Faculty Working Paper 92-0141

Encoding and Memory Differences between Numerical and Verbal Product Information

Madhubalan Viswanathan
Department of Business Administration

Bureau of Economic and Business Research
College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

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FACULTY WORKING PAPER NO. 92-0141

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July 1992

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Abstract

The focus of this paper is on encoding and memory differences between numerical and verbal product information. Arguing that verbal information is more likely to be processed in terms of its meaning than numerical information, hypotheses were derived for differences in processing effort, recognition, and recall between these two modes of information for learning and choice or judgment tasks. Across two studies, numerical information was found (i) to be recognized faster and more accurately, (ii) to be recalled more exactly, and (iii) to require less encoding time, when compared to verbal information for a learning task. However, several advantages for numerical information disappeared following a choice or a judgment task. Two more studies suggested that advantages for numerical information disappeared during learning when attributes were completely described using either numerical or verbal information. The findings are interpreted in terms of differences in the encoding and representation of numerical and verbal information in consumer memory.

Marketing communications often involve the use of numerical and verbal modes of presenting attribute information such as in information conveyed on packages. While some research in the past has focused on numerical versus verbal information (cf., Yalch and Yalch, 1984; Scammon, 1977; Viswanathan and Narayanan, 1992), it remains a neglected area of consumer research. The focus of this paper is on assessing and explaining differences in consumer encoding and memory for numerical versus verbal magnitudes or labels describing product attributes. A magnitude has been defined "as the quantification of a product characteristic or attribute on some continuum" (Viswanathan and Childers 1992). For example, calorie content is an attribute for several food products that can vary along a calorie continuum, with a specific brand's calorie content of, say, "120 calories" or "high" calories, being the value or magnitude that quantifies this product characteristic.

While numerical and verbal modes are often used to convey attribute magnitudes in marketing communications, it is not clear as to how such information is encoded and used by consumers. For example, while packages often disclose product information typically using numerical data (such as '200' calories), an important issue is whether consumers encode such information in terms of its meaning (i.e., the magnitude or value conveyed by it such as 'high' calories) or at a surface level (i.e., as a number). On the other hand, the magnitude conveyed by verbal information, such as 'high' calories, is readily apparent, thereby leading to the possibility that the meaning conveyed by such information is encoded in memory. Research on the nature of encoding of numerical versus verbal information would provide a basis to understand how consumers encode and use such information in decision making. Such research would provide insights for designing marketing communications as well as in devising public policy to facilitate the interpretation of information by consumers. Recent research on the use of numerical versus verbal nutrition labels (cf., Levy et al. 1991) points to the importance of research on the encoding of these two modes of 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 research on magnitudes (Viswanathan and Childers 1992). While past consumer research has examined ways in which consumers combine attribute information to make a brand decision and how consumer memory is organized around brands and attributes, there is little understanding of how consumers process magnitude information on product attributes and use it in decision making (i.e., at a lower level than past research which has typically been at the level of a brand in relation to its attributes). An understanding of the processing and use of magnitudes by consumers could provide a basis for explaining several important phenomena in consumer research such as memory-based judgments that involve the use of magnitude information. Drawing on past research about the encoding of numerical and verbal information in consumer memory, hypotheses are generated and tested for differences in encoding and memory for numerical versus verbal labels conveying magnitude information.

Review of Relevant Research and Hypotheses

Past research on the encoding of numerical and verbal information as a function of processing goals is briefly reviewed to provide a basis for generating hypotheses about differences in encoding and memory between numerical and verbal information as a function of processing goals. Using the rationale that the meaning or magnitude conveyed by a verbal label is readily available whereas a numerical label requires additional processing to derive its meaning or magnitude, verbal information is argued to be processed at its *meaning or magnitude* level whereas numerical information may be processed in terms of its *surface features* in a learning task. As a result, numerical information is argued to be encoded more *exactly* (in terms of surface features) than verbal information during a learning task. Both types of information are argued to be processed at the magnitude level during a choice or judgment task. Based on magnitude versus surface level processing of verbal versus numerical information, hypotheses are generated for differences in processing effort for each task as well as differences in memory following each task.

The Effect of Processing Goals on the Encoding of Numerical Versus Verbal Information

Past research provides a basis to hypothesize about the encoding of numerical versus 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 (such as price information). They argued that since approximate information is often sufficient in dealing with magnitude information but 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 task instructions. The results are interpreted as suggesting two types of representations of numbers in memory at nominal and magnitude levels, respectively. 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 magnitude conveyed by a label being encoded (i.e., the processing of the meaning of a label) while nominal encoding refers to the surface features of a label being encoded in memory. The authors argue that when magnitudes are encoded, only approximate numbers are recalled, suggesting that magnitude level processing of numbers leads to only approximate rather than exact encoding of numerical information. However, when surface features are encoded, the exact information is more likely to be encoded.

Viswanathan and Childers (1992) hypothesized that numerical information on a product attribute is likely to be recoded to a verbal-like form during a choice or judgment task in order to extract and use the magnitude conveyed by it (i.e., a numerical label such as "200" calories may be recoded to a label like "high" calories) whereas such recoding is less likely for verbal information Consistent with other research, an argument advanced by the authors was that numerical product information has to be compared to other information to derive its magnitude (cf., Venkatesan et al., 1986) whereas verbal information has an evaluative inference embedded in it (cf., Scammon, 1977; Huber, 1980). 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 surface or nominal level).

Past research provides a basis for assessing differences in encoding and memory for numerical versus verbal information as a function of processing goals. An important distinction has been made in past research between magnitude level encoding where the meaning conveyed by a label is encoded versus nominal encoding where the surface level features are encoded. This distinction parallels the distinction in research in cognitive psychology (cf., Nelson et al., 1977) between sensory processing (i.e., the processing of physical features of a stimulus) versus semantic processing (i.e., the processing of meaning conveyed by a stimulus). Differences between numerical and verbal labels in the degree to which the magnitude conveyed by them is readily available may lead to different degrees of magnitude versus surface level encoding.

Past research suggests that the meaning or magnitude conveyed by a verbal label may be readily available when compared to a numerical label. Huber (1980) argued that verbal information is more evaluative than numerical information and showed that subjects made evaluations more frequently when using verbal information (since such information was similar to evaluative labels) when compared to numerical information. The ease of deriving evaluations from verbal information is illustrated in a finding that adjectival rather than percentage descriptors of nutritional information leads to more accurate identification of nutritious brands (Scammon 1977). Research on nutritional information disclosure (Venkatesan et al. 1986) suggests that a number derives its meaning in comparison with other numerical information. It appears that numerical magnitudes are associated with an objective unit of measurement such as miles per gallon which provides a standardized context to interpret the numerical magnitude. But such a context is not evaluative nature and the magnitude conveyed has to be interpreted by some comparison process (cf., Venkatesan et al., 1986) either with other brand information or with some reference point (i.e., a label describing a brand such as "200" calories has to be compared to labels for other brands or to some reference point). However, verbal magnitudes provide an evaluative context with the use of attribute specific verbal anchors (i.e., the magnitude conveyed by verbal labels such as "high" or "low" calories can be interpreted directly since such anchors convey an evaluative inference of highness or lowness). For example, a key difference between '120' calories and 'high' calories is that the verbal magnitude makes the inference of *highness* in calorie content. Since the magnitude conveyed by a verbal label is readily apparent whereas the magnitude conveyed by a numerical label may have to be derived, verbal information may be more difficult to process purely in terms of surface level features.

