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Assessing the Value of Graphical Presentations in Financial Reports

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Keywords
Information presentations, decision usefulness, tables and graphs, general purpose financial reports

Assessing the Value of Graphical Presentations in Financial Reports

Arabella Volkov[1] & Gregory K. Laing[2]

Abstract

The purpose of this study was to replicate the research of Davis (1989) to test the decision usefulness of different information presentations as alternatives to financial information that would normally be represented as numbers. A laboratory experiment, based upon Davis' (1989) study, was conducted using a within subject experimental design to test for information effects. The experiment consisted of two groups with fifteen subjects in each. Decision usefulness was measured from the perspective of a user's efficiency and effectiveness (operationalised as accuracy and response time) in answering questions of different levels of complexity. Evidence of the superior effectiveness and efficiency of one form of information presentation over another was found only at the lowest level of question complexity. The results of this study are not consistent across the range of findings expressed by Davis (1989) and So and Smith (2004). The model does however provide a robust tool for assessing the decision usefulness of different forms of information presentations. The restricted number of subjects and the use of surrogates may present as a limitation to generalisability. However, the nature of the financial information and the task were suitably matched to the expectations of the knowledge and experience of the student surrogates. The results suggest that tables, bar graphs and line graphs are appropriate information presentations to use in general purpose financial reports when decision performance is being measured in terms of a user's efficiency and effectiveness.

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JEL Classification: C91; M40

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Introduction

The issue of providing general purpose financial reports has for the most part been examined from the perspective of the relevance of information to assist decision making in regards to allocation of scarce resources. This has been criticised for not considering whether there are aspects of financial reporting presentation that might provide greater assistance to decision makers (Alfredson 2000; Burgess 2002). The imperative for decision usefulness underpins the qualitative characteristics of accounting information as expressed in the Australian Conceptual Framework and the Statement of Accounting Concepts (ICAA & CPA 2011). The Australian Framework "Objective of General Purpose Financial Reporting" (SAC 2 2011, p.11) states that:

> "General purpose financial reporting focuses on providing information to meet the common information needs of users …".

SAC 2, paragraphs 28 to 40, elaborate on the objective of general purpose financial reporting by describing the types of information that will be useful to the users of general purpose financial reports (ICAA & CPA 2011). However, SAC 2 does not provide guidelines that specify how the information provided in general purpose financial reports should be presented.

The presentation of information in financial reports may be achieved using more than just numbers. International research has shown that the use of graphs in annual reports is widespread, with in excess of eighty percent of companies found to be using graphs to present some form of information, (Beattie & Jones 1992, 1999, 2000, 2002; Frownfelter-Lohrke & Fulkerson, 2001). In the case of Australian companies Beattie and Jones (1999) reported that eighty percent of Australian companies had used financial graphs in their annual reports. More recently Davison (2008 p. 792) observed that:

> The corporate annual report is an exercise in communication, in both the traditional and the modern-day sense of the term. An increasing proportion of that communication is carried by the discretionary words and pictures that surround the financial statements and other regulated disclosures. Despite the growing quantity and sophistication of such material released by the business community annually, and despite research that has revealed its importance to both lay and expert readers, it remains inadequately researched.

In a study investigating the use of concise financial reports in Australian companies, Hrasky and Smith (2008) reported that the use of graphs in financial reports by the largest 500 Australian companies ranged from none to 67, with the mean use of graphs being six per annual report in the year 2001. This use of financial graphs and other visual presentations in annual reports has occurred without sufficient research into the benefits to the users for the purpose of decision-making. It is of concern that the inclusion of graphical representations in general purpose financial reports has not been addressed by the International Accounting Framework, nor have the potential benefits received any consideration regarding their potential usefulness for meeting the objective of SAC 2.

Presumably, the objective of 'providing information to meet the common information needs of users' is applied by general purpose financial report designers when choosing how to represent accounting information in financial reports. In an early review of the literature, Laing

(1991) raised the need for further research on the role of different presentation formats to better convey meaning to decision-makers. One problem highlighted by the literature was the lack of a single theory or model to test the differences between various presentation methods (Laing 1991; Penrose 2008; Wainer & Thissen 1981).

This study contributes to the literature by building on prior research (Courtis 1997; Davis 1989; DeSanctis & Jarvenpaa 1989; Green, Kirk & Rankin 1993; Uyar, 2009) in order to formulate a model that examines the effects of different information presentations. The generalisability of the prior research by Benbasat et al. (1986) and Davis (1989) is assessed through replication and by the introduction of aspects not included in the previous studies. The justification for replication research is that it plays a pivotal role in the advancement of theory development through cross validation and contributing to the generalisability across a diverse or broader spectrum of society (Sing, Ang & Leong 2003; Liyanarachchi 2007; Kane & Reece 1984; Smith 1970; Thompson 1994).

Literature Review

Prior research suggests the existence of a relationship between the type of task undertaken and the effectiveness of a particular information presentation (Benbasat & Dexter 1985; Benbasat et al. 1986; Coll, Coll & Thakur 1994; Vessey 1991). This is consistent with literature on semiotics that holds that symbols play an important role in the process by which individuals produce or become conversant with mathematical objects (MacGregor & Stace, 1995; Radford 2003). Semiotic objectification implies that objects, artefacts, linguistic devices and signs are intentionally used by individuals to derive meaning in language and mathematics (Radford 2003). Similarly, research into congruence between task and display format has reiterated the importance of matching the demands of a given task to the display format (Jarvenpaa, 1989). Davis (1989) investigated the response rate to different methods of presenting accounting data. This research allowed for the monitoring and manipulation of the variables that were used in the experiment. The results obtained by Davis (1989) indicated that the decision task and the forms of presentation of the information affected performance interactively and that no one type of presentation was superior in all situations.

