The Journal of Behavioral Finance
2006, Vol. 7, No. 4, 214–221

Recall of Financial Information for Investment Decisions: The Impact of Encoding Specificity and Mental Imagery

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Given the volume of data analyzed in investment decisions, analysts and investors often must rely on their memory of financial information. Prior research suggests that differences in the amount of information used by investors may affect their valuation of securities and market prices. Thus, factors influencing the amount and accuracy of information recalled could impact estimates of stock value and market prices. Financial information is often presented in different formats. This study examines whether differences in format presentation at encoding and retrieval affect the recall of financial data. We also investigate whether memory for financial information can be improved with a simple technique that uses mental imagery to reinstate the original encoding conditions. We find that even a minor change in the presentation format has significant effects on memory for financial information. Our results also suggest that the use of mental imagery to reinstate the original format may significantly improve memory for financial data.

Introduction

Users of financial information often rely on memory when making financial decisions, even when external information is available. Securities analysts, investors, and others involved in financial analysis may rely on their long-term and working memory because of the large quantities of information they encounter, in addition to time and efficiency constraints (Libby and Trotman [1993], Moeckel and Plumlee [1989]).

Experimental markets research suggests that when information is differentially available to investors (e.g., some investors have more information about a security than others), market prices are affected, and the individuals with less information are at a disadvantage (e.g., Bloomfield, Libby, and Nelson [1999]). Differences in investors' abilities to recall information will result in differentially available information. Thus, factors that affect the encoded representations stored in memory structures, and the decision-maker's ability to retrieve that data, can have important effects for financial decision-making (Kida and Smith [1995]).

Financial information can be presented in many different formats. Investors or analysts may review spreadsheets with company ratios and ratings presented in one way, and then consult popular financial web sites that use completely different formats (e.g., Kiplinger's displays different ratios in separate rows, while Quicken reverses that format, and presents ratios in separate columns). Later, without direct access to the information, the investor or analyst will need to recall the information when making investment decisions. In effect, decision makers often receive and encode information arranged in one format, and then later try to recall it in a different format (possibly because they are more familiar with a different format, or presently exposed to a different format).

Thus, the question arises, does format presentation affect recall? Psychological theory suggests it does. Studies have found that memory is improved if the conditions at retrieval more closely match the conditions present at encoding, a phenomenon known as the "encoding specificity principle" (Tulving and Thomson [1973]). However, that research has typically investigated the encoding and retrieval of abstract information such as word lists in contexts that are fundamentally different from those experienced in financial settings. Whether encoding specificity affects memory for financial information is therefore an open question.

The purpose of this study is to investigate whether a match between the original encoding context and the retrieval context affects memory of financial information. If we find that memory is negatively affected by a mismatch of conditions, an additional question arises. Thus we also investigate whether memory of financial information can be enhanced by using mental imagery that attempts to reinstate the original encoding conditions.

Our subjects had approximately five years of business experience. We asked the participants to analyze a

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spreadsheet containing two years of financial ratios and ratings for a given company. After a delay, they were divided into four groups and asked to recall the ratio values and ratings. One group was given the spreadsheet with the original ratio/rating names and category labels, but without the corresponding values. A second group was given a spreadsheet that reversed the ratio/rating names and years (i.e., presented in columns instead of rows). Comparisons between the groups indicate that memory improved as the match between encoding and retrieval conditions increased—superior recall was evident when the same format was used at both encoding and retrieval.

Subjects in the third and fourth groups were given a free-recall task, where ratio names and categories were not provided to aid recall. Group 3 was given no special instructions, while group 4 was told to imagine the format of the original spreadsheet. The focus here was whether mental reinstatement of the original encoding conditions would improve memory. While the initial analysis indicated no significant difference in recall, manipulation checks revealed that a significant number of subjects in both groups used mental imagery, whether instructions were given or not. As a result, we analyzed the data by comparing the recall of subjects who used imagery extensively to those who did not. Results suggest that using imagery to mentally reinstate the original encoding conditions significantly improved recall of financial information.