Encoding of Numerical and Verbal Information During Learning

During a learning task where the processing goal is to learn or memorize information rather than use it in a choice or judgment, past research would suggest that numerical and verbal information would be encoded at the surface or nominal level without modification (cf., Hinrichs and Novick 1982; Viswanathan and Childers 1992). However, while numerical information may be encoded at the surface level, verbal information may be encoded at the magnitude level since the meaning or magnitude of a verbal label may interfere with its surface features during encoding. Due to the ready availability of meaning, verbal information may be encoded in terms of its equivalent meaning (i.e., the magnitude conveyed) rather than in exact terms (i.e., surface features) to a greater extent than numerical information. Therefore, these two types of information may differ in the degree to they are exactly encoded, (i.e., identical to the presented information in terms of surface features). Using the analogy of memorizing a telephone number, the exact content of the numerical information may be encoded during learning since the immediate goal is not to use the information in a choice or judgment. In fact, a means of avoiding the expenditure of effort in extracting the meaning equivalent of numerical information as suggested by some researchers (Venkatesan et al., 1986) may be to encode it without modification. Such information would be available for future usage in its original form. Verbal information may, however, be processed at the magnitude level to a greater degree leading to the representation of a *meaning equivalent* of such information rather than the exact information in memory. To summarize, encoding differences between numerical and verbal information may occur during a learning task such that numerical information may be encoded more exactly in memory.

Encoding of Numerical and Verbal Information During Judgment

The relatively exact encoding of numerical information is not expected in a choice or a judgment task since magnitude level encoding is expected to occur for both numerical and verbal information, Viswanathan and Childers (1992) argue that it is more likely that numerical information is recoded to a verbal-like form during choice or judgment. Hinrichs and Novick (1982) also point to a similar conclusion that approximate information is encoded when the magnitude of a number is emphasized.

Implications for Processing Effort, Recognition and Recall.

Using a setting where both numerical and verbal information are provided with the single goal of either (i) learning brand information or (ii) making judgments about brands, operational hypotheses can be generated for differences in processing effort and subsequent recognition and recall between numerical and verbal information.

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). Since numerical information is more exactly encoded than verbal information during learning, faster and more accurate recognition of such information is predicted. Following a judgment task, such an advantage for numerical information is not predicted since both numerical and verbal information may be encoded at the magnitude level.

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

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

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

H1d: Numerical information will *not* be recognized more accurately than verbal 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. Since numerical information is expected to be encoded more exactly than verbal information, reconstruction of such information in its exact form during recall is more likely. However, such a relationship is not predicted following a judgment task.

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.

Processing effort

The encoding of numerical information is predicted to be easier than the encoding of verbal information during learning since additional effort may be required to process verbal information at the magnitude level and derive a meaning equivalent whereas numerical information may be encoded without modification. Using encoding time as a proxy for processing effort, faster learning of numerical information is predicted during learning. However, such a relationship is not expected during a judgment task.

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.

A previous study (Viswanathan and Childers 1992) involved a methodology that was used to assess the processing of numerical and verbal information under learning and choice conditions. The data from this study was reanalyzed for purposes of evaluating the hypotheses presented here and the results are described as Study 1. 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 hypotheses were assessed again in Study 2 using learning and judgment tasks. Two more studies identified a condition where several advantages predicted for numerical information disappeared.

Studies 1 and 2

Overview of Design of Study 1

The methodology involved a task manipulation between subjects with two levels (i.e., directed learning and on-line choice (cf. Biehal and Chakravarti 1983)) and a within subjects manipulation of information mode. This initial choice or learning task was followed by a distracter task 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 required to make 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 (the subjects in the experiments) 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.[1] Magnitudes were assigned to brands and attributes such that (i) equal proportions of numerical versus verbal information were used across brands and attributes, (ii) both modes were used to convey an equal number of scale-points along a five point continuum (to prevent valence of information being 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.[2]

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). Appropriate software was used to register the time that subjects spent on each screen.

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 (i.e., false information about brands along 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 name, 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 name 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 of Study 1

2 (task; between subjects) by 2 (information mode; within subjects) factorial ANOVAs were run on the dependent variables based on recognition, recall, and encoding time.

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 task.[3] For the ANOVA on mean response times, 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 specific contrasts suggested that numerical information was recognized significantly faster than verbal information following learning ($F(1,38) = 23.16$; $p < 0.001$; means = 7.42s and 8.97s, respectively, for numerical and verbal information), providing support for H1a. However, numerical information was not recognized significantly faster than verbal information following choice ($F(1,38) = 1.82$; means = 7.30s and 7.73s, respectively, for numerical and verbal information), providing support for H1b.

For recognition accuracy, a similar ANOVA led to significant main effects for task ($F(1,38) = 4.71$; $p < .05$) and mode ($F(1,38) = 20.14$; $p < .001$). Numerical information was recognized significantly more accurately than verbal information following learning ($F(1,38) = 11.26$; $p < .01$; means for numerical versus verbal information = 0.88 and 0.77, respectively), providing support for H1c. Numerical information was also recognized significantly more accurately than verbal information following choice ($F(1,38) = 8.95$; $p < .01$; means for numerical versus verbal information = 0.81 and 0.71, respectively), suggesting the rejection of H1d.

Analysis of recall accuracy

The number of accurately recalled items was computed for each subject in order to evaluate H2a and H2d. In order to evaluate the extent of *exact* recall in terms of surface features, accurate recall of numerical information referred to recall of the exact digits while accurate recall of verbal information referred to recall of the exact verbal label. An ANOVA on the proportion of items that were accurately recalled led to significant effects for task ($F(1,38) = 5.76$; $p <.05$) and mode ($F(1,38) = 30.29$; $p < .001$). An examination of the specific contrasts suggested that exact recall of numerical information was significantly greater than of verbal information following learning ($F(1,38) = 20.09$; $p < .001$; means = 0.51 and 0.27, respectively, for numerical and verbal information), providing support for H2a. However, exact recall of numerical information was also significantly greater than of verbal information following choice ($F(1,38) = 10.91$; $p < .01$; means = 0.34 and 0.17, respectively, for numerical and verbal information), rejecting H2b.

Analysis of Encoding time

A 2 (task) by 2 (mode) factorial ANOVA was performed on the encoding times. Significant effects were obtained for task ($F(1,78) = 43.58$; $p < .001$) and mode ($F(1,78) = 6.90$; $p < .05$). Numerical information required significantly less encoding time than verbal information during learning ($F(1,78) = 8.01$; $p < .01$; means = 32.7 and 36.0, respectively for numerical and verbal information), providing support for H3a. However, numerical information did not require significantly less encoding time than verbal information during choice ($F(1,78) = 0.78$; means = 12.2s and 13.2s, respectively for numerical and verbal information), providing support for H3b.

Based on the results of Study 1 using learning and choice tasks, support was obtained for all hypotheses except H1d and H2b. It appears that numerical information is easier to encode than verbal information during a learning task, is subsequently recognized faster and more accurately, and is also recalled more exactly. Several of these advantages disappear following a choice task. Further tests of the hypotheses were conducted in Study 2.

Overview of Study 2

Since Study 2 was largely similar to Study 1 in terms of the stimulus materials and procedures, only differences between the two studies are discussed here. The tasks used here were a learning task, a judgment task, and a learning & judgment task to examine the pattern of results for varying degrees of learning and judgment. 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. Two aspects of Study 2 different from Study 1 were the use of a free rather than a cued recall task and the use of confidence ratings in the recognition task (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 of Study 2

3 (task; learning, learning & judgment, and judgment; between subjects) by 2 (information mode; numerical versus verbal; within subjects) factorial ANOVAs were run on the dependent variables based on recognition, recall, and encoding time.

