment (F(1,44) = 2.66; p > .10; Mean RTs for numerical and verbal information following learning, learning & judgment, and judgment were 7.07s, 9.04s, 7.89s, 9.93s, 7.80s, and 8.59s, respectively). These results provide support for H1a and H1b and are consistent with the results of the pretest. The learning and judgment task led to a difference between numerical and verbal information that was comparable to the learning task. The results are summarized in Figure 1.

In terms of accuracy of recognition, a similar ANOVA led to a significant main effect for mode such that numerical information was recognized significantly better than verbal information (F(1,44) = 96.69; p < .001). This effect appeared to hold across all three tasks (Mean accuracy for numerical and verbal information following learning, learning & judgment, and judgment were 0.80, 0.66, 0.82, 0.60, 0.76, and 0.63, respectively). Therefore, even though encoding at the magnitude level was argued for numerical information following a judgment task, an advantage in terms of recognition appears to persist, thereby providing support for H1c but not for H1d. This is consistent with the results of the pretest where significantly higher recognition accuracy was not obtained for either task. The results are summarized in Figure 1.

Analysis of recall data

A 3 (task; learning, learning and judgment; judgment) by 2 (mode; NN versus VV) factorial ANOVA was performed on the recall based on a strict criterion. Significant effects were obtained for presentation (F(2,47) = 6.52; p < .01), mode (F(1,47) = 10.83; p < .01), and the interaction between presentation and mode (F(2,47) = 4.36; p < .05). An examination of the specific contrasts suggested that NN was significantly higher than VV for the learning task (F(1,47) = 13.54; p < .01; Means for NN and VV = 4.59 and 2.94), for the learning and judgment task (F(1,47) = 6.24; p < .05; Means for NN and VV = 3.29 and 2.18), but not for the judgment task (F(1,47) = 0.17; Means for NN and VV = 1.69 and 1.88). These results provide support for H2a and H2b and are summarized in Figure 2.
A similar analysis using a lenient criterion required the inclusion of the recall of numerical information in a verbal form and verbal information in a numerical form as well. Therefore a 3 (task; learning, learning and judgment, & judgment) by 2 (mode at presentation; numerical versus verbal) by 2 (mode at recall; numerical versus verbal) factorial ANOVA was conducted on the recall data. A significant main effect was found for mode at presentation such that numerical information was recalled more accurately than verbal information (F (1,47) = 4.61; p < .05; Mean recall = 6.00, 5.64, 5.53, 4.35, 4.06, and 3.88 for numerical and verbal information at learning, learning & judgment, and judgment, respectively). An examination of effects at each task led to a non-significant effect for learning (F (1,47) = 0.30), a marginally significant effect for learning and judgment (F (1,47) = 3.32; p < .08), and non-significant effect for judgment (F (1,47) = 0.08). Based on the results, an advantage for numerical information occurs in terms of approximate recall only for the learning and judgment condition. It should be noted that this task involves elements of both nominal and magnitude encoding which may have lead to an advantage in terms of approximate recall. However, the results for the learning task and the judgment task are not consistent with those of the pretest where an advantage for numerical information in terms of approximate recall was obtained.

In order to examine the extent to which recall of verbal information involved the use of evaluative equivalents or idiosyncratic label equivalents, the strict recall of verbal information was reanalyzed. An item was scored as being accurately recalled only if the exact label used at presentation was recalled (referred to as literal recall while the results reported above refer are referred to as non-literal recall). Literal versus non-literal recall following learning was 2.59 and 2.94, respectively and, following judgment, was 1.06 and 1.88, respectively. Therefore, 11.9% of accurately recalled information following learning and 43.6% of accurately recalled information following judgment were not recalled literally. All the information that was recalled non-literally involved the use of different labels than those presented for a specific attribute (with some degree of confusion between the labels of the four attributes used). However, evaluative equivalents of information (such as 'good' or 'decent') were not recalled. Hence, the results refute the prediction that evaluative equivalents may be encoded and suggest that, following learning, some recall is non-
literal. However, the extent of non-literal recall appears to be very low, therefore bringing into question any explanation of differences between numerical and verbal information based on the use equivalent but not identical labels for verbal information. Although the effect appears to be stronger following judgment, the advantage for numerical information was not found following judgment.