Research into information presentations and decision-making performance has mainly focused on the differences between the use of graphs and tables. Early research by Moriarity (1979) and supported by Leivian (1980) found that decision-makers, regardless of their amount of experience at interpreting financial reports, could discriminate results better using graphs than financial balances or ratios. Research by Schulz and Booth (1995) comparing graphical to tabular representations of financial information and their effects on auditors' analytical review judgements supported Moriarity's findings (1979) that a significant time advantage was found using graphical representations. Stock and Watson (1984) also found that the use of graphs facilitated the users' understanding and interpretation of data for decision-making.

Research conducted by Meyer, Shinar and Leiser (1997) employed a multi-factorial experiment to determine performance with tables and graphs. Their findings suggested that a possible explanation for the inconsistent results in prior studies could be due to multiple factors that have not been considered in research design influencing the decision-making performance of subjects in these studies. Their study revealed the importance of considering multiple variables

as an approach to the study of different displays to ensure that valid display guidelines are developed.

Research has suggested (Beattie & Jones 2002; Iselin 1995) that the provision of relevant cues in a financial report to a decision-maker would make the decision environment more predictable. Iselin (1995) argued that as the decision environment becomes more predictable then uncertainty will be reduced and decision quality will be improved. However, Iselin's description of the decision environment is very broad and needs further definition in order to understand the potential effects on performance with an information presentation. Meyer et al. (1997) detailed other factors that may affect the decision environment such as the visual conditions under which the information presentation is seen, the presence of time pressure for the decision-maker, and large quantities of information being provided which are additional to the relevant decision-making information. They suggested that an information presentation that may be appropriate under one set of environmental conditions might not be appropriate under another set of conditions. The suggestions of Iselin (1995) and Meyer et al. (1997) regarding the effects of the decision environment on decision-making performance are consistent with the finding that time pressure degrades the performance of a subject in the decision-making process while a complete information set (reducing uncertainty) will usually improve performance (Ahituv 1998).

The manner in which information is presented to a user has been suggested to affect the efficiency and effectiveness of the decisions being made using the information provided. However, studies concerning selection of an appropriate presentation relevant to a particular decision-making task have been inconclusive (DeSanctis 1984; Schaubroeck & Muralidhar 1991). Bertin's (1983) theory has been identified as the only complete theory concerning performance with different forms of presentation (Wainer & Thissen 1981).

For the purpose of this study the hypotheses from Davis (1989) are re-examined with some modifications being made to accommodate changes to the data collection and to overcome perceived scaling problems that have been identified as existing in the original analysis. In the research by Davis (1989) the efficiency of an information presentation was measured by the time taken to answer a question as suggested by Bertin (1983), and the effectiveness of an information presentation was measured by the accuracy of the answers for a given information presentation as suggested by Lusk (cited in Davis 1989: p. 497). Following from Davis' (1989) propositions the hypotheses derived for testing these aspects were:

> *H_1- The form of information presentation that allows a question to be answered in the least amount of time will be different for questions of different levels of complexity.*
>
> *H_2- The form of information presentation that results in the most accurate answers to a question will be different for questions of different levels of complexity.*

The effectiveness and efficiency of the use of colour is still debatable with previous research resulting in conflicting results (Benbasat et al. 1986, Montazemi & Wang 1989). Research by Benbasat, Dexter and Todd (1986) indicated that colour has a positive influence on the effectiveness of performance with an information presentation, especially graphical presentations. Further it has been suggested by Tan and Benbasat (1993) that the addition of colour to graphical representations (in particular bar graphs) would aid the user to discriminate the lines or bars on a graph better than shaded or hatched graphs. Field dependent subjects and

subjects working under time constraints appear to derive the greatest benefit from colour information presentations (Benbasat et al. 1986). These propositions led to the following hypotheses:

> *H_3- The amount of time taken to answer a question using a colour information presentation will be different to the time taken to answer a question using a monochrome presentation.*
>
> *H_4- The accuracy of answers to questions using a colour presentation will be different to the accuracy of answers to questions using a monochrome presentation.*

Method

The experiment was conducted using two groups consisting of fifteen subjects**.** The experiment was divided into two parts. The first part of the experiment uses a full-factorial within-subject experimental design to test hypotheses one and two and used the data from group A of the study. The second part of the experiment used a full-factorial between-subject experimental design to test hypotheses three and four and used the data from groups A and B to compare between groups. The subjects were randomly assigned to either group A (monochrome treatment) or group B (colour treatment). Group A received fifteen monochrome experimental treatments (five questions manipulated over the three forms of presentation). Group B received fifteen colour experimental treatments (five questions manipulated over the three forms of presentation). In both groups the questions and information presentations were presented in random order for each subject. Subjects who undertook the colour treatment were screened for colour-blindness using the colour discrimination test developed by Ishihara (1976). Colour-blind subjects were placed in the monochrome treatment, as the use of colour blind subjects in the colour treatment group would confound interpretation of the results for hypotheses one and two.

