The impact of presentation format and individual differences on the communication of information for management decision making

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Abstract
Accounting information is essentially multivariate and the relationships among variables may be difficult to establish. Differing multivariate information presentation methods may impact on the quality of the decisions made by users. Existing studies in this area have given scant attention to differences between individual users, despite earlier suggestions from the second author of this paper that both gender and personality might impact on information processing. This study focuses on the interaction of the decision maker (addressing issues of gender, personality, cognitive style and ability) with the data presentation method (including tables, graphical and pictorial methods) in the management decision making process. The paper reports on experiments conducted with respondents of varying degrees of accounting sophistication, using a failed/non-failed decision environment. Results provide support for the use of graphical and pictorial methods as means of representing data for this decision task, while also identifying the influence of gender, spatial ability and tolerance of ambiguity. These findings have implications for the matching of information presentation with the characteristics of the decision maker in management decision making.

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1. Background

One objective of accounting is to provide information useful to management decision making. Accounting information is essentially multivariate and evaluation of traditional tabular-presented data can be both tedious and time consuming. Besides, relationships among the variables may be difficult to establish (MacKay and Villarreal, 1987). The potential exists for information technology to be used to improve the presentation of multivariate accounting information so that it is better able to meet its objectives. With new capabilities available, the traditional boundaries to accounting information presentation can be re-assessed to determine a new direction for the accounting profession as information providers. This study re-assesses these boundaries by providing evidence of the effect of differing multivariate accounting information presentation methods on the quality of decisions made by users.

A major component of any information system is the individuals that supply, manipulate, access and rely on the system. Individuals' information needs and requirements for decision making, are the reasons information systems exist. To ignore differences in the individuals hinders the conclusions of any research that considers the impact of information systems. Previous studies in multivariate accounting information presentation (e.g. Smith, 1999) have concentrated on demographic variables alone, ignoring more fundamental and radical dimensions of individual differences – cognitive style, cognitive ability and personality. This study employs a more comprehensive approach by including such dimensions of individual differences. This approach should increase the validity of outcomes and may help to explain some of the inconsistency in the results from previous studies.

The dual purposes of this study are:
1. To determine the difference, if any, in decision making quality when presenting multivariate data with tables, profiles and schematic faces.
2. To examine the relationship, if any, between decision making quality using the various data presentation methods (tables, profiles, schematic faces) and the individual characteristics (cognitive style, cognitive ability, personality and demographic variables) of the user.

2. Review of the literature

So far research in the accounting context has been confined to the uses of schematic faces and grouped graphs (Moriarity, 1979; Smith and Taffler, 1984, 1996; Stock and Watson, 1984; MacKay and Villarreal, 1987; Umanath and Vessey, 1994; and Smith, Taffler and White, 2002):
- Schematic faces were developed by Chernoff (1973), who matched quantitative variables with the features of a cartoon face. The variables were scaled so that the facial feature was dependent on the mean and standard deviation of the variables being represented. The faces give an attractive gestalt impression (e.g. happy or sad) and have been studied and used extensively in a number of different environments.
- Grouped graphs are line graphs or bar graphs whereby one, two or at the most three variables, depending on their axis requirements, are grouped together in one graph (Jarvenpaa and Dickson, 1988). Two or more graphs, depending on the number of variables studied, are usually necessary in order to accommodate all the variables. This is different from the schematic face where the face represents a unit containing all the variables. In this sense, grouped

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graphs are not well-suited for representing multivariate data, although Umanath and Vessey (1994) used them successfully to display multivariate information.

Because of the inherent weakness of grouped graphs for multivariate data presentation, this study is extended to include an alternative multivariate graphic presentation technique called "profiles" (Bertin, 1967). With profiles, each observation is represented by k vertical bars/lines for k-dimensional data, each bar/line having height proportional to the value of the corresponding variable. This is the most common method of representing multivariate data, despite its principal disadvantage being dependence on the ordering of the variables. In this study, the standard deviations of the variables above/below the means are used instead of the actual values, to facilitate comparisons among the other presentation methods used in the study.