Analysis of Encoding Time

A 3 (task) by 2 (mode) factorial ANOVA was performed on the mean encoding times for each subject. Significant effects were obtained for task (F(2,95) = 15.78; p < .001), model (F(1,95) = 14.23; p < .001) and the interaction between task and mode (F(2,95) = 4.69; p < .05). Numerical information required significantly less encoding time than verbal information for the learning task (F(1,95) = 20.77; p < .001; Means = 24.39 versus 28.62s) but not for the learn/judgment task (F(1,905) = 2.25; Means = 17.29 versus 18.66) and the judgment task (Means = 10.49 and 10.89s). The results are summarized in Figure 3.

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Insert Figure 3 about here

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Discussion of Results

Several findings emerged from these analyses. First, numerical information is recognized faster and more accurately following tasks involving learning. The advantage of numerical information in terms of recognition accuracy persists even for a judgment task. In line with the explanations suggested earlier, it appears that nominal encoding may lead to the more exact encoding of numerical information when compared to verbal information and/or the representation of numerical information in memory which is easier to distinguish than verbal information.

Second, numerical information tends to be recalled in terms of its exact value to a greater extent than verbal information following a learning task. Therefore, numerical information, which is relatively precise at presentation, may be encoded and/or retrieved in a relatively exact form. Verbal information appears to be encoded and/or retrieved in a relatively inexact form. The results suggest that, in addition to differences between numerical and verbal information at presentation, differences at encoding appear to lead to recall of information that is even more different in terms of precision. The explanations in terms of the use of idiosyncratic label equivalents and evaluative equivalents are not strongly supported in light of the small degree of recall of verbal information with the use of
idiosyncratic anchors. However, inexact encoding (using imprecise labels) and uniqueness of representation remain possible explanations for these findings.

Third, the easier encoding of numerical information during learning based on encoding time provides some support for an explanation based on the easier encoding of numerical information when compared to verbal information. Such easier encoding may be due to the ease of distinguishing numerical information (as suggested by recognition results), or due to additional processing required for translating a verbal label to some equivalent (based on the results of literal versus non-literal recall, translation to a more imprecise equivalent remains a possible explanation).

It appears that advantages in recall, recognition, and encoding time exists for numerical information when the task at exposure to information requires subjects to learn information rather than make a choice or judgment. Based on the results of the pretest and the first study, at least two conclusion can be drawn. First, given the existence of the advantage following tasks involving elements of learning, differences can be attributed to nominal rather than magnitude level encoding of information. Second, it appears that predictions made based on both the exactness of encoding and uniqueness of memory representations hold. However, it is not possible to compare these two explanations based on these studies.

While several explanations were considered for memory differences between numerical and verbal information, another study was conducted to identify a condition where the advantage for numerical information may disappear. This was in order to further attempt to narrow down the explanation(s), which, based on the pretest and the first study, appear to be rooted in nominal encoding. The procedure was identical to the learning condition in the first task except that all values along each of two attributes were either numerical or verbal. The aim here was to present information such that, along any particular attribute, all pieces of information are either numerical or verbal.

The two potential explanations for the earlier results led to the choice of such a design. If the advantage for numerical information occurs due to lack of interference with other information when compared to verbal information (i.e., more finely distinguished representations in memory), this advantage should decrease or disappear when information is presented such that all four pieces of information on an attribute are numerical. This is argued to occur because, with an increase in the number of pieces of numerical information on an attribute, the amount of interference along an
attribute should increase due to a repetition of the ten possible digits in the context of a unit of measurement. Apparently when equal proportions of information on an attribute are numerical and verbal, interference does not play an important role since advantages are found for numerical information.