Background Literature and Hypothesis Development

Information Availability and Market Decisions

Experimental market research suggests that prices and market investment decisions are affected by information that is differentially available to investors (Bloomfield [1996], Bloomfield and Libby [1996], Bloomfield, Libby, and Nelson [1999], Forsythe and Lundholm [1990], Lundholm [1991], O'Brien and Srivastava [1991], Plott and Sunder [1982]). For example, Bloomfield, Libby, and Nelson [1999] gave "more-informed" investors three value-relevant financial ratios. "Less-informed" investors received only one of the ratios. Their findings indicated that even after market prices had stabilized following several rounds of trading, the less-informed investors systematically transferred wealth to the more informed investors.

This research physically manipulated the amount of information available to investors. However, differences in the availability of information to a decision maker may also result from differences in an individual's ability to recall information when memory is relied upon in an investment decision.

Encoding Specificity

According to the encoding specificity principle, recall of a memory trace becomes more likely as the similarity between encoding and retrieval conditions increases (Tulving and Thomson [1973]). Presumably, the context in which encoding occurs results in a unique memory trace, and thus, reinstatement of that context facilitates recall (Davies [1988]).

Tulving and Thomson [1973] first demonstrated this principle in a semantic context by examining the recall of target words originally learned along with weakly associated cues (e.g., the target word *light* was paired with the cue *head*). Results indicated that recall was significantly higher when subjects were given the original weak cues to aid recall, as opposed to cues not originally given but more strongly associated with the target (e.g., when the target word *light* was paired with the cue *dark*).

In addition to a semantic context, studies have examined context effects relating to the physical environment, the emotional or physical state of the subjects, and the physical properties of the target items or associated cues. In a particularly interesting example of physical environment effects, Godden and Baddeley [1975] had members of a diving club learn word lists under water and on dry land, and then tested recall in either the original or alternate environment. Divers who learned words underwater (on dry land) had better recall when tested underwater (on dry land) as compared to dry land (underwater). Similar reinstatement effects have occurred by changing the room in which recall is tested (e.g., Smith [1979], Smith, Glenberg, and Bjork [1978]), and by manipulating background music, noise, or odor (e.g., Balch, Bowman, and Mohler [1992], Schab [1990], Smith, Standing, and Deman [1992], and Smith [1985]).

The impact of encoding and retrieval contexts have even been found for pharmacological and mood states. Studies demonstrate, for example, that when subjects memorize target items while under the influence of drugs, their memory is better when they are put back in a drug-induced state (Eich [1980, 1995]).

Finally, context effects have been found by changing the physical properties of target items, such as their position or the background color on which they are presented (e.g., Dulsky [1935], Murnane and Phelps [1993], Weiss and Margolius [1954]). In effect, psychological research indicates that reinstatement of the original learning environment can significantly improve memory.

While considerable support exists for the encoding specificity principle in psychology, however, we need to determine whether the effects are sustained for fi-

nancial information that directly relates to investment decisions. Financial research has largely ignored the possible impact of encoding/retrieval similarity. Kida and Smith's [1995] model of the encoding and retrieval of numerical data for financial decision making theorizes that encoding specificity effects will occur in financial settings. However, the model has not been empirically tested, despite the fact that specificity has the potential to affect financial decision making. As a consequence, we test the following hypothesis:

> H1. Recall of information in financial settings will increase when the retrieval context more closely matches the encoding context.

Mental Imagery

If recall is shown to be better when the retrieval conditions match the encoding conditions in financial settings, an interesting question arises. Can memory be improved by mentally, as opposed to physically, reinstating the original encoding conditions? In other words, can mental imagery be used as a substitute for reinstating the physical conditions present at encoding? If decision makers are instructed to simply imagine the conditions that existed when the data were initially encoded, would the negative effects of an encoding/retrieval mismatch be mitigated? If so, a useful decision aid would be available to help improve memory in financial settings.

Several psychological studies have involved the recall of eyewitness identification (Fisher et al. [1984], McSpadden, Schooler, and Loftus [1988]) and word lists (Smith [1979, 1984]), and have found significant mental reinstatement effects. For example, Smith [1979] found no significant difference in recall between subjects in a physical reinstatement condition (i.e., learning and recall in the same room), and subjects tested in a different room but given mental imagery instructions. Overall, this research suggests that mental imagery can be used to improve memory and possibly mitigate any negative effects stemming from a mismatch between encoding and retrieval conditions. To determine whether this occurs in financial settings, we test the following hypothesis:

> H2. The use of mental imagery to reinstate the original encoding context will significantly improve recall in financial settings.