Students were used in this experiment as surrogates for the users of financial reports. According to Trotman (1996) students may be suitable surrogates where the research does not rely solely on prior learning and the task can be completed by the surrogates. Liyanarachchi's (2007) review of the use of students as surrogates in experiments supports their use in decision-making studies and suggests that maintaining the realism of experiments and replication of prior results is more critical with respect to generalisability than the use of real subjects. Students with an accounting major were chosen on the basis that they had been exposed to the concepts covered in financial information and in particular the notion of 'profit' which was important because interpretation of this term was required by a number of the tasks in the experiment.

The subjects were instructed to complete the questions at their own pace and that while no time limits applied, the speed and accuracy of their responses to their questions were equally important. For each of the fifteen treatments the subject was presented with an information presentation and a question on a standard fifteen-inch computer monitor. The subject was asked to respond to the question using the information presentation displayed at that time. The subject's response to a question was recorded using the computer keyboard and the computer recorded the time taken to respond to a question without displaying the time to the subject. The computer software package used to display the fifteen treatments allowed the subject to control

when the next question would be displayed and cleared the previous information presentation and question once a response has been entered by the subject.

This study consisted of one control variable, two independent variables and two dependent variables. The control variable was the information set. The two independent variables were the information presentation and the question to be answered. The two dependent variables were the time taken to answer the question and the accuracy of the answer to the question.

The information set was derived from the information set used in the study conducted by Davis (1989). This was composed of one categorical, one ordinal and one quantitative variable. Specifically, the data used was a time series of four companies' profits over an eleven-year period.

Six forms of information presentation were used in this experiment: bar charts (monochrome and colour), line graphs (monochrome and colour) and tables (monochrome and colour). Using poorly designed information presentations or poor resolution of the medium used to display the information presentation has potentially confounded previous studies (Benbasat et al. 1986). Accordingly, in order to minimise any confounding effects in the design of the information presentation, the design guidelines of Bertin (1983) for graphics and Ehrenberg (1977) for tables were used to design the information presentation.

Two graphic representations commonly used to report these indicators were bar and line graphs. These are in common use by reporting entities in Australia and Bertin (1983) identified these representations as appropriate for the display of the time-series data as used in this experiment.

The colour and monochrome information presentations included identical tables and graphs, presented identically apart from colour treatment. In order to ensure that the results of colour treatment did not confound the results all patterns, line widths and bar widths were held consistent between the monochrome and colour treatments. Additionally, the colour schemes for all three information presentations were consistent with each company represented by the same colour scheme. For the group receiving the colour report formats the colours used in the presentations were chosen according to two criteria (Benbasat et al. 1986). The first criterion was that the four colours should allow for easy discrimination. The second required the avoidance of colours that have context specific connotations (for example, Red as this is deemed to have special meaning in a business environment).

Consistent with Davis' (1989) study, in order to minimise testing effects, the superficial characteristics of the information presentations were changed so that the ability of the subject to realise that she/he is being asked the same five questions repeatedly is reduced. The superficial characteristics that were changed for each information presentation were:

1. The years to which the profit figures referred (e.g. 1991-2001 for the bar graph presentation and 1985-1995 for the line graph presentation)[3].
2. The companies' profit data was arithmetically manipulated so that the profitability of one company was held constant relative to the other companies across all three information presentations (e.g.. the profit figures for the bar chart presentation were calculated by adding five to the profit figures for the table presentation).

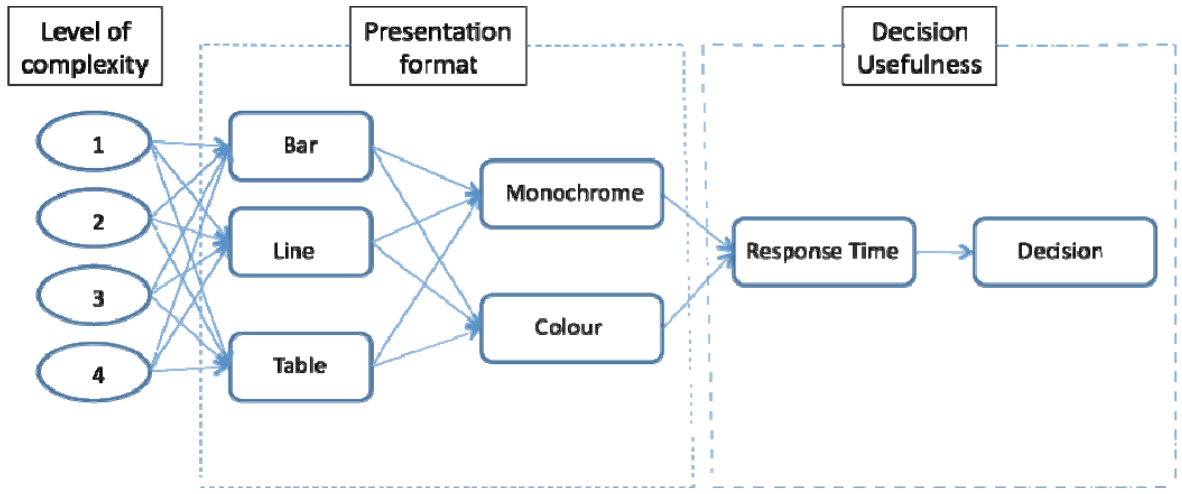
[3] The periods were used as a matter of convenience and are not representative of actual financial periods. They form part of the test and in that regards act as a distraction to direct attention away from the information being the same just presented differently.

Arithmetically manipulating the data also reduces the effects of maturation making it more difficult for the subject to memorise the correct responses as testing progresses. According to Davis (1989), as the relative complexity of the questions increases two things occur: first, the difficulty of the steps the subject performs to arrive at an answer increases; second, the number of times a particular step is performed increases. The questions employed in this study are based upon those used by Davis (1989) with modifications to the wording. The two dependent variables in this experiment are accuracy and the time taken to respond to a question.