Conversely, if earlier results are due to a disadvantage for verbal information based on inexact encoding, such an advantage may disappear when all labels along an attribute use the same verbal anchor with different modifiers. The use of verbal labels to describe all the brands along an attribute would lead to a better representation of the relative categories occupied by each label. For example, the use of a range of verbal labels such as ‘very high’, ‘high’, ‘low’, and ‘very low’ may facilitate a clearer interpretation of each category by providing a means of assessing each label relative to all other labels on a category. Therefore, the exact encoding of verbal labels may be more likely to occur. However, the presentation of equal proportions of numerical and verbal information may not facilitate such a clear interpretation.

To summarize, decreases in the absolute level of recognition accuracy, recognition speed, and recall accuracy, and an increase in encoding time for numerical information would provide support for the uniqueness of memory representation view. However, increases in the absolute level of recognition accuracy, recognition speed, and recall accuracy, and a decrease in encoding time for verbal information would provide support for the exactness of encoding view.

Study 2

The procedure used here was similar to the learning condition in Study 1 except that all four brands were described by numerical information for two attributes and by verbal information for the other two attributes. Two versions of the procedure were created such the two attributes that were assigned to numerical (verbal) conditions in one version were assigned to the verbal (numerical) conditions in the second version. Approximately equal numbers of subjects were assigned to each version. The initial learning task was followed by the distracter task and either the recall task or the recognition task.

The procedure in this study was similar to the learning task with two groups of subjects. One group performed the recall task while the other performed the recognition task. A major
difference was the assignment of mode to each attribute. In contrast to the earlier studies, two attributes were presented numerically while two others were presented verbally (referred to as the 'all' condition since 'all' information on an attribute was either numerical or verbal, with the manipulation in Study 1 being referred to as the 'mixed' condition). The attributes that were assigned to each mode were balanced across two sets of approximately equal number subjects. It should be noted that the manipulation of mode in the manner stated above led to a different recognition task. This was because the fillers used on a particular matched original information on some other brand, thereby leading to potentially more difficult recognition task. Hence, while differences between numerical and verbal information across Studies 1 and 2 can be made, comparisons of absolute levels of recognition across Study 1 and Study 2 are not possible.

Results

Analysis of Recognition Data

A 2 (presentation; attributes 'mixed' versus 'all') by 2 (mode; numerical versus verbal) factorial ANOVA was performed on mean RTs of accurate recognition which produced a significant main effect for mode (F(1,29) = 14.63; p < 0.001). Examination of the effect of mode for the "mixed" condition and "all" condition produced a significant main effect for the "mixed" (F(1,29) = 11.97; p < .01; Mean for numerical and verbal information = 7.07s and 9.04s, respectively) and a marginally significant effect for 'all' (F(1,29) = 3.71; p < .07; Mean for numerical and verbal information = 7.35s and 8.41s, respectively).

A similar analysis for was performed on accuracy of recognition. Significant effects were obtained for mode (F(1,29) = 9.30; p < 0.01) and the interaction between presentation and mode (F(1,29) = 5.45; p < .05). Numerical information was recognized more accurately than verbal information. However, an examination of the interaction suggested that numerical information was recognized more accurately than verbal information for the "mixed" condition (F(1,29) = 14.04; p < .01; Means for numerical versus verbal information = 0.80 and 0.66, respectively) but not for the "all" condition (F(1,29) = 0.26; Means for numerical versus verbal information = 0.72 and 0.70, respectively). The results are summarized in Figure 4.

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Insert Figure 4 about here

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Analysis of recall accuracy

A 2 (presentation; mixed versus all) by 2 (mode; NN versus VV) factorial ANOVA was performed on recall based on the strict criterion. A significant main effect was obtained for mode (F(1,31) = 5.63; p < .05). An investigation of the main effect suggested the NN was significantly higher than VV for the mixed condition (F(1,31) = 7.70; p < .01; Means for NN versus VV = 4.59 and 2.94, respectively) but not in the 'all' condition (F(1,31) = 0.38; Means for NN and VV = 4.31 and 3.94). These results also suggest a facilitation of exact recall of verbal information in the 'all' condition when compared to the 'mixed' condition, though this effect was not significant. The results are summarized in Figure 5.