Methodology

Subjects

Participants were 115 graduate business students enrolled in professional MBA and MSA programs. On average, the subjects had 4.7 years of business experience, and were employed primarily by public accounting firms and companies providing investment/financial services. Fifty-one percent were male, and 49% were female.

Encoding Phase

The experiment consisted of two stages, an encoding phase and a retrieval phase. In the encoding phase, participants were asked to review a spreadsheet containing nine financial ratios and three ratings giving additional information for a certain company. The spreadsheet was divided into four sections, with headers titled *Profitability*, *Liquidity*, *Capital Structure and Solvency*, and *Additional Information*. Three ratios were presented in each of the first three sections, and three ratings were contained in the additional information section.

At the beginning of each section, a highlighted row (white text on a continuous band of blue) contained the section title, followed by headers for the current year and prior year. Within a section, each ratio or rating was presented in a separate row, with the name of the ratio or rating appearing in the first column, followed by its current year and prior year values in the second and third columns, respectively. This presentation format is similar to the one found on Kiplinger's website (see Appendix A for a copy of the information presented). Values for the data were set so there was no overall positive or negative bias for the company (there were an equal number of positive and negative items in the data). Ratios and their corresponding comparative values were taken directly from the numerical data used by Kida, Smith, and Maletta [1998], who pretested the data to ensure an even balance between positive and negative information.

The participants were instructed to review the information and concentrate on the factual details. They were told they would later be asked to recall the information in order to make some decisions about the company, such as its desirability as a short- and long-term investment, or the likelihood that it would experience future financial difficulties. The participants were also told that, in making their decisions, they might need to analyze the company's profitability, liquidity, and financial/capital structure.

Retrieval Phase

One hour later, subjects were randomly assigned to one of four recall conditions. In the first condition (*cued recall/same format*), participants were given the same spreadsheet as in the encoding phase, but without the values of the ratios and ratings. They were instructed to fill in all the details they could remember as accurately as possible.

The second recall group (*cued recall/different format*) received the same instructions, but were given a different spreadsheet to complete in which the columns and rows were flipped from the spreadsheet viewed at encoding (i.e., the ratio and rating names were presented in columns instead of rows, and the current and prior year headers were presented in rows instead of columns). Comparisons of these recall conditions would provide data on whether recall is affected when a relatively small change occurs in the encoding and retrieval conditions (i.e., switching the presentation formats).

Two other recall conditions focused specifically on the impact of mental imagery. In one (*free recall/no imagery instructions*), subjects were given the same instructions as in the cued-recall conditions. However, instead of filling in a spreadsheet, they were asked to write down what they recalled on a blank sheet of paper. In the other (*free recall/imagery instructions*), the following mental imagery instructions were added:

> In your mind, try to create a mental image of how the information appeared. Picture how the information was organized and highlighted, the arrangement of the columns and rows, the categories of information given, and the specific information in each category.

After completing the recall task, participants placed the instrument in an envelope and then responded to demographic questions (e.g., gender and work experience), and a manipulation check indicating the extent to which they used mental imagery in the recall of the information. The seven-point imagery scale was anchored by "did not use a mental image" and "used a mental image extensively," with "used a mental image somewhat" in the middle. Subjects also responded to a seven-point scale indicating their familiarity with the information presented to ensure our results were not confounded by familiarity differences between groups. A Kruskal-Wallis ANOVA indicated no significant differences in familiarity across groups ($p = 0.220$).

Exact recall of the ratio and rating values, and recall within +/–10% of the exact values, were measured and coded by one of the researchers and an independent coder who was not aware of our hypotheses. A correct value was counted in the cued-recall conditions if it was written in the cell corresponding to the correct ratio name and year. In the free recall conditions, a correct value was counted if it was labeled with the correct ratio name or if it appeared in the appropriate location on the page relative to other ratios and ratings. Inter-rater reliability was 0.989 as measured by Cronbach's alpha, and 0.979 as measured by the Pearson correlation (Black [1999]). Any differences were resolved jointly by the two coders.