Accuracy is defined as a correct response to the question asked. While there is only one correct answer to each question, responses to a question were assigned a maximum score of three and a minimum score of zero. Responses that gave the correct answer were assigned a score of three. Responses that gave the second most correct answer were assigned a score of two and responses that gave the third most correct answer were assigned a score of one. All other responses were assigned a score of zero.

Davis (1989) assigned the variable 'accuracy' a score of one for a correct answer and a score of zero for an incorrect answer. Parametric statistical tests were then conducted on this variable even though the accuracy scores were dichotomous and measured at an ordinal level. While the measurement scale used in this study appears to better approximate an interval scale, to assume that the accuracy scores have a common and constant unit of measurement is erroneous. To define accuracy as being measured on an interval scale it would be necessary to assume that a correct answer at one level of complexity is exactly equivalent (in terms of effectiveness) to a correct answer at a different level of complexity (Siegel & Castellan, 1988). As no theoretical basis to make this assumption was found in the literature the measurement scale for accuracy was treated as an ordinal scale. The structure of the research model is presented in Figure 1 below.

Figure 1.
Research Model



A software program was developed to administer the fifteen treatments. This program allowed for the fifteen questions to be presented in either monochrome or colour.

The use of the software also measured in seconds the time taken to respond to a question and was calculated as being the seconds that elapse from when the subject clicks 'next' to view a question until the subject clicks 'continue' to indicate they have finished the question.

The use of computers has a number of advantages for experimental research (Trotman 1996) such as:

- Increased realism (increasing external validity);
- Better measurement of dependent variables (increasing internal validity);
- Standardisation of timing of subjects;
- Reduction in omitted answers in factorial design; and
- Facilitation of randomisation of treatments and data collection.

In view of the type of variables being examined the use of a computer to administer the treatments was deemed appropriate for this experiment. On-screen instructions explained how to proceed through the fifteen questions. To commence answering a question the subject clicked on a command button, the software then commenced timing the subject's responses in seconds. As soon as the subject clicked a command button to indicate completion of the question, the timer stopped. Both the answer and the time taken to complete the question were then written back to a database for analysis. A response was mandatory for each question and subjects could not terminate the program until all fifteen questions were answered.

The delivery of the treatments via a software application minimised, as far as practical, interference in the treatments by the researcher and the threat to internal validity of the experiment caused by instrumentation effects. The timing of answers to the questions were standardised through the use of a timer built into the software program. The software randomised the order of delivery of the questions and the information presentations.

Results

Descriptive statistics were generated for both the monochrome and colour treatments. The statistics are summarised in Table 1 (response time) and Table 2 (accuracy). The descriptive statistics are divided according to the complexity of the question (question one being the least complex and question five the most complex) and then by the type of presentation (bar graph, line graph or table).

For both the monochrome and the colour treatment the information presentation that resulted in the fastest mean time varied according to the complexity of the question (Table 1). For example, for the least complex question in the monochrome treatment the table presentation resulted in the fastest mean time (12 seconds), while for the most complex question the fastest mean time was for the line graph presentation (35 seconds). A comparison of the mean response times calculated for the monochrome and colour treatments revealed some unexpected results. Overall, the colour treatment resulted in slower mean response time to the questions when compared to the mean response time for the monochrome treatment.

The descriptive statistics for accuracy (Table 2) suggest that the most marked differences in accuracy between the information presentations occur at the lowest level of complexity (question one) and at the third most difficult level of complexity (question three). For question one, the median score for accuracy was the highest for the table presentation for both the colour and monochrome treatments. For question three a comparison of the median scores between the

two treatments reveals that for the monochrome treatment the median scores were higher for both the line graph and the table while there was no difference for the bar graph.

Table 1
Descriptive Statistics – Response Time

		Monochrome Treatment (Seconds)				**Colour Treatment (Seconds)**			
		Min	**Max**	**Mean**	**Standard Deviation**	**Min**	**Max**	**Mean**	**Standard Deviation**
Q1	Bar	8	42	18	11	10	60	24	12
	Line	9	53	25	14	9	29	16	6
	Table	5	30	12	7	8	47	18	10
Q2	Bar	6	70	22	17	8	41	24	10
	Line	6	41	17	9	5	50	19	13
	Table	7	47	23	12	21	61	33	12
Q3	Bar	14	103	38	23	13	159	61	46
	Line	14	54	32	12	18	72	43	19
	Table	9	61	28	15	19	74	40	18
Q4	Bar	15	85	46	25	16	94	37	20
	Line	19	59	35	12	15	114	40	27
	Table	16	56	35	12	28	101	56	25
Q5	Bar	14	135	55	36	17	113	63	32
	Line	14	75	35	16	8	141	50	33
	Table	10	101	52	24	28	131	73	32

In order to draw inferences from these results and to test the hypotheses parametric and nonparametric tests were conducted on the data. All analyses involving the dependent variable 'response time' were transformed by taking the base ten log of each case. This transformation was used to ensure that the assumption of normality was not violated.

H1 *The form of information presentation that allows a question to be answered in the least amount of time will be different for questions of different levels of complexity.*

To test this, a two-way repeated measure ANOVA was conducted on the data collected for the group receiving the monochrome treatment. The results of this test are contained in Table 3. Examination of the descriptive statistics reveals that although the data exhibits some skewness and kurtosis, both are minimal and thus the normality assumption has not been violated. Examination of the variances shows that the F-max is greater than three, as a result homogeneity of variance was not assumed. For this reason a higher significance level of 0.001 was used.