Insert Figure 5 about here

A similar analysis using a lenient criterion required the inclusion of the recall of numerical information in a verbal form and verbal information in a numerical form as well. Therefore a 2 (presentation; mixed versus all) by 2 (mode at presentation; numerical versus verbal) by 2 (mode at recall; numerical versus verbal) factorial ANOVA was conducted on the recall data. A significant main effect was found for mode at presentation was not found (F (1,31) = 0.87; Mean recall = 6.00, 5.64, 6.31, and 6.06, for numerical and verbal information at the 'mixed' and 'all' conditions, respectively). Based on the results, no differences in approximate recall were found across the two conditions. An interesting result in terms of approximate recall was the greater tendency in the 'all' condition to recall information in the form in which it was presented (Mean recall for NN, NV, VN, and VV for the 'mixed' and 'all' conditions were = 4.71, 1.29, 0.88, 4.76, 6.06, 0.25, 0.00, and 6.06, respectively).

Literal versus non-literal recall of verbal information was analyzed using a 2 (presentation; mixed versus all) by 2 (type of recall; literal versus non-literal) factorial ANOVA. A significant effect of type of recall was obtained for the 'mixed' condition (F(1,31) = 6.36; p < .05) but not for the 'all' condition (F(1,31) = 1.69). Literal versus non-literal recall for verbal information following the 'mixed' condition was 2.59 and 2.94, respectively, and following the 'all' condition was 3.75 and 3.93, respectively.

Analysis of encoding time
A 2 (presentation; mixed versus all) by 2 (mode; numerical versus verbal) factorial ANOVA was performed on the data based on mean encoding time. Significant effects were obtained for mode (F(1,63) = 4.18; p < .05) and the interaction between presentation and mode (F(1,63) = 4.44; p < .05). Numerical information required significantly less time than verbal information for the 'mixed' condition (F(1,63) = 8.49; p < .01; Mean encoding times for numerical versus verbal information = 24.4s versus 28.6s) but not for the 'all' condition (means for numerical versus verbal information = 20.64s and 20.58s). The 'all' condition required marginally significantly less encoding time than the 'mixed' condition for verbal information (F(1,72) = 3.99; p < .06) but not for the numerical condition. It appears that the 'all' condition facilitates learning when compared to the mixed condition, particularly for verbal information. The results are summarized in Figure 6.

Discussion

The results of Study 2 in terms of the disappearance of an advantage for numerical information when compared to verbal information point to one condition when such an advantage does not occur. While it is possible that the advantage for numerical information disappeared due to interference among digits as suggested earlier, the likely explanation appears to be the difficulty in the encoding of verbal labels in the 'mixed' condition with this disadvantage being eliminated for the 'all' condition. Interference may only partially explain the results in terms of the drop in recognition accuracy of numerical information from the 'mixed' to the 'all' condition. However, comparable levels of recognition speed, precise recall, and encoding time of numerical information do not lend support to this explanation. In fact, given the use of fillers which overlapped with original information in the recognition, the recognition task may have been more difficult for the 'all' condition.