Results

Encoding Specificity

Hypothesis 1 states that recall will be higher under conditions that more closely match the original encoding conditions. Thus, we expected subjects in the cued recall/same format group to recall more ratios and ratings than those in the cued recall/different format group. Similarly, we anticipated subjects in the free recall condition without imagery instructions would remember less than those in either of the cued-recall conditions.

As illustrated in panel A of Table 1, the ANOVA results indicate significant differences between the groups when recall was measured as the number of exact values ($F = 8.485$, $p = 0.000$), and also when measured within +/–10% of the exact values ($F = 10.570$, $p = 0.000$).

The contrasts in panel B further show that exact recall was significantly higher for subjects in the cued recall/same format condition when compared to the cued recall/different format condition (7.93 versus 6.72, respectively, $p = 0.018$), a particularly strong test of encoding specificity effects. This indicates that simply exposing subjects to different spreadsheet formats, a situation often encountered in financial decision making, impacts recall accuracy.

In addition, participants in the cued recall/same format and cued recall/different format conditions exhibited significantly greater recall than those in the free recall/no imagery condition (7.93 and 6.72 versus 4.72, $p = 0.000$ and 0.004, respectively). In the free recall group, the conditions at retrieval were even further removed from the conditions at encoding (i.e., there were no ratio and rating names to aid memory). Similar effects were found when recall was measured within +/–10% of the exact values. Thus, differences in recall were found with changes in encoding/retrieval conditions.

Mental Reinstatement

Our second hypothesis predicts that the use of mental imagery to reinstate the original learning context will improve recall. To test this hypothesis, we compared the free-recall/imagery instruction group to the free recall/no imagery instruction group. The results are in panel B of Table 1.

The imagery instructions did not significantly affect subjects' recall of exact values ($p = 0.334$), or recall within 10% of the actual values ($p = 0.376$). While it may appear these results do not support a mental reinstatement hypothesis, an examination of the manipulation check reveals an explanation for this insignificant difference. Although subjects were instructed to use mental imagery in one group and not the other, re-

Table 1. *Recall Comparisons of Different Retrieval Conditions*

Panel A: Number (*SD*) of Items Recalled and Analysis of Variance

		Cued Recall Same Format [*n* = 28]	Cued Recall Different Format [*n* = 29]	Free Recall No Imagery Instructions [*n* = 29]	Free Recall With Imagery Instructions [*n* = 29]	*F*- Statistic	*p*-Value
Exact Recall	Mean	7.93	6.72	4.72	5.04	8.485	.000
	(SD)	(2.14)	(2.60)	(2.78)	(3.33)		
Recall within	Mean	10.00	8.35	5.76	6.04	10.570	.000
+/–10%	(SD)	(2.61)	(3.09)	(3.50)	(3.86)		

Panel B: Contrast Tests Between Groups

	Exact Recall		Recall Within +/–10%	
Contrast	Test Statistic[a]	*p*-Value	*t*-Statistic	*p*-Value
Condition 1 versus Condition 2	–2.109	0.018	1.891	0.031
Condition 1 versus Condition 3	4.395	0.000	4.847	0.000
Condition 1 versus Condition 4	3.970	0.000	4.532	0.000
Condition 2 versus Condition 3	2.768	0.004	2.982	0.002
Condition 2 versus Condition 4	2.338	0.011	2.664	0.005
Condition 3 versus Condition 4	0.429	0.334	0.318	0.376

Note: [a]Because of normality issues, the Mann-Whitney U-statistic, converted to the more familiar *z*-statistic, is used for the exact recall condition 1 versus condition 2 comparison. The *t*-statistic is used for all other contrasts. All *p*-values are one-tailed.
Condition 1 = Cued recall/same format; Condition 2 = Cued recall/different format; Condition 3 = Free recall/no imagery instructions; Condition 4 = Free recall/imagery instructions.

sponses to the seven-point mental imagery scale, indicating the extent of imagery used, revealed no significant difference between the two (4.97 versus 4.48, respectively, $p = 0.233$). In fact, 55% of the subjects with no imagery instructions used considerable imagery anyway (5–7 on the imagery scale), while 35% of the subjects with imagery instructions used little mental imagery (1–4 on the mental imagery scale).