Table 2:
Descriptive Statistics – Accuracy

		Monochrome Treatment		Colour Treatment	
		Median	**Mode**	**Median**	**Mode**
Q1	Bar	1	2	2	2
	Line	2	2	2	2
	Table	3	3	3	3
Q2	Bar	3	3	3	3
	Line	3	3	3	3
	Table	3	3	3	3
Q3	Bar	3	3	3	3
	Line	3	3	0	0
	Table	2	3	0	0
Q4	Bar	3	3	3	3
	Line	3	3	3	3
	Table	3	3	3	3
Q5	Bar	3	3	2	2
	Line	3	3	2	2
	Table	3	3	3	3

The Mauchly test of sphericity was not significant for complexity, the type of information presentation or the interaction effect, indicating that the assumption of sphericity has not been violated. The main effect for complexity was significant at $p<0.001$. This indicates that the complexity of a question did affect the response time to a question. The main effect for information presentation was not significant indicating that the type of information presentation used to ask a question did not affect the time taken to respond to the question asked. The interaction effect for complexity and information presentation was significant at $p<0.001$, suggesting that response times to questions using different information presentations did vary as the complexity of the question varied. These results are summarised in Table 3 below.

The interaction between the type of information presentation used and the complexity of the question asked was investigated to determine which forms of information presentation resulted in the fastest response times for each level of question complexity. This was achieved by conducting *post hoc* comparisons of the pairs of cell means using the Scheffé method. The response times to questions using one form of information presentation were compared to the response times to questions using the other forms of information presentations. The results of these comparisons are summarised in Table 4 below.

Table 3
Results of Two-way Repeated Measures ANOVA for the DEPENDENT VARIABLE Response Time

	Sum of Squares	df	Mean Square	f	p
Complexity	6.105*	4	1.526	43.001	<.001
Information Presentation	0.139	2	6.969E-02	1.638	0.212
Complexity X Information Presentation	0.984*	8	0.123	5.361	<.001

* Significant at p= 0.001

Table 4
Results of Post-hoc SCHEFFÉ TEST Comparing RESPONSE TIMES Using DIFFERENT INFORMATION PRESENTATIONS AT DIFFERENT LEVELS OF COMPLEXITY

PAIRED PRESENTATIONS	QUESTION NUMBER	MEAN DIFFERENCE	SIG.
Bar graph & line graph	1	-0.1300	0.289
Bar graph & table	1	0.1567	0.169
Line graph & table	1	0.2868*	0.004
Bar graph & line graph	2	0.0662	0.777
Bar graph & table	2	-0.0566	0.831
Line graph & table	2	-0.1229	0.424
Bar graph & line graph	3	0.0417	0.878
Bar graph & table	3	0.1209	0.344
Line graph & table	3	0.0792	0.628
Bar graph & line graph	4	0.0731	0.557
Bar graph & table	4	0.0760	0.532
Line graph & table	4	0.0029	0.999
Bar graph & line graph	5	0.1501	0.270
Bar graph & table	5	0.0020	1.000
Line graph & table	5	-0.1481	0.280

* Significant at p = 0.05

The only significant difference in response times was between the line graph and the table information presentations at the lowest level of complexity (question one). Examination of the mean response times revealed that the table (mean response time 12 seconds) resulted in faster response times to question one when compared to the line graph (mean response time 25 seconds). However, the table presentation did not produce response times that were significantly

different to the bar graph presentation. At all other levels of complexity the response times to the questions were not significantly different regardless of the information presentation used. Therefore no one presentation could be stated as resulting in a significantly faster response times at these levels of complexity. These results suggest that the hypothesis should be rejected and that the form of information presentation that allows a question to be answered in the least amount of time was not different for questions of different levels of complexity.

H2 *The form of information presentation that results in the most accurate answers to a question will be different for questions of different levels of complexity.*

As the data collected for the accuracy of responses was measured on an ordinal scale a nonparametric test was chosen to test this hypothesis. According to Siegel and Castellan (1988) the statistical test of choice for k related samples measured on an ordinal scale is the Friedman two-way analysis of variance by ranks. This test was used to test for differences in response times in the monochrome treatment for all five levels of complexity. The results of these tests are presented in Table 5 below.

Table 5
Results of Friedman Two-way Analysis of Variance by Ranks Comparing Accuracy of Answers to Questions using Different Information Presentations at Five Levels of Question Complexity

	MEAN RANK				
QUESTION NUMBER	BAR GRAPH	LINE GRAPH	TABLE	CHI-SQUARE	ASYMP. SIG
1	1.37	1.93	2.70	15.50*	<0.001
2	2.07	1.90	2.03	0.70	0.705
3	2.20	2.03	1.77	2.53	0.282
4	2.13	2.03	1.83	1.75	0.417
5	1.97	1.87	2.17	2.80	0.247

* Significant at p= 0.05 (N= 15, df = 2)

The results of this test suggest that the accuracy of question answers using different information presentations was only significantly different at the lowest level of complexity. As a significant difference was found at the lowest level of complexity, the Dunn procedure with the Bonferroni correction (as recommended by Polit 1996) was used to isolate the pairs of information presentations that resulted in significantly different accuracy score.[4] After correction a significance level of 0.017 was used. The result of this procedure is summarised in Table 6 below.