A stronger explanation is provided in terms of the difficulty of encoding verbal information in the 'mixed' condition. Such an interpretation is supported by findings in terms of encoding time and recall. Based on Study 2, it appears that the lower memory for verbal information in a 'mixed' setting can be eliminated in settings where an entire attribute is described either verbally or numerically, leading to the use of similar anchors for verbal information on an attribute. When equal
proportions of numerical and verbal information are used to describe brands along an attribute, a disadvantage for verbal information occurs. The use of the same mode to present information for an attribute facilitates the exact encoding of verbal information, as evidenced by lower encoding times. In fact, in terms of directionality, lower encoding times were obtained for numerical information as well. The advantage for numerical information in terms of exact recall disappears in the ‘all’ condition. Interestingly, the ‘all’ condition is different in that there is a greater degree of recall of information in the mode in which it was presented, perhaps a result of the facilitation of encoding.5

Based on the results of Study 2, it appears that a rationale based on the exactness of encoding of numerical versus verbal information may be explain differences in consumer memory for numerical versus verbal information. Recall, recognition, and encoding of verbal information is facilitated by the presentation of all information on an attribute in numerical or in verbal form. Given the easier encoding of verbal information in combination with disappearance in differences in recall and recognition accuracy, the exactness of encoding explanation appears to be supported. However, this explanation alone does not account for all the results. For example, an advantage for numerical information in terms of recognition speed is found across both conditions, thereby suggesting that an easily distinguishable memory representation of numerical information may be a factor as well. This result is similar to the advantage in terms of recognition accuracy for numerical information that was found across all tasks in the pretest and Study 1. It should be noted that, if exactness of encoding were the only explanation for the results, a recognition advantage for numerical information should disappear along with advantages in terms of recall and encoding time. However, advantages based on recognition appear to persist, thereby suggesting that the outcome of encoding (i.e., the memory representation) for numerical information may be easier to distinguish than for verbal information. This effect appears to be a strong one since it persist even during a judgment or choice task (in terms of recognition accuracy), when encoding at the magnitude level is argued to occur.

General Discussion

Superior recognition and recall of numerical information was found here under certain conditions as well as lesser encoding time. Numerical information is easier to recognize, is recalled
more exactly, and is also easier to encode than verbal information. Further, a separate study identified a condition under which such memory advantages disappear. Under conditions where an entire attribute is described either verbally or numerically, the encoding, recognition, and recall of verbal information is facilitated. Therefore, this research suggests that, with certain forms of presentation of verbal information, comparable levels of memory between verbal and numerical information may be achieved.

Several explanations for differences between numerical and verbal information were assessed. One conclusion from this research is that memory advantages for numerical information occur under conditions involving nominal encoding such as a learning task. It appears that under learning conditions, numerical information is treated like a nominal label such as a phone number whereas verbal information is encoded relatively more inexact than the form in which it is presented. Such encoding may reflect the typical usage of numerical versus verbal information in terms of differing degrees of precision. It also appears that some advantage for numerical information in terms of recognition occurs due to the relatively unique memory representation of numerical information. In fact, this recognition advantage persists even in tasks involving magnitude encoding.

Past research has identified conditions under which magnitudes presented in numerical versus verbal forms undergo different forms of encoding. The present study adds to existing knowledge of consumer memory for information by looking at implications of differences in encoding for consumer memory. This research also adds to past research on magnitudes (cf., Viswanathan and Childers 1992) by focusing on base-line differences in memory for numerical versus verbal magnitudes. This research also has implications for memory for numbers and words in general.

Several avenues of future research are suggested by this research. A further investigation of conditions under which differences between numerical and verbal information exist is required. Factors that could be considered here include the format of information presentation (i.e., attribute-based versus brand-based presentations). A further understanding of the reason(s) for the exactness of encoding of numerical information when compared to verbal information is required. Explanations also need to be generated and tested for the more unique representation of numerical information in
memory. Several explanations generated here in terms of basic dimensions on which magnitudes in general differ (such as precision) are extendible to other modes of information as well. Pictorial and graphical information could be viewed as conveying magnitudes in a relatively precise fashion. Therefore, several generalizations drawn about numerical information may be extended to pictorial as well as graphical information.