Clearly, the imagery instructions did not yield two distinctly different groups (one that mentally reinstated the original context and one that did not). A possible reason, as Bjork and Richardson-Klavehn [1989] argue, is that some subjects naturally use mental reinstatement when retrieving information in a different context condition. That is, even when not given imagery instructions, subjects can, and often will, attempt to mentally reinstate the original encoding conditions at retrieval. The results from our manipulation check support this view.

As a consequence, to test our mental reinstatement hypothesis more effectively, we split each group based on the mean use of mental imagery for the group, and then performed within-group comparisons. Table 2 gives the comparisons of high imagery (5–7 on the imagery scale) and low imagery (1–4 on the scale) usage. Note that we excluded the cued recall/same format group from the analysis because they were given the same spreadsheet format during both encoding and retrieval.

Panel A of Table 2 reveals that subjects in the high mental imagery group of the cued recall/different format condition recalled significantly more exact values (7.71 versus 5.80, $p = 0.023$) and values within +/–10% of the exact values (9.50 versus 7.27, $p = 0.025$) when compared to the low imagery group. In fact, further analysis indicates no significant difference between the amount of information recalled by the high imagery group in the different format condition and the recall of subjects in the same format condition (7.71 versus 7.93, $p = 0.786$ for exact recall; 9.50 versus 10.00, $p = 0.576$ for recall within 10%). Thus, using mental imagery produced recall results as good as those obtained when subjects were physically given the same format at encoding and retrieval.

Panel B gives the results from the split of the free recall/no imagery group, which do not support hypothesis 2 (4.81 versus 4.62, $p = 0.427$ for exact recall; 5.81 versus 5.69, $p = 0.465$ for recall within 10%). However, a closer examination of these data reveals a likely reason for the insignificant effect. Approximately 62% of the subjects in this condition rated their use of mental imagery as either 4 or 5 on the imagery scale, too close for a good differentiation. In addition, the overall group variance was roughly half that of the other free-recall condition. As a consequence, there was little variance in the use of mental imagery within this group, so we did not have two distinct subgroups to effectively test hypothesis 2.

Table 2. *Recall Comparisons of High Versus Low Mental Imagery*

Panel A: Cued Recall: Different Format[a]

		Low Mental Imagery [n = 15]	High Mental Imagery [n = 14]	t- Statistic	p-Value
Exact recall	Mean	5.80	7.71	–2.095	0.023
	(SD)	(2.04)	(2.84)		
Recall within +/–10%	Mean	7.27	9.50	–2.057	0.025
	(SD)	(2.94)	(2.90)		

Panel B: Contrast Tests Between Groups

		Low Mental Imagery [n = 13]	High Mental Imagery [n = 16]	t-Statistic	p-Value
Exact recall	Mean	4.62	4.81	–0.187	0.427
	(SD)	(2.18)	(3.25)		
Recall within +/–10%	Mean	5.69	5.81	–0.090	0.465
	(SD)	(3.35)	(3.73)		

Panel C: Free Recall: With Imagery Instructions

		Low Mental Imagery [n= 10]	High Mental Imagery [n = 19]	t-Statistic	p-Value
Exact recall	Mean	2.90	6.16	–2.789	0.005
	(SD)	(2.85)	(3.06)		
Recall within +/–10%	Mean	3.40	7.42	–3.032	0.003
	(SD)	(3.31)	(3.44)		

Note: [a]The conditions were split into two subgroups based on the mean use of mental imagery on the seven-point imagery scale. Using this measure, low mental imagery was 1–4, and high mental imagery was 5–7 for each group. The cued recall/same format group was not analyzed because that group was given the same spreadsheet format during encoding and recall.