[4] The Dunn procedure uses the Mann-Whitney *U*-test to compare the ranks for all the possible pairs of information presentations. The Bonferroni correction avoids a higher than desired risk of Type I error by revising the significance level such that the desired α is divided by the number of pairs being compared. Therefore, the significance level used for this test was 0.05/3 or 0.017.

Accuracy scores were significantly different when the table presentation was compared to both the line graph and the bar graph. Examination of the mean ranks from the Friedman test suggests that use of the table presentation (mean rank 2.70) resulted in more accurate responses than either the bar graph (mean rank 1.37) or the line graph (mean rank 1.93).

Table 6

Results of Duncan Procedure with Benforroni Correction for Paired Information Presentations at Lowest Complexity Level (Question 1)

PAIRED PRESENTATIONS	Mann Whitney *U*	Z	Sig.
Bar graph & line graph	61.50	-2.311	0.21
Bar graph & table	27.00*	-3.875	<0.001
Line graph & table	36.00*	-3.617	<0.001

* Significant at p= 0.017

The results of these statistical analyses suggest that the table presentation was the most effective presentation for the lowest level of complexity. However, no difference in effectiveness was found at any other level of complexity. A significant difference in the accuracy of responses using different information presentations at only one level of question complexity does not support the hypothesis and it is therefore rejected.

H3 *The amount of time taken to answer a question using a colour information presentation will be different to the time taken to answer a question using a monochrome presentation.*

In order to test this hypothesis an independent t-test was performed on the data collected. The analysis was conducted on all fifteen questions that the subjects were asked regardless of the level of complexity or the type of information presentation. Based upon this result the hypothesis should be accepted ($t = -3.276$ with a significance level of $p < 0.05$). The result indicated that there is a significant difference between the time taken to answer a question using a colour presentation when compared to the time taken to answer a question using a monochrome presentation. Further analysis of the mean response times of the two groups indicates that the monochrome information presentations (mean response time 31.56 seconds) resulted in a faster response times to the questions asked than the colour information presentations (mean response time 39.78 seconds).

Further Analysis of Response Times

To further analyse the significant findings both univariate and multivariate statistical analyses were conducted on the data collected.

UNIVARIATE ANALYSIS

Grouped independent t-tests were performed on the data collected for the monochrome and colour treatments. These tests assisted in isolating which levels of complexity and which

information presentations accounted for the significant differences between the response times for the monochrome and colour treatments. The results of these t-tests are presented in Tables 7 and 8 below.

Table 7
Results of t-tests Comparing Mean Response Times Grouped by Complexity for Colour and Monochrome Treatments

QUESTION	t	Sig. (Two-tailed)
1	-1.028	0.307
2	-1.905	0.06
3	-2.990*	0.004
4	-0.879	0.382
5	-2.018*	0.047

* Significant at p = 0.05 (df = 88)

Significant differences in the mean response times for the different treatments were found for two levels of complexity: question three ($t = -2.990$, $p = 0.004$) and question five ($t = -2.018$, $p = 0.047$). When grouped by type of information presentation the only significant difference in mean response time between the two treatments was found with the table presentation ($t = -3.720$, $p < 0.001$). Examination of the mean response times using the table presentation revealed that response times using the monochrome tables were faster than those using the colour tables.

Table 8
Results of t-tests Comparing Mean Response Times grouped by Information Presentation for Colour and Monochrome Treatments

INFORMATION PRESENTATION	t	Sig. (Two-tailed)
Bar graph	-1.623	0.107
Line Graph	-0.313	0.755
Table	-3.720*	<0.001

* Significant at p= 0.05 (df = 148)

Another independent t-test was conducted that grouped the data by both the complexity of the question asked and the information presentation used. The results of this test are presented in Table 9 below.

Table 9
Results of t-tests Comparing Mean Response Times (transformed)

INFORMATION PRESENTATION- QUESTION COMPLEXITY	t	Sig. (two-tailed)
Bar graph- Question 1	-1.724	0.096
Line graph- Question 1	0.619	0.541
Table- Question 1	-2.177*	0.038
Bar graph- Question 2	-1.240	-0.1117
Line graph- Question 2	-0.026	0.979
Table- Question 2	-2.582*	0.015
Bar graph- Question 3	-1.549	0.133
Line graph- Question 3	-1.571	0.127
Table- Question 3	-2.155*	0.04
Bar graph- Question 4	0.988	0.331
Line graph- Question 4	-0.095	0.925
Table- Question 4	-3.049*	0.005
Bar graph- Question 5	-0.776	0.444
Line graph- Question 5	-0.944	0.353
Table- Question 5	-1.985	0.057

*Significant at p=0.05 (df = 28)

At four levels of question complexity (questions one, two, three and four) the response times for answering the questions was significantly different for subjects using a table presentation and undergoing the monochrome treatment when compared to the subjects using a table presentation and undergoing the colour treatment. These results suggest that when using a table information presentation the time taken to answer the question will be faster if the presentation is monochrome rather than colour.

MULTIVARIATE ANALYSIS

Multivariate analysis was performed to further explore the influence of the independent variables used in this study upon the dependent variable ‘response time’. This analysis should further explicate the effect of introducing colour into an information presentation while also allowing for an examination of the other independent variables namely the ‘information presentation’ and ‘question complexity’. Therefore, a standard multiple regression was performed on the dependent variable ‘response time’ using the independent variables ‘question complexity’,

'colour' and 'information presentation'. The independent variable 'information presentation' was nominal and was recorded into dummy variables for the analysis (Table 10).