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 task condition.[4] For response times of recognition, a significant main effect was found for mode ($F(2,44) = 31.91$; $p < 0.001$). An examination of the specific contrasts suggested that numerical information was recognized significantly faster than verbal information following learning ($F(1,44) = 15.38$; $p < 0.001$; means = 7.07s and 9.04s, respectively, for numerical and verbal information), providing support for H1a, and following learning & judgment ($F(1,44) = 17.73$; $p <$

0.001; means = 7.89s and 9.93s, respectively, for numerical and verbal information). However, numerical information was not recognized significantly faster than verbal information following judgment ($F(1,44) = 2.66$; $p > .10$; means = 7.80s and 8.59s, respectively, for numerical and verbal information), providing support for H1b (see Figure 1 and Table 1).

Insert Figure 1 and Table 1 about here

In terms of accuracy of recognition, a similar ANOVA led to a significant main effect for mode ($F(1,44) = 96.69$; $p < .001$). An examination of the specific contrasts suggested that numerical information was recognized significantly more accurately than verbal information following learning ($F(1,44) = 24.33$; $p < 0.001$; means = 0.80 and 0.66, respectively, for numerical and verbal information), providing support for H1c, and following learning & judgment ($F(1,44) = 54.98$; $p < 0.001$; means = 0.82 and 0.60, respectively, for numerical and verbal information). The effect was also found following judgment ($F(1,44) = 22.19$; $p < .001$; means = 0.76 and 0.63, respectively, for numerical and verbal information), suggesting the rejection of H1d (see Figure 1 and Table 1).

Analysis of recall data

For the ANOVA on the number of accurately recalled items, significant effects were obtained for task ($F(2,47) = 8.37$; $p < .001$), and mode ($F(1,47) = 29.63$; $p < .001$). An examination of the specific contrasts suggested that numerical information was recalled significantly more accurately than verbal information following the learning task ($F(1,47) = 21.03$; $p < .001$; means for numerical and verbal information = 0.57 and 0.32) providing support for H2a, and for the learning and judgment task ($F(1,47) = 12.30$; $p < .01$; means for numerical and verbal information = 0.41 and 0.22). However, numerical information was not recalled significantly more accurately than verbal information following the judgment task ($F(1,47) = 1.93$; means for numerical and verbal information = 0.21 and 0.13), providing support for H2b (see Figure 2 and Table 1).

Insert Figure 2 about here

While verbal information was argued to be encoded in terms of its meaning, several possible outcomes of such encoding were assessed using the recall data. One possibility is that verbal information is encoded in memory in terms of its equivalent evaluative meaning (for e.g., a label such as 'very high' calories may be encoded as 'bad' on calories). Another possibility is that, since verbal information involves the use of an idiosyncratic verbal modifier and anchor (such as, 'very high' for calorie content), it may be also be translated to match the way in which consumers typically think about the specific attribute ('very high' calories may be translated to 'large number' of calories). In order to examine the extent to which the encoding of meaning equivalents of verbal labels involved the use of evaluative equivalents or idiosyncratic anchor equivalents, recall of verbal information was reanalyzed such that an item was scored as being accurately recalled if the meaning conveyed by it was captured in a recalled item. Therefore, a verbal response was considered accurate if it represented the equivalent of the scale point of original information on the five point scale based upon the pretest (referred to as meaning recall while the results reported above are referred to as literal recall). Literal versus meaning recall following learning was 0.32 and 0.37, respectively, and following judgment was 0.13 and 0.24, respectively. (H2a and H2b were supported using meaning recall instead of literal recall of verbal information as well.) Therefore, 13.5% of meaning recall following learning and 45.8% of meaning recall following judgment consisted of the use non-literal recall. Most of the information that was recalled non-literally involved the use of different modifiers/anchors than those presented for a specific attribute. Evaluative equivalents of information (such as 'good' or 'poor') were recalled only in rare instances. A similar analysis was performed on inaccurately recalled items (i.e., recalled items that did not convey the meaning of original information). 38.2% and 57.3% of inaccurate recall following learning and judgment, respectively, involved the use of different verbal anchors. Therefore, it appears that encoding of meaning equivalents of verbal information results in a lesser amount of literal recall when compared to numerical information and appears to lead to the use of verbal anchors different from the anchors originally presented for an attribute.

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 ($F(2,95) = 15.78$; $p < .001$), mode ($F(1,95) = 14.23$; $p < .001$), 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 = 24.4s versus 28.6s) providing support for H3a, but not for the learning and judgment task ($F(1,95) = 2.25$; means = 17.3s versus 18.7s). Numerical information did not require significantly less encoding time than verbal information for the judgment task ($F(1,95) = 0.19$; means = 10.5s and 10.9s), providing support for H3b (see Figure 3 and Table 1).

Insert Figure 3 about here

Discussion of Results of Studies 1 and 2

Study 2 replicated most of the findings of Study 1 except that H2b found support here while it was rejected in Study 1. Numerical information was recognized faster and more accurately than verbal information, was recalled exactly to a greater extent than verbal information, and was easier to encode than verbal information during learning. Several of these advantages for numerical information disappear in a choice or a judgment task. Even though numerical information has been argued to be recoded during such a choice or a judgment task (cf., Viswanathan and Childers 1992), it appears to require the same encoding time as verbal information and to lead to directionally faster recognition speed, significantly higher recognition accuracy, and significantly or directionally higher recall accuracy. The memory and judgment task led to similar results as the learning task except for the lack of a significant difference in encoding time between numerical and verbal information. These results provide support for the argument that verbal information is encoded at the magnitude level to a greater degree than numerical information during learning.

A condition where the disadvantages for verbal information can be decreased or eliminated was examined in two studies to further understand the nature of encoding and memory for numerical versus verbal information. If the results of the first two studies were due to a disadvantage for verbal information based on inexact encoding, such a disadvantage was expected to disappear when an attribute is completely described verbally since such a presentation would lead to a better representation of the magnitudes represented by each label *relative* to the other labels. For example, the use of a range of verbal labels such as 'very long', 'long', 'short', and 'very short' to describe the attribute, battery life of a calculator, (contrasted with the use of labels such as '380' hours, 'long', '40' hours, and 'extremely short' in Study 1 and Study 2) may facilitate meaning level encoding that *coincides* with surface level encoding by providing a means of assessing each label relative to all other labels on an attribute. The interpretation and encoding of the meaning conveyed by each verbal label in exact terms (i.e, similar to surface features of presented labels) is facilitated when each label can be compared to all other labels describing a particular attribute. However, if all labels for an attribute are not in a verbal form, the interpretation and encoding of meaning using idiosyncratic labels may occur to a greater degree To summarize, a disappearance of the advantage for numerical information due to increases in the absolute level of recognition accuracy, recognition speed, and recall accuracy, and a decrease in encoding time for verbal information was predicted in Studies 3 and 4.

Studies 3 and 4

The procedure used in Study 3 was similar to the learning condition in Study 2 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 that 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 learning task was followed by either the recognition task or the recall task. 31 students at a midwestern university participated in this study with an approximately equal number of students assigned to each dependent variable. It should be noted that the recognition task was different in this study because the fillers used here for a brand matched original information on some other brand. Hence, while differences *between* numerical and verbal information across Studies 2 and 3 can be made, comparisons of absolute levels of recognition across Study 2 and Study 3 may be difficult to interpret.