There was a greater range of imagery use in the free recall/imagery instructions group, and the data from this group provide strong support for hypothesis 2. Panel C shows a highly significant difference between the high and low imagery subgroups (6.16 versus 2.90, $p = 0.005$ for exact recall; 7.42 versus 3.40, $p = 0.003$ for recall within 10%).

Conclusion

We examined the effects of a mismatch between encoding and retrieval conditions on memory of financial information, as well as possible ways to mitigate those effects. Consistent with Kida and Smith's [1995] model of the encoding and retrieval of numerical data in financial decision making and prior empirical psychological research, we find that as retrieval conditions more closely match encoding conditions, memory of financial information improves. We also find that mental imagery can improve memory of financial information when external cues are not available.

Our results further suggest that when cues are present, but in a format different from how they were encoded, the use of mental imagery may achieve results that are similar to physically reinstating the original format. In general, our findings indicate that the recall of financial information may be improved by using a standard presentation format. If such a format is not feasible, the use of imagery to mentally reinstate the original encoding format may prove useful.

Our results have important implications for investment decision making, where, due to data volume and time and efficiency constraints, investors and analysts may rely on their memory to recall important financial information. Experimental markets research has found that when investors have different amounts of information available, the imbalance affects estimates of security values and market prices. Investors with less available information tend to transfer wealth to more informed investors (Bloomfield, Libby, and Nelson [1999]). Therefore, the use of simple techniques to improve memory by mitigating the detrimental effects of an encoding/retrieval mismatch could result in more informed investment decisions.

Although our results have important implications for financial decision making, more research needs to be conducted to examine the generalizability of the findings. For example, to investigate the impact of mental imagery, we divided subjects into high and low

imagery groups based on self-reported ratings. While self-reports are often used in such analyses, they open the possibility of competing explanations since random assignment is not made. Future research is needed to replicate our results, taking into account different task and decision variables that may affect the recall issue. Given the documented effects of expertise on memory, future research should also examine whether different levels of financial expertise affect the encoding specificity results found here.

Since we investigated subject recall of exact values, it is also not clear whether our results would hold for comparative information or affective reactions. Kida, Smith, and Maletta [1998] found that affective reactions and comparisons are easier to recall than numerical values. Whether reinstatement of the original context, physically or mentally, improves recall of that type of information is an interesting avenue for future research. We also did not examine how differences in the time delay between encoding and retrieval might affect recall. The effects of an encoding/retrieval mismatch may actually be greater as the time between the two increases.

Additional factors for examination include: the amount of information considered, the impact of accountability, and the effect of other presentation contexts (e.g., computer versus hardcopy). Given the important role of memory in financial decision making, further research into the match of encoding and retrieval conditions would clearly be beneficial if it could enhance decision accuracy and efficiency.

Acknowledgments

We are grateful to Steve Gill for assistance and comments. The helpful comments of James Smith, Richard Asebrook, and Kelly McKillop are also appreciated.

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APPENDIX A
Encoding Spreadsheet Presented to Subjects

Profitability	Current Year	Prior Year
Earnings per Common Share	$0.14	$0.72
Net Income/Net Sales	4.5%	8.3%
Net Income/Operating Assets	0.47%	3.5%

Liquidity	Current Year	Prior Year
Average Days to Collect Accounts Receivable	34 days	45 days
Current Assets/Current Liabilities	0.73	2.1
Average Days to Pay Accounts Payable	29 days	41 days

Capital Structure and Solvency	Current Year	Prior Year
Debt/Equity	0.72	1.6
Earnings Before Interest and Taxes/Interest Expense	3.8	2.7
Long-Term Debt/Total Assets	16%	21%

Additional Information	Current Year	Prior Year
S&P Long-Term Bond Rating (risk rating based on repayment ability) *Ratings*: AAA (extremely strong), AA (very strong,) A (strong), BBB (adequate), BB (speculative)	AA	A
Zacks Analyst Consensus Rating (average analyst recommendation to buy or sell) *Ratings*: Strong Buy, Moderate Buy, Hold, Moderate Sell, Strong Sell	Hold	Moderate Buy
Index of Net Insider Trading (positive = more insider buying, negative = more insider selling) *Ratings*: Very Positive, Positive, Neutral, Negative, Very Negative	Neutral	Positive