In conclusion, important differences in aspects of memory for numerical versus verbal information were demonstrated in this paper. Past research was used to develop predictions for understanding memory differences due to differences in encoding of numerical and verbal information. Several explanations were assessed here with the results suggesting that a memory advantage for numerical information may occur under conditions involving nominal encoding of information such as a learning task. Further, explanations for these differences include differences in the exactness of encoding and differences in the uniqueness of memory representations of numerical versus verbal information.
References


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Footnotes

1 The terms "coarse-grained" and "fine-grained" refer to how finely distinguished the values on a continuum are from other possible values. A scale that is sensitive to 1 cm is more fine-grained than a scale that is sensitive to 1 inch, since a 1 cm interval is a finer increment than a 1 inch interval. These terms are used in a relative sense and do not convey any absolute level of "grainedness."

2 In looking at differences between numerical and verbal information, it is interesting to look at a parallel in the verbal learning literature. It is easier to recognize low frequency words than high frequency words (Gregg 1976) since it is easier to distinguish whether low frequency words were presented when compared to high frequency words (Srull 1986).

3 A major concern with the use of response latencies is that subjects within and across task conditions may be performing at different levels of speed-accuracy tradeoffs leading to differences in response times. Correlations between response times and accuracy were not significant (directed learning \(r = .13; p > .05\), choice \(r = .14; p > .05\), and for both goals \(r = .18; p > .05\)) suggesting that subjects were performing at comparable levels of speed-accuracy tradeoffs.

4 Correlations between response times and accuracy are indicated in parenthesis for directed learning \(r = 0.40\), learning and judgment \(r = -0.46\), and judgment \(r = -0.02\) suggesting that speed-accuracy tradeoff was a concern for the learning task. A further examination of this task suggested that the numerical condition led to a greater trade-off \(r = 0.57\) than the verbal condition \(r = 0.18\).

5 An alternate explanation for the findings is that the presentation format facilitates the encoding of relational rather than absolute information along an attribute, since all information on an attribute is available in the same mode. Therefore, the advantage due to numerical information encoded absolutely disappears here. However, such an explanation would require that the absolute levels of accuracy of precise recall as well as ease of recognition of numerical information would be lower in the 'all' condition when compared to the 'mixed' condition. The findings do not support this explanation.
FIGURE 1

RESULTS OF RECOGNITION TASK

<table>
<thead>
<tr>
<th>Information Mode</th>
<th>Recognition speed (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical</td>
<td>10</td>
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<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>8</td>
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<table>
<thead>
<tr>
<th>Information Mode</th>
<th>Recognition accuracy</th>
</tr>
</thead>
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<tr>
<td></td>
<td>0.75</td>
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<tr>
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<td>0.70</td>
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<tr>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
</tr>
</tbody>
</table>

- Learning task
- Judgment task
FIGURE 2

RESULTS OF RECALL TASK

Accuracy of recall

Information mode at exposure and recall

Numerical at exposure and recall

Verbal at exposure and recall

- Learning task
- Judgment task
FIGURE 3

RESULTS OF ANALYSIS OF ENCODING TIME

Encoding time (in seconds)

- Numerical information
- Verbal information

Information mode

- Learning task
- Judgment task
FIGURE 4
RESULTS OF RECOGNITION TASK

Recognition speed (in seconds)

10
9
8
7
6

Information Mode
Numerical information
Verbal information

Recognition accuracy

0.80
0.75
0.70
0.65
0.60

Information Mode
Numerical information
Verbal information

- 'Mixed' presentation
- 'All' presentation

Recognition speed of numerical and verbal information.

Recognition accuracy of numerical and verbal information.

Accuracy decreases with information mode for both modes.

Speed increases with information mode for both modes.
FIGURE 5
RESULTS OF RECALL TASK

Accuracy of recall

5
4
3
2
1

Numerical at exposure and recall

Verbal at exposure and recall

Information mode at exposure and recall

'Mixed' presentation

'All' presentation
FIGURE 6
RESULTS OF ANALYSIS OF ENCODING TIME

Encoding time (in seconds)

30
25
20
15
10

Numerical information

Verbal information

Information mode

'Mixed' presentation

'All' presentation