Results of Study 3

The data from Study 2 (referred to as the 50-50 condition since each attribute had equal proportions of numerical and verbal information) was combined with the data from Study 3 (referred to as the 100-0 condition since each attribute had either completely numerical or completely verbal information) for analyses.

Analysis of Recognition Data

A 2 (presentation; attributes '50-50' versus '100-0') by 2 (mode; numerical versus verbal) factorial ANOVA was performed on mean response times of accurate recognition[5] which produced a significant main effect for mode ($F(1,29) = 14.63$; $p < 0.001$). Examination of the effect of mode for the "50-50" condition and "100-0" condition produced a significant main effect for the "50-50" condition ($F(1,29) = 11.97$; $p < .01$; mean for numerical and verbal information = 7.07s and 9.04s, respectively) and a marginally significant effect for '100-0' condition ($F(1,29) = 3.71$; $p < .07$; 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 ($F(1,29) = 5.45$; $p < .05$). An examination of the interaction suggested that numerical information was recognized more accurately than verbal information for the "50-50" condition ($F(1,29) = 14.04$; $p < .01$; means for numerical versus verbal information = 0.80 and 0.66, respectively) but not for the "100-0" condition ($F(1,29) = 0.26$; means for numerical versus verbal information = 0.72 and 0.71, respectively; see Figure 4 and Table 1).

Insert Figure 4 about here

Analysis of recall accuracy

A 2 (presentation; mixed versus 100-0) by 2 (mode; numerical versus verbal) factorial ANOVA was performed on the number of accurately recalled items for each subject. A significant main effect was obtained for mode ($F(1,31) = 8.31$; $p < .01$). An investigation of the main effect suggested the numerical information was recalled significantly higher than verbal information for the '50-50' condition ($F(1,31) = 10.44$; $p < .01$; means for numerical versus verbal = 0.57 and 0.32, respectively) but not for the '100-0' condition ($F(1,31) = 0.78$; means for numerical and verbal = 0.54 and 0.47; see Figure 5 and Table 1). These results suggest a facilitation of exact recall of verbal information in the '100-0' condition when compared to the '50-50' condition. Literal versus meaning recall for verbal information following the '50-50' condition was 0.32 and 0.37, respectively, and following the '100-0' condition was 0.47 and 0.49, respectively. 13.5%

and 4.1% of meaning recall for 50-50 and 100-0, respectively, consisted of non-literal recall. A similar analysis was performed on inaccurately recalled items (i.e., recalled items that did not convey the meaning of original information). 38.2% and 8.2% of inaccurate recall consisted of the use of different verbal anchors following 50-50 and 100-0 conditions, respectively, with the difference being significant ($F(1,24) = 8.32$; $p < .01$). These results suggest that literal recall of verbal information was enhanced in the 100-0 condition when compared to the 50-50 condition.

Insert Figure 5 about here

Analysis of encoding time

A 2 (presentation; '50-50' versus '100-0') 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 '50-50' 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 '100-0' condition (means for numerical versus verbal information = 20.6s and 20.6s, respectively; see Figure 6 and Table 1). The '100-0' condition required marginally significantly less encoding time than the '50-50' condition for verbal information ($F(1,72) = 3.99$; $p < .06$) but not for the numerical condition. It appears that the '100-0' condition facilitates the learning of verbal information when compared to the '50-50' condition.

Insert Figure 6 about here

Discussion of Results of Study 3

The results of Study 3 in terms of the disappearance of advantages for numerical formation when compared to verbal information point to the effect of presentation of information differences between numerical and verbal information. Based on Study 3, it appears that the ver recognition and recall, and longer encoding time for verbal information in a '50-50' setting be decreased or eliminated in settings where an attribute is completely described either verbally merically. The use of equal proportions of numerical and verbal information to describe ds along an attribute leads to disadvantages for verbal information. A possible explanation for the higher level of literal recall following the 100-0 condition when compared to the 50-50 condition is the greater degree of meaning level encoding that coincided with surface level encoding in the 100-0 condition.

Overview of Study 4

A fourth study was performed where a similar procedure as in Study 3 was used except that information on all four attributes for all four brands was either numerical or verbal. 62 students at a midwestern university participated in the study with two groups of an approximately equal number of subjects assigned to the numerical and verbal conditions. Within each group of subjects, an equal number performed either the recall task or the recognition task after the learning task.

Results of Study 4

Numerical information was recognized faster than verbal information ($F(1,30) = 6.10$; $p < .05$) (means = 6.00s and 7.36s, respectively, for numerical versus verbal information).[6] However, no differences in the accuracy of recognition (means = 0.68 and 0.67, respectively, for numerical versus verbal information), accuracy of recall (means = 0.43 and 0.34, respectively, for numerical versus verbal information), and encoding times (means = 23.5s and 24.1s, respectively, for numerical versus verbal information) across the two conditions were found (see Table 1). These results replicated the findings for the '100-0' condition in Study 3 in terms of *differences* between numerical and verbal information. Study 4 replicated the findings of Study 3 and point to one condition when the advantages for numerical information for the learning task disappear.

Discussion of Findings

The results of Studies 1 and 2 provided support for the rationale in terms of surface versus meaning level encoding leading to differences in the exactness of encoding of numerical versus verbal information. However, Studies 3 and 4 demonstrated that 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 the disappearance of differences in recall and recognition accuracy, the rationale in terms of exactness of encoding 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 in Studies 3 and 4 as well. It should be noted that, if exactness of encoding were the only explanation for the results, a recognition speed advantage for numerical information should disappear along with advantages in terms of recall and encoding time.

A possible explanation for this finding is that differences in meaning versus surface level encoding may also have led to *retrieval* differences between numerical and verbal information. Representations of numerical and verbal labels in memory may differ in terms of the extent to which they overlap with other labels in memory. In terms of surface features, numerical labels may overlap with numerical labels for other attributes as well as other brands due to the use of common digits while verbal labels may overlap with verbal labels for other attributes (due to the use of common anchors and modifiers) as well as other brands (due to the use of common modifiers). However, since the meaning conveyed by verbal labels is encoded in memory, such representations may also overlap with labels for other brands and attributes that convey a similar meaning. In other words, verbal labels may overlap with other verbal labels in terms of surface features *as well as meaning* whereas numerical labels may overlap only in terms of surface features. Numerical labels may, therefore, be more uniquely represented in memory than verbal labels as a result of surface level rather than magnitude level encoding. As a result, the retrieval of verbal information may be more difficult due to potential interference with other labels in memory as suggested by the slower recognition speeds even in Study 3 and Study 4.

General Discussion

The focus of this paper was on understanding differences in encoding and memory for numerical versus verbal information, two widely used modes of conveying attribute magnitudes in marketing communications. Numerical information appears to be easier to encode than verbal information during a learning task and easier to recognize and recalled more exactly than verbal information following a learning task. However, several of these advantages disappear during a choice or a judgment task. Further, two more studies suggested that the encoding, recognition, and recall of verbal information is facilitated when an attribute is completed described either verbally or numerically. Therefore, this research suggests that certain forms of presentation of verbal information may lead to comparable levels of memory between verbal and numerical information. In terms of explanations for these findings, it appears that under learning conditions, numerical information may be treated like a nominal label such as a phone number whereas verbal information is likely to be encoded in terms of its meaning, leading to differences in the degree of exact encoding of information. However, when all information on an attribute is described verbally, these differences disappear, perhaps due to meaning level encoding coinciding with surface level encoding.