This study recognises the lack of strong, conclusive evidence from previous studies supporting the use of graphical presentations. Specifically, for decision accuracy, Moriarity (1979), Stock and Watson (1984) and Smith and Taffler (1996) found faces to be superior to tables while MacKay and Villarreal (1987), Umanath and Vessey (1994) found no significant difference. Likewise, for decision processing time, although most studies found faces to allow speedier decisions, Umanath and Vessey (1994) found no significant difference between the two. Such inconsistency can be attributed to the dependence of decision quality on situation factors such as task and subject characteristics[1]. Although the importance of the inclusion of situation factors has long been emphasised in the decision science literature for decisions involving two or at most three variables (DeSanctis, 1984; Benbasat and Dexter, 1985; Dickson, DeSanctis and McBride, 1986; Jarvenpaa, 1989; Campbell and Kain, 1990; Ramnarayanan and Gardner, 1991), no comparable research has been reported in the accounting literature, notwithstanding the more complex multivariate information presentation requirement in accounting. MacKay and Villarreal (1987) studied task nature (whether requiring holistic or particularistic response modes), subject's prior knowledge and experience, and gender; Umanath and Vessey (1994) studied the task's cognitive fit with presentation displays and information load; Smith and Taffler (1996) studied users' levels of accounting sophistication; and Smith, Taffler and White (2002) the impact of variable-feature assignments[2]. Thus, as far as individual characteristics are concerned, the accounting literature has not considered the impact of more fundamental variables like cognitive style, cognitive ability and personalities on management decision making. Bonner and Lewis (1990) reported that cognitive ability was better at explaining variations in performance between experienced and inexperienced auditors than was years of experience. Many studies have also revealed that differences in decison makers' cognitive styles, cognitive abilities and personality are important factors in decision making and performance (Gul 1984; Campbell and Kain, 1990; Davis, Grove and Knowles, 1990; Brown, 1992; Moussavi, Evans and Shia, 1995; Lal and Hassel, 1998).

In view of this significant gap in the accounting literature, a more comprehensive study of the effects of individual characteristics on multivariate accounting information presentation is overdue, and is undertaken in this study.

The study begins by combining the different, though overlapping approaches of Zmud (1979), Benbasat and Taylor (1982) and Ho and Rodgers (1993), as a basis for studying individual characteristics under four components: cognitive style, cognitive ability, personality and demographic variables.

Ho and Rodgers (1993) provide a definition of cognitive style[3] as "distinctive ways of acquiring, storing, retrieving and transforming information". An individual's cognitive style is a characteristic property of his/her own attitude or preference for information. It is consistent over time and is not influenced by situational factors within a normal range of conditions.

The Myers-Briggs type indicator (MBTI) (Myers and McCaulley, 1985) is used to determine cognitive styles along two basic dimensions[4], perception (information acquisition) and judgment (data processing and evaluation). In the perception dimension, MBTI categorises individuals as sensors (S) or as intuitors (N). In the judgment dimension, MBTI classifies individuals as thinking (T) or feeling (F) types. This study investigates the proposition that rational STs prefer tables while intuitive NFs prefer graphical displays of information.

Libby and Luft (1993) define cognitive ability as "the capacity to complete the information encoding, retrieval, and analysis tasks". Abilities should be specific to particular problem domains and thus should be useful in determining an individual's capacity to process certain kinds of information. In this study, cognitive ability is measured using the field dependency test or so-called Group Embedded Figures Test

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(GEFT) due to Oltman, Raskin and Witkin (1971). Individuals showing high field dependency (FD), are thought to have less ability to separate objects from their environment and are therefore better with intuitive approaches to problems. Individuals showing high field independence (FI) are thought to demonstrate a greater spatial ability to separate objects from their environment and are therefore better equipped to deal with detail and basic relationships. It is anticipated in this study that FDs will be better with graphics while FIs are better with tables.

Kagan and Segal (1988), define personality as "the total pattern of characteristic ways of thinking, feeling, and behaving that constitute the individual's distinctive method of relating to the environment". Personality is relevant in decision making because it affects how finely people discriminate information or to what extent they differentiate data given a certain situational constraint and problem content (Ho and Rodgers, 1993). Tolerance for ambiguity is relevant here (Gul, 1984; Lal and Hassel, 1998; Ghosh and Ray, 1997); decision makers who are intolerant of ambiguity differentiate their accounting information to a greater extent than do decision makers who are tolerant of ambiguity. The A-T20 Test (MacDonald, 1970) measures the degree to which respondents are comfortable with uncertainty and can tolerate ambiguity in messages and outcomes. We might anticipate that respondents who are tolerant of ambiguous situations/messages would process the schematic faces more easily, and might be more comfortable with data presented in alternative formats.

In comparing the different presentation formats, faces, because of their failure to preserve underlying data, contain information less differentiated; consequently, it is expected that the intolerant groups will not perform as well with facial displays.

Work experience and gender are the two demographic variables included in this study. Taylor (1975) found older managers had some difficulty in integrating information into accurate decisions, sought greater amounts of information but judged the value of information more accurately than younger managers. Gul (1993) found age was not related to accountants' decision confidence, suggesting that the effect ascribed to age and experience may be explained by other variables like cognitive style, cognitive ability and personalities.

Powell and Johnson (1995) review studies on gender and decision support systems, and suggest that gender differences in the nature and quality of decisions can be approached by referring to differences in three areas: abilities and motivation, risk attitude and confidence, decision style. There is evidence that males and females differ in their cognitive abilities of verbal, quantitative and visual-spatial skills (e.g. Halpern, 1992), though some researchers believe the gender differences may be diminishing (Feingold, 1988). For MBTI cognitive styles, Hammer and Mitchell (1996), found men preferred thinking while women preferred feeling, which is in accordance with earlier estimates.