Table 10
Dummy Codes for Multiple Regression

		New coding in dummy variables	
		Bar graph	Line graph
	Previous coding		
Bar graph	1	1	0
Line graph	2	0	1
Table	3	0	0

Based upon the univariate analysis a multiple regression was performed using the transformed data for response time. The results of this analysis are presented in Table 11. Multivariate checks were performed on the data. Examination of the residual scatterplots did not suggest that the assumptions of normality, linearity or homoscedasticity had been violated. Examination of the Mahalanobis distance for each case revealed no outliers in the space of the predictors ($df = 4$, $p<0.001$). Similarly, examination of Cook's distance for each case suggested that no data point could be considered influential[5].

One outlier with a standard deviation of -3.277 was identified, however deletion of this case from the regression analysis did not significantly alter the results so it was included in the final analysis. Examination of Pearson's correlation for the variables revealed that no two variables had a correlation greater than 0.7 indicating that no multicollinearity was present[6].

The regression was significant with $F = 59.545$ and $p<0.001$. The four independent variables had an R^2 of 0.349 indicating that 34.9 percent of the variation in subjects' response times to the questions asked could be attributed to the independent variables used in the study. Three of the variables contributed significantly to predicting a subject's response time (i.e. question complexity, colour and line graph information presentation). The β coefficients for 'question complexity' and 'colour information presentation' were positive while the β coefficient for line graph was negative. This indicates that increasing the question complexity and/or using colour in an information presentation will increase response time (while holding all other variables constant). Interestingly, the results also indicate that the use of a line graph will decrease response time compared to the use of a bar graph or a table when all other variables are held constant. This result conflicts with the findings for hypothesis one for which the only significant difference in response times was found at the lowest level of complexity where the

[5] Cases with influence scores greater than 1.00 would have been suspected of being influential as recommended by Tabachnick and Fiddel (1996).

[6] As a 'rule of thumb' Tabachnick and Fiddel (1996) recommend that two variables with a bivariate correlation of 0.70 or more may indicate multicollinearity. In the experiment by Fischer (2000) decision times using two-dimensional and three-dimensional bar graphs were compared. The use of three dimensions in a graph was considered by the researcher to introduce irrelevant cues into the decision-making task

table presentation was significantly faster than the line graph presentation. This conflicting result could be due to the small amount of shared variance found in the regression model.

Table 11
Results of Standard Multiple Regression for the Dependent Variable Response Time (transformed)

								95% confidence interval for b		
	R	R^2	Adj R^2	Unstandardised β weights	F or t statistic	df	Sig.	Lower bound	Upper bound	sr
Model Summary	0.59	0.349	0.343	na	59.545*	4	<0.001	na	na	na
Question complexity				0.12	14.633*	445	<0.001	0.101	0.132	0.56
Colour				0.09	3.997*	445	<0.001	0.046	0.135	0.153
Bar graph				0.01	0.395	445	0.693	-0.043	0.065	0.015
Line graph				-0.06	-2.239*	445	0.026	-0.116	-0.008	-0.086

*Significant at p=0.05

The semi-partial correlations indicate that question complexity explained 31.4 percent of the variance while the use of colour explained 2.3 percent of the variance. The other two dummy variables, 'bar graph information presentation' and 'line graph information presentation' explained very little of the variance (0.02 percent and 0.70 percent respectively). The shared variance was only 0.44 percent indicating that only a very small amount of the variance was shared.

H4 *The accuracy of answers to questions using a colour presentation will be different to the accuracy of answers to questions using a monochrome presentation.*

In order to test this hypothesis a Mann Whitney U test was performed on the data collected. The analysis was conducted on all fifteen questions that the subjects were asked regardless of the level of complexity or the type of information presentation. The result indicates that there was no significant difference between the accuracy of answers to questions using a colour presentation when compared to the answers to questions using a monochrome presentation ($Z = -1.453$, $p > 0.1$)

Discussion

The results indicate that the efficiency and effectiveness of an information presentation was not dependent upon the complexity of the question to be answered. This finding contrasts with that of Davis (1989) who found that the efficiency of an information presentation did vary as the complexity of the questions asked varied. The results further contradict Davis' findings and suggest that the three types of information presentations used in this study were appropriate for all five questions asked. This conclusion assumes that the decision performance measurement

criteria being used are response time to the question asked and the accuracy of the answers to the questions asked. Conclusions cannot be drawn from this study regarding whether the appropriate form of an information presentation will vary as the question to be answered varies when other decision performance criteria such as problem comprehension, memory for information or viewer preference are used.

The inconsistencies in the results from this study and those of Davis (1989) could be due to at least two factors: the interactive effects of other variables and the statistical methods used. The first explanation with regard to hypotheses one and two considers the possible interactive effect of the decision-maker on decision performance. Meyer et al. (1997) suggested that a person's experience with an information presentation and the task being undertaken will interactively affect their performance. This proposition could explain the differences in findings between the studies. The experience levels of subjects undertaking the prior study could have differed significantly due to the following factors:

The shorter learning and adjustment process could account for the absence of significant differences in the response time using the three types of information presentations for the different task complexities.