These findings point to important advantages for numerical information during learning in terms of processing effort and memory. Several of these advantages persist for learning and judgment tasks and also for choice or judgment tasks. Surface level or nominal encoding of numerical information appears to be one source of advantage for numerical information along with the possibility that numerical information is more uniquely represented in memory. However, verbal information appears to have an advantage in terms of being encoded at the meaning level which may make it easier to use such information during the course of decision making. While numerical information has advantages in terms of processing effort and memory, surface rather than meaning level encoding of numerical information may affect the usage of such information in subsequent decisions (i.e., such information may be less likely to be used at all or less likely to be used at the meaning level in subsequent decisions). It should be noted that this study used subjects who were knowledgeable about the product category which may have made it possible to encode numerical information at the magnitude level in a choice or judgment task. However, when consumers with low knowledge of a product category are faced with numerical information, they may encode such information at the surface level even in a choice or judgment task. Hence, the findings obtained for the learning task in this study may extend to choice or judgment tasks in low knowledge settings.

Implications for Consumer Research

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 encoding and memory for information by looking at implications of differences in meaning versus surface level encoding of magnitudes describing product attributes. 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. It appears that an important property of information describing product attributes is the degree to which the magnitude conveyed by it is readily available for processing. While the occurrence of surface level processing was found for numerical information during learning, such processing may also occur when consumers are performing a choice or judgment due to the additional effort that may be required to derive a magnitude from numerical information or due to a lack of knowledge required to interpret numerical information.

Several avenues of future research are suggested by this research. Conditions under which differences between numerical and verbal information may or may not exist need to be investigated. It appears that the presentation of all information on an attribute in numerical or in verbal form facilitates an interpretation of the various magnitudes *relative to each other*. Factors that could be examined include the format of information presentation (i.e., attribute-based versus brand-based presentations) and the use of well defined labels. Another line of research should focus on the usage of information that is encoded at magnitude versus surface levels. It is possible that, while surface level encoding of numerical information may lead to advantages in terms of subsequent memory, such encoded information may be less likely to be used in subsequent judgments than information originally encoded at the magnitude level. Numerical information encoded at the surface level may also be used subsequently without access to the meaning conveyed by it (for example, to make superficial comparisons between brands using the sizes of two numbers without a sense of the meaning conveyed by it). Research should also focus on different presentations of numerical information that would facilitate its encoding at the meaning level such as a study of types of reference information that would facilitate the interpretation of numerical information. Such research would have important implications for areas such as nutrition information where some recent research has focused on the use of numerical versus verbal labels (cf., Levy et al. 1991). Finally, similar research is required for other modes of presenting magnitude information such as pictorial and graphical information. Important implications can be derived for memory and usage of these types of information by studying meaning versus surface level encoding of such information.

Limitations

Several limitations of this research need to be clarified. The experiments manipulated processing goals using variations of learning and choice or judgments tasks. Day to day situations where consumers are exposed to information may involve elements of both learning and choice/judgment. In an effort to overcome this limitation, a learning and judgment task was used in Study 2. Also, the artificiality of the experimental setting in terms of fictitious brand names and information presentation in a structured sequence enhanced control, but may have reduced the ecological validity of the findings. Lastly, inferences were drawn from encoding time, recognition, and recall about the nature of encoding of numerical versus verbal information. Research using additional dependent variables relating to the usage of such information in various tasks is required in order to perform further tests of various explanations and develop a broad understanding of differences in the processing of numerical and verbal information.

In conclusion, important differences in encoding and memory for numerical versus verbal information were demonstrated in this paper. Past research was used to develop predictions for differences in the encoding of numerical and verbal information, and therefore, differences in subsequent memory. Based on the findings, it appears that numerical information may have several advantages in terms of processing effort and memory during learning whereas verbal information may have an advantage in terms of being interpreted in terms of the meaning conveyed by it. Several advantages for numerical information decrease or disappear for a choice or a judgment task. It also appears that disadvantages for verbal information could be decreased with appropriate presentation of verbal labels describing attributes. This paper provides a set of findings about the processing of magnitude information, the basic input to decision making, that have important implications for the encoding, memory, and usage of such information by consumers.

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Footnotes

1 The pilot tests were designed to test and calibrate the experimental procedure to prevent ceiling or floor effects for memory, and to achieve comparable levels of credibility of numerical and verbal information, processing of both modes to comparable levels, and adherence to task instructions (please see Viswanathan and Childers (1992) for details of the pilot test).

2 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 (please see Viswanathan and Childers (1992) and Viswanathan and Narayanan (1992) for details of the pretest). 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. The brand names along with the chosen values along attributes warranty length, battery life, number of arithmetic functions, and display width, respectively, were as follows: (i) 'Baron' - Extremely brief, 40 hours, Extremely high, and 12 digits, (ii) 'Colony' - 5 months, Long, 3 functions, and Extremely wide, (iii) 'Profile' - Lengthy, 380 hours, Low, and 3 digits, and (iv) 'Angle' - 72 months, Extremely short, 38 functions, and Narrow.

3 A major concern with the use of response times 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 tasks ($r = .18$; $p > .05$)) 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 ($r = 0.40$; $p > .05$), learning and judgment ($r = -0.46$), and judgment ($r = -0.02$), suggesting that speed-accuracy tradeoff was a concern for the learning task. Further examination of this task suggested a greater trade-off in the numerical ($r = 0.57$; $p < .05$) than the verbal

condition (r = 0.18; $p > .05$). It should be noted that, though the numerical condition appeared to have a significant trade-off, it had significantly higher accuracy and lower response time than the verbal condition.

5 Correlations between response times and accuracy were 0.12 ($p > .05$) and 0.34 ($p > .05$) for the numerical and verbal conditions, respectively, in Study 3.

6 Correlations between response times and accuracy were 0.02 ($p > .05$) and 0.49 ($p > .05$) for the numerical and verbal conditions, respectively, in Study 4.

TABLE 1

Summary of Results

	Study 1		Study 2		Study 3	Study 4
Presentation	50-50		50-50		100-0	100-0
Task	Learning	Choice	Learning	Judgment	Learning	Learning
Recognition speed (in seconds).						
Numerical information	7.42	7.30	7.07	7.80	7.35	6.00
Verbal information	8.97	7.73	9.04	8.59	8.41	7.36
Recognition accuracy.						
Numerical information	0.88	0.81	0.80	0.76	0.72	0.68
Verbal information	0.77	0.71	0.66	0.63	0.71	0.67
Recall accuracy.						
Numerical information	0.51	0.34	0.57	0.21	0.54	0.43
Verbal information	0.35	0.28	0.32	0.13	0.47	0.34
Encoding time (in seconds).						
Numerical information	32.7	12.2	24.4	10.5	20.6	23.5
Verbal information	36.0	13.2	28.6	10.9	20.6	24.1

FIGURE 1

RESULTS OF RECOGNITION TASK FOR STUDY 2

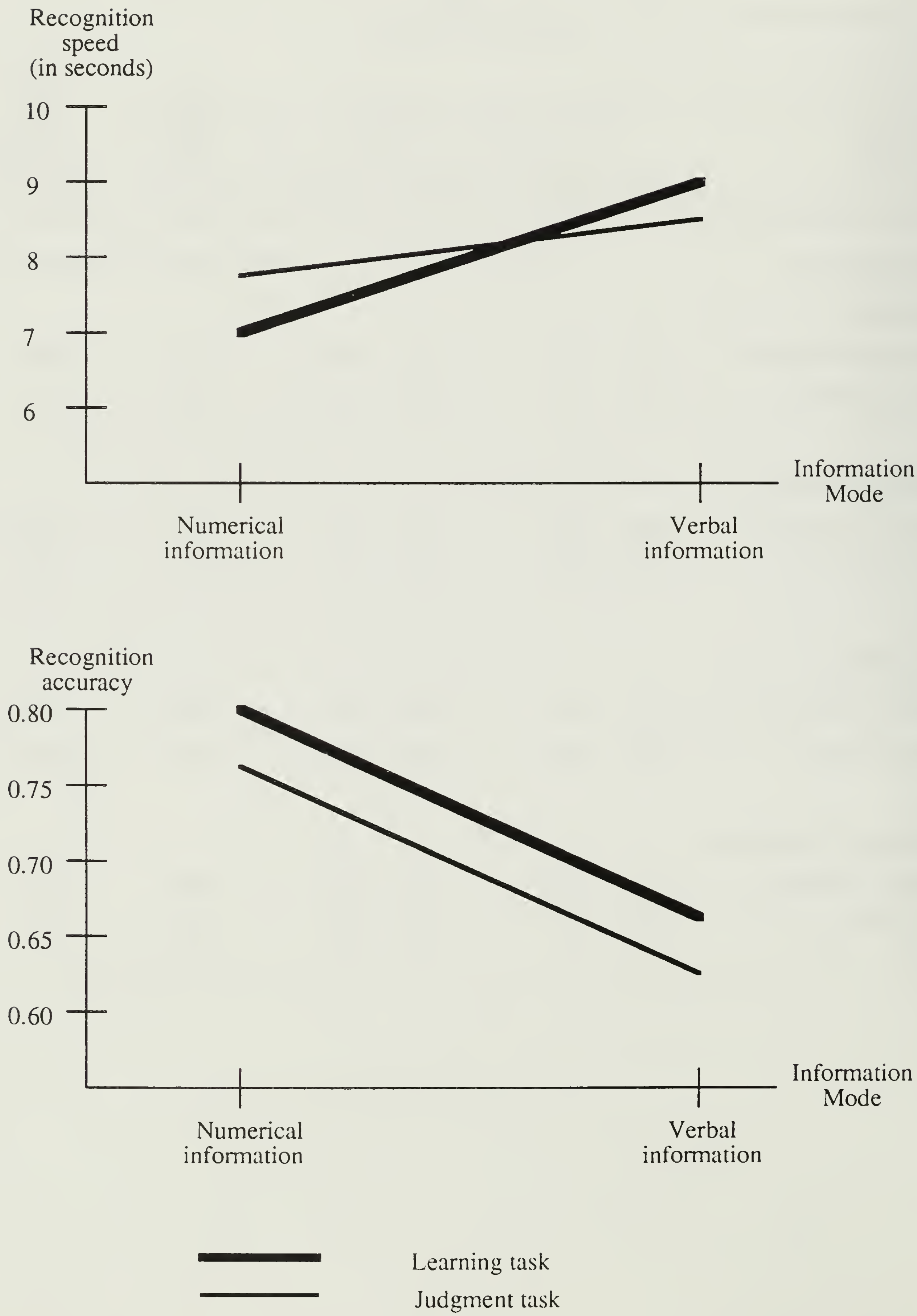


FIGURE 2

RESULTS OF RECALL TASK FOR STUDY 2

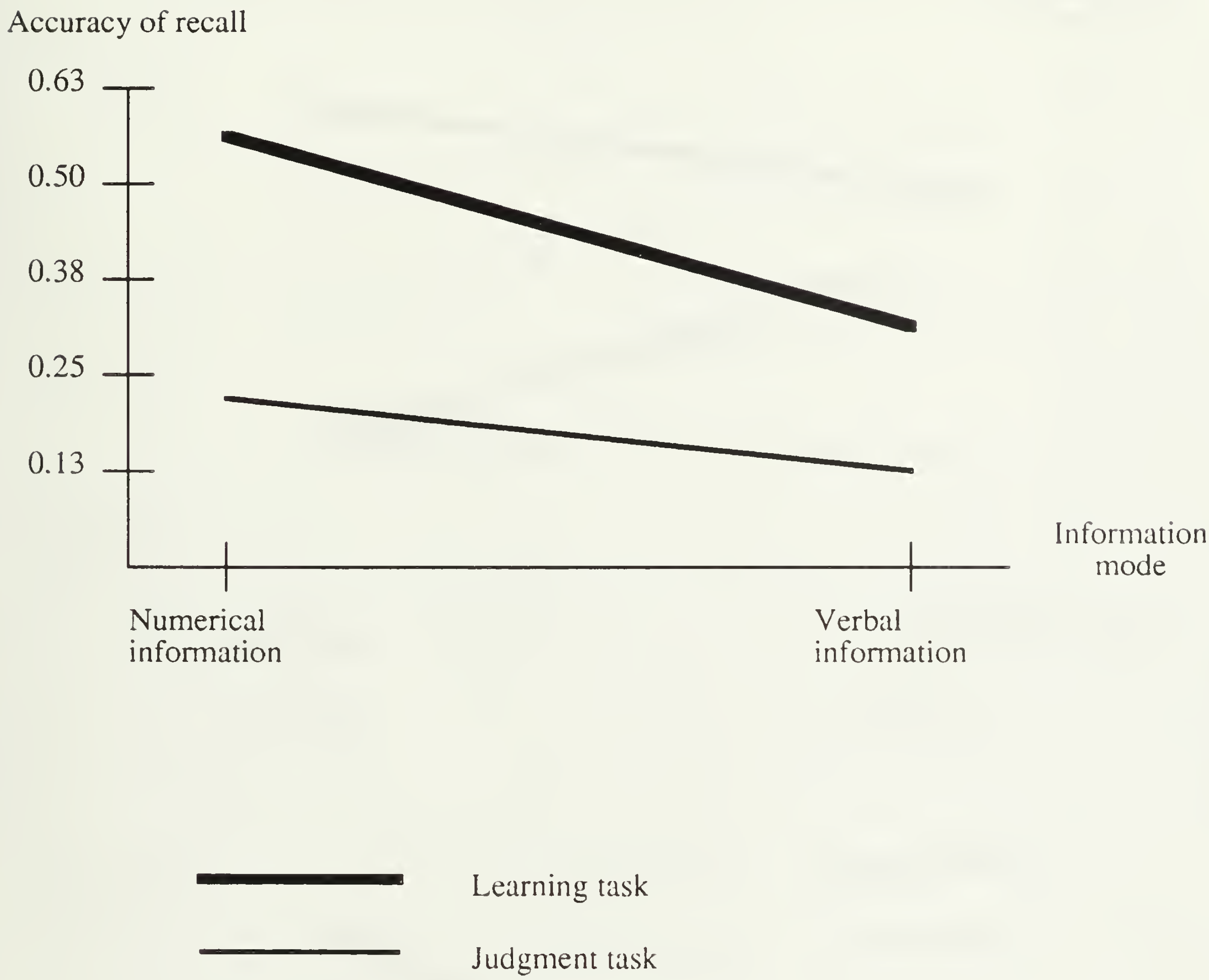