The statistical tests employed by Davis (1989) differed from the current study in one particular aspect. Davis assumed that the scores for accuracy were measured on an interval scale and conducted parametric tests on the data obtained. This assumption was considered erroneous. In the current study the accuracy data was assumed to be at an ordinal level and therefore parametric testing was considered inappropriate. It is possible that the different findings for hypothesis one in the Davis study are due to inappropriate statistical testing. However, it is not possible to reach any conclusions as to whether nonparametric testing of the prior study's data would have altered the research findings, as the full data set for that study is unavailable. Alternatively, the different results for hypothesis one for the two studies may be due to sampling error and differential range restriction as suggested by Schaubroeck and Muralidhar (1991).

The results of this study do provide support for the conclusions of Schaubroeck and Muralidhar (1991) which were that task complexity does not moderate the effect of an information presentation where decision accuracy is the performance criterion. The results also suggest that task complexity does not moderate the effect of an information presentation where response time is the performance criterion. It is possible that the experience levels of the subjects used in this research differed from those used by Davis (1989).

Further research could incorporate differing experience levels, as an independent variable, to clarify whether experience level, task complexity and the form of information presentation interactively affect decision performance. Such research may be relevant to the designers of general purpose financial reports because the users may have varied backgrounds and prior experience using graphical and tabular information presentations.

Response Time - Monochrome vs Colour Presentation

The results of this study indicated that the response time using colour information presentations was significantly slower than the response times using monochrome information presentations. This suggests that colour information presentations reduces the efficiency of information presentations which contradicts the suggestion by Lohse (1993) that visual primitives such as colour could reduce the information-processing load on short-term memory.

Further analysis on the data suggested that the significant differences in the response times for the monochrome and colour treatments occurred in the table presentation. While the mean response times using the colour bar and line graph were slower than the monochrome equivalents in all but one question the slower response times in the colour treatment group was therefore related to the table presentations.

The addition of colour to the table presentation did not appear to assist the subjects in identifying, scanning, estimating or comparing the data presented. Research by Fischer (2000) found that that the inclusion of irrelevant depth cues increased the response times of the subjects, and that increasing the complexity of the graphic display generally slowed down comprehension[7]. The addition of colour was an irrelevant cue that affected performance in much the same way as colour had affected performance with graphic presentations. It is suggested that this increased data load (Iselin 1995) may have required the subjects to filter out more irrelevant cues than was necessary using the monochrome table information presentation reducing decision performance in terms of the user's response time.

In terms of response time, the introduction of colour into an information presentation would appear to be detrimental to decision performance when this addition does not provide more relevant cues to the decision-maker. The use of colour in table presentations appears to increase the data load of this information presentation.

The regression analysis indicated that the use of colour in an information presentation would slow response time. Further, the regression provided confirmation that the independent variable 'question complexity' had been correctly operationalised. As expected, the regression also indicated that most of the variance in response times was due to question complexity and that as question complexity increased response time also increased (assuming all other variables were held constant).

The independent variables explained only 34.9 percent of the variation in response times. The model developed from the literature review suggests that other variables such as the cognitive style of a decision-maker or the decision environment also affect decision performance. The results of the multiple regression indicates that other variables affect response time and future research may seek to incorporate the variables suggested in the model.

Accuracy - Monochrome vs Colour Presentation

The results indicated that there was no difference in the effectiveness of monochrome information presentations when compared to colour presentations. This finding suggests that the use of colour in general purpose financial reports does not detract from or enhance a users' decision performance with an information presentation when measured in terms of the accuracy of decisions.

The addition of colour to the information presentations did not improve performance with graphical presentations in terms of accuracy as was proposed by Tan and Benbasat (1993). The ability of the subjects using colour information presentations to discriminate trends was not different to the ability of the subjects using monochrome information presentations in terms of the accuracy of the answers to the questions.

[7] Fisher (2000) compared two-dimensional and three dimensional bar graphs to evaluate decision times.

Research Limitations

The information presentations used in this study were two-dimensional time-series bar graphs, line graphs and tables displayed to the subjects on a 15-inch computer monitor. The findings of this study are therefore only applicable to these three types of information presentations. However, these information presentations are commonly used in Australian financial reports (Beattie & Jones 1999; Hrasky & Smith 2008). Further, the tasks undertaken by the subjects were elementary data extraction tasks, undertaken by individuals, and may have limited applicability to more complex data extraction tasks involving group decision-making.

The small sample size may not be representative of the population and future research may seek to obtain a wider audience by the use of the Internet. The computerised instrument could be developed for Internet use and this would allow for access to a greater number of subjects to be involved. Future research could also examine whether differing experience levels of the subjects has an influence on the variables. Another consideration is the respective intelligence of the participants in addition to their experience; further research incorporating consideration of intelligence and the assigning of participants to ensure an equal 'group intelligence' would improve the implementation of the testing model.

Another possible limitation of the research design was not allowing the participants to 'skip' questions they were unable to answer; this may have resulted in participants randomly selecting answers to these questions and skewing the results obtained. This flaw in the software package employed could be easily remedied in future testing.

Further research could be undertaken to study the interactive effects of task complexity and information presentations using other criteria such as viewer preference or memory for the information provided. This research should also consider the possible effects of a decision-maker's experience level and intelligence on the decision-making task. The relevance of this research would be dependent upon how decision performance is defined by the user of a financial report and the designer of a financial report.

Implications

The results of this study indicate that when decision usefulness is measured in terms of the accuracy of answers or response time to reach a decision both tables and graphs are equally suitable methods for representing accounting information regardless of the level of question complexity. However, the use of colour in information presentations appears to slow response times where the colour does not provide relevant cues to the decision-maker. There appears to be no increase in the accuracy of decisions made when a colour information presentation is used rather than a monochrome information presentation.

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