FIGURE 3

RESULTS OF ANALYSIS OF ENCODING TIME FOR STUDY 2

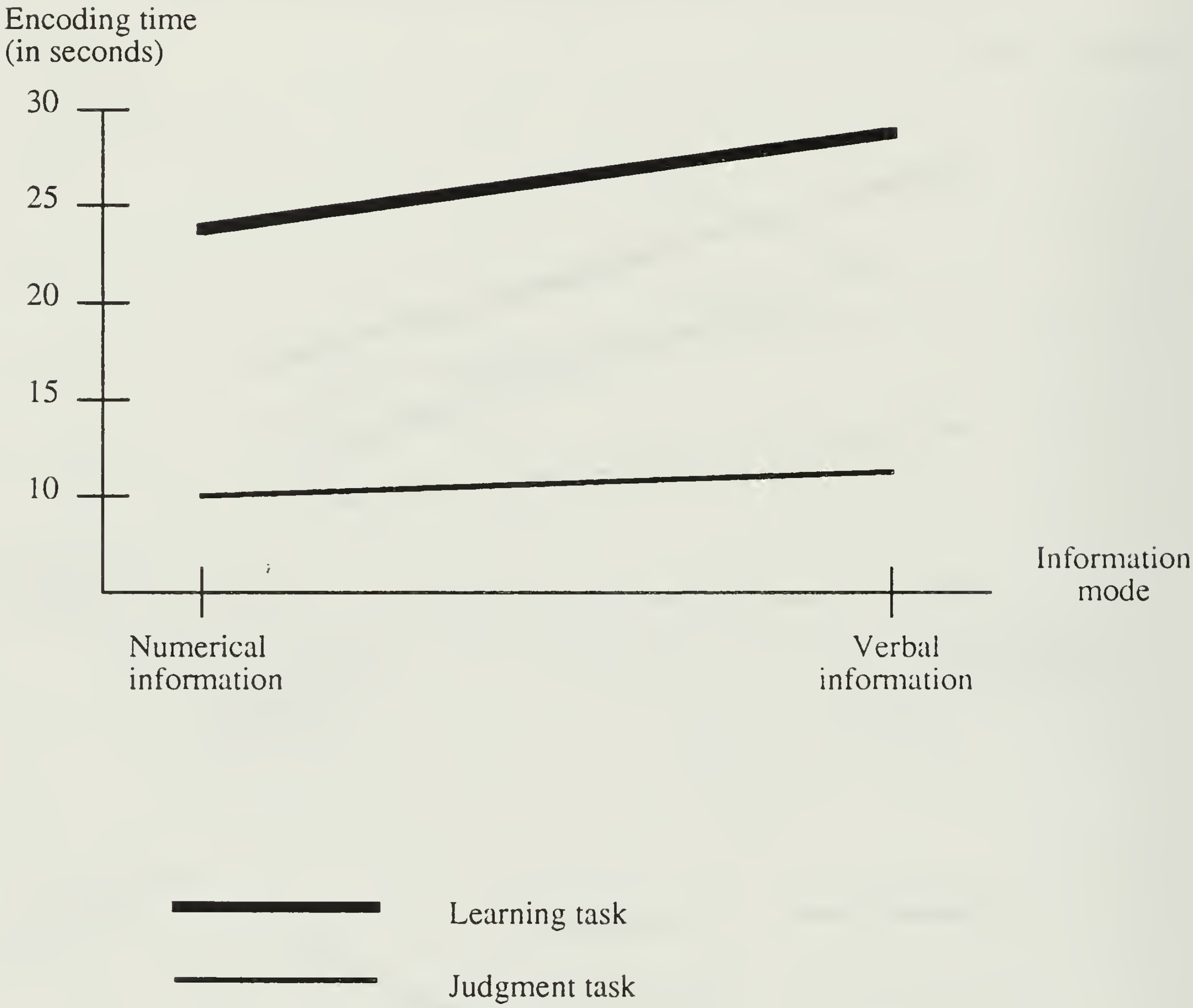
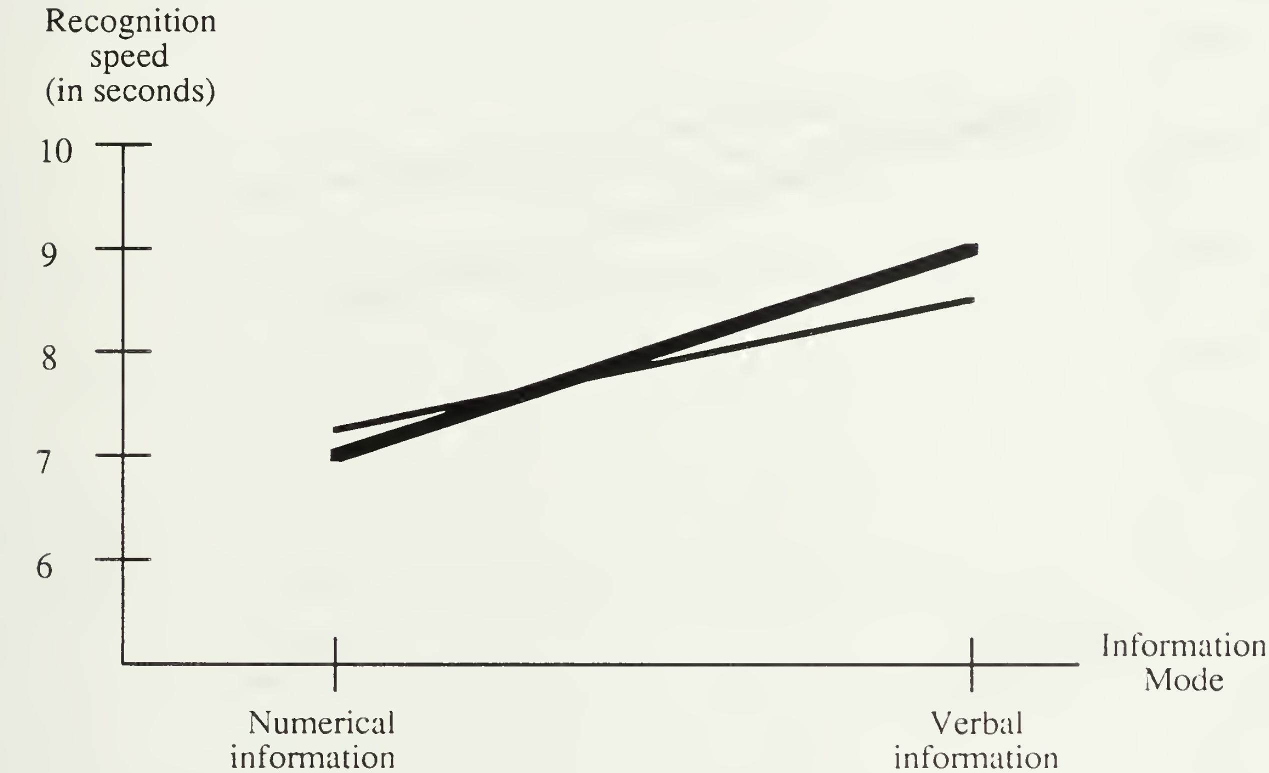


FIGURE 4

RESULTS OF RECOGNITION TASK FOR STUDY 2 & STUDY 3



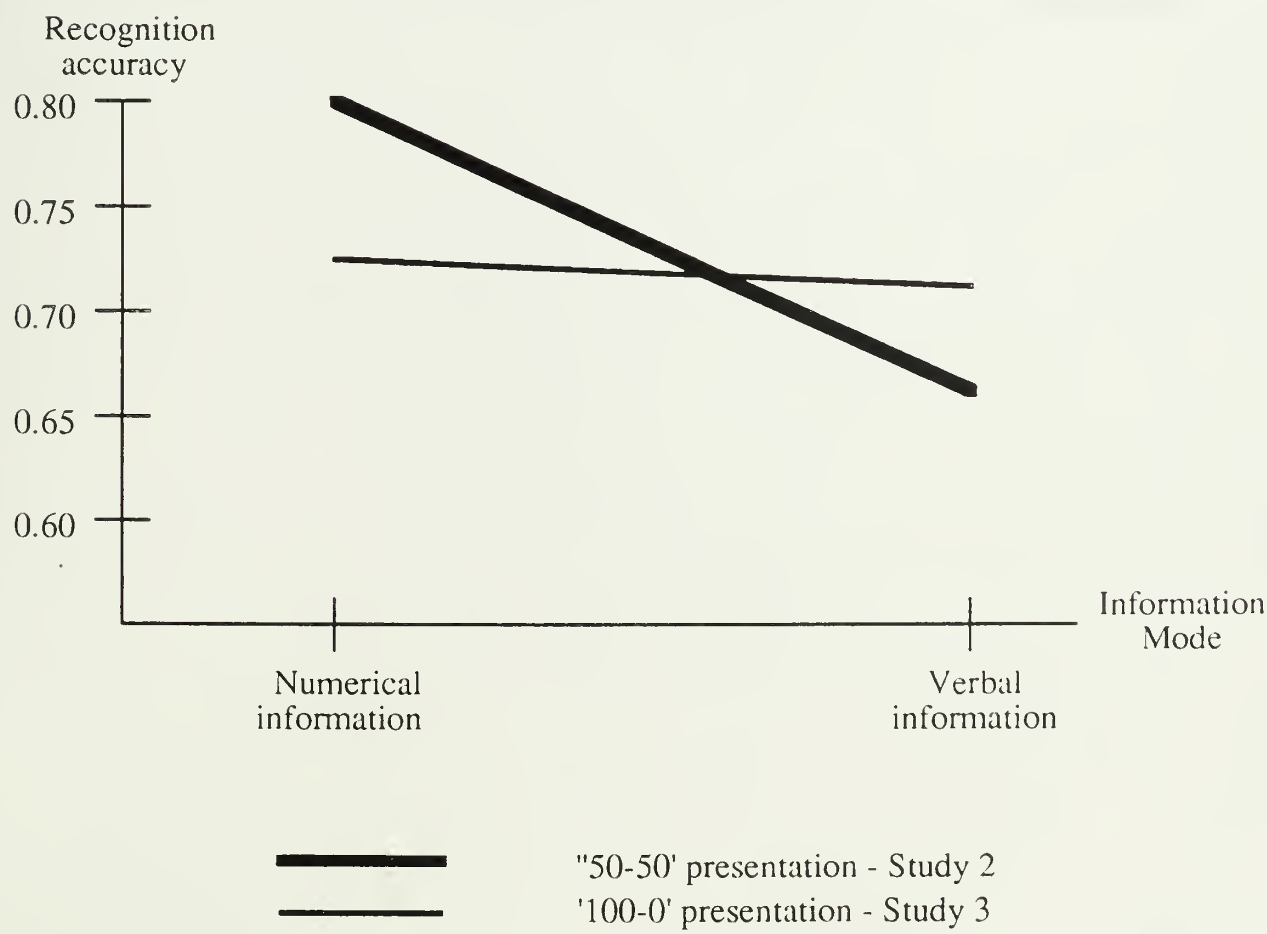


FIGURE 5

RESULTS OF RECALL TASK FOR STUDY 2 & STUDY 3

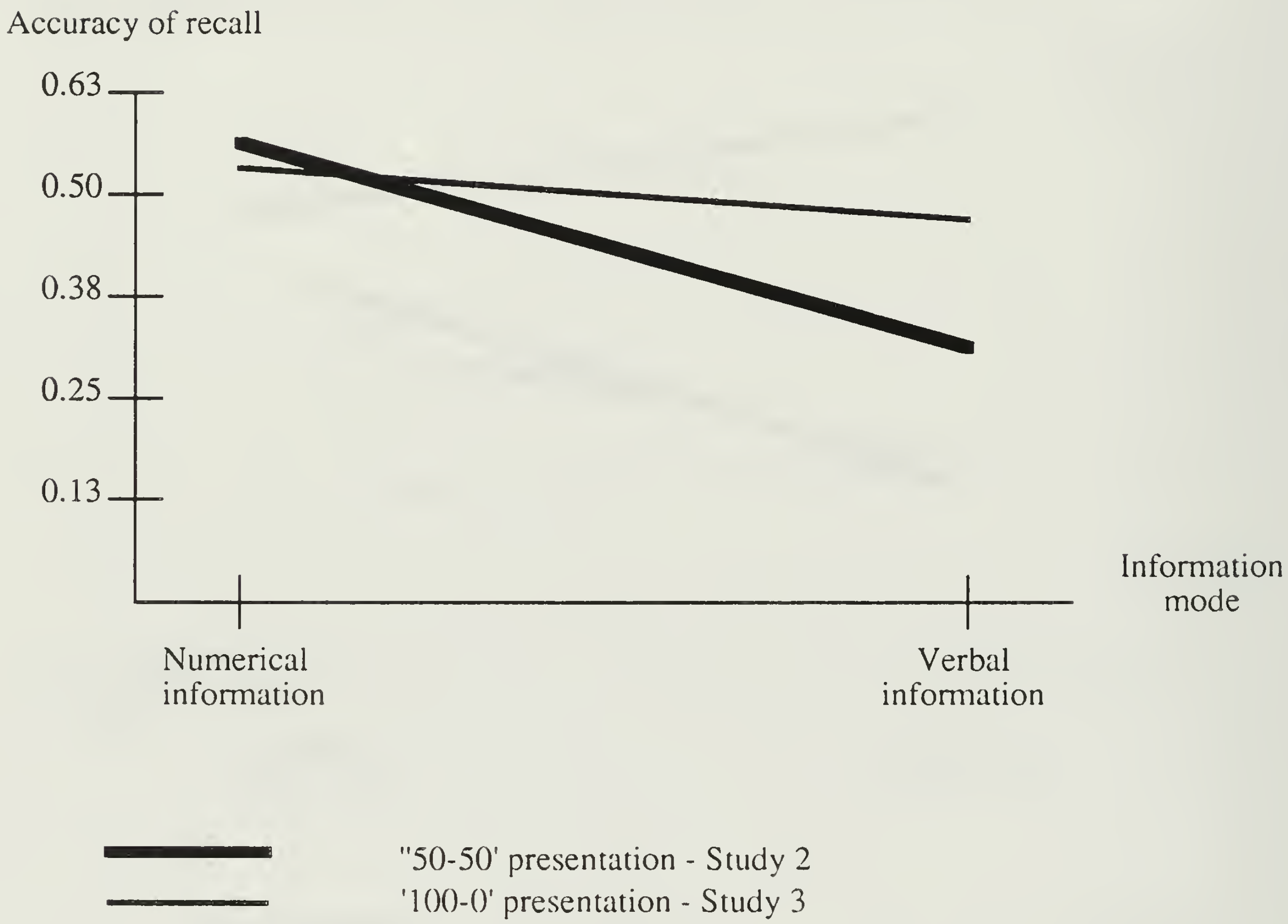


FIGURE 6

RESULTS OF ANALYSIS OF ENCODING TIME FOR STUDY 2 & STUDY 3