A significant body of literature exists in psychology on responses of subjects to facial displays (e.g. Ekman, 1982; Bruce, 1991). Most of this literature is not related to the use of Chernoff's schematic faces but is still useful for forming expectations of how individuals will react to facial displays of decision making data. In these studies, one of the most consistent findings is a gender difference: females are more responsive to facial displays than males.

While a substantial amount of the psychological literature has historically been focused on gender differences in the quality of decisions, more recently, attention has shifted towards differences in psychological sex roles (Kelly *et al.*, 1982, Voelz, 1985; Radecki and Jaccard, 1996). It is argued that, independent of a person's gender, an individual's personality can be essentially masculine (dominant and self-assertive) or feminine (nurturant, expressive and interpersonal). Research has shown that psychological sex role is an important variable influencing effectiveness in decision making (Kelly *et al.*, 1982). The Bem Sex Role Inventory (Bem, 1974) is used in this study to assess the masculinity and femininity of the subjects.

Another possible explanation for the apparent inconsistencies in research of multivariate accounting information presentation is the lack of a well-defined theoretical construct for assessing the quality of accounting decisions, a common problem recognised by Ashton and Ashton (1995) for all judgment and decision making research in accounting and auditing. The ultimate goal of different methods of information presentation is to improve the quality of decision making. In order to have an objective evaluation of any presentation method, a good decision quality construct, embracing all the different dimensions of quality, is important. Accuracy and time taken are the only two dimensions measured in most studies and previously mentioned studies on multivariate accounting information presentation format are no exception. Eierman, Niederman and Adams (1995), in their decision support system model of constructs and relationships, have however included four dimensions for the decision quality construct, namely effectiveness, confidence, economic value and efficiency. While effectiveness and economic value together are closely associated with accuracy, and efficiency correlates with time taken, confidence has been ignored in most studies when decision quality is measured. In this study, the decision maker's confidence of decision is evaluated, together with accuracy and time taken.

The task in this study is the bankruptcy prediction or so-called failed/non-failed company decision. Because Moriarity (1979), MacKay and Villarreal (1987), Umanath and Vessey (1994); Smith and Taffler (1996) and Smith, Taffler and White (2002) have all used this task environment in their studies, the use of the same task here renders readily comparable results later on. There is also a wealth of literature demonstrating the high predictability of the bankruptcy event (e.g. Altman 1968, Taffler 1982).

3. Hypotheses

H1. Schematic faces will be processed quicker and with no loss of accuracy, compared to graphical and tabular representations of the same data set.

H2. Women will exhibit a higher degree of decision quality (accuracy, timeliness and confidence) than men, when working with facial displays.

H3. Intolerant groups will perform relatively poorly, when compared to other groups, when processing facial displays of information.

H4. Individuals exhibiting high field independence (FI) will show higher decision quality when processing tables, while field dependents (FD) will be better with graphics.

H5. S-T cognitive types will exhibit higher decision quality when processing tables, while N-F types will exhibit higher decision quality when working with graphic displays.

4. Research method

Two groups of students from an Australian university participated in the study:

- 86 third-year accounting undergraduate students, with little or no experience of accounting practice; and
- 51 part-time students of masters or doctoral programmes in business, all active in management roles.

Of 137 respondents in total, 81 were male and 56 female.

Experiments were conducted in tutorial groups of approximately 15 persons in three successive two-hour sessions. Because all of the test instruments required over three hours in total for completion, a nominal financial reward for participation was provided to encourage motivation towards the tasks.

In the first two sessions the respondents were asked to complete the following instruments (with feedback on performance provided at the subsequent session):

- Myers-Briggs Type Inventory (see Myers and McCaulley, 1985) – to measure cognitive style on four dimensions.
- Bem Inventory (Bem, 1974) – to measure masculinity/femininity of attitudes.
- AT-20 Scale (MacDonald, 1970) – to measure tolerance for ambiguity.
- Group Embedded Figures Test (GEFT), Oltman *et al.* (1971) – to measure cognitive ability through spatial recognition of embedded graphical figures.

Data on gender and work experience were also collected during the administration of these instruments.

In the final session respondents performed the financial decision-making task. Four different test instruments were prepared each conveying the same information, but in different formats. Each instrument represented the performance of 20 companies (14 healthy and six failed) over a five year period[5]:

1. Financial ratio data, in tabular form, together with industry mean and standard deviation data for each of the four ratios[6]:
   - $\frac{PBIT}{TA}$ to represent profitability;
   - $\frac{TL}{NW}$ to represent gearing;
   - $\frac{QA}{CL}$ to represent liquidity, and
   - $\frac{WC}{NCE}$ to represent working-capital position.
2. Bar charts – with a cluster of four bars in profile representing performance in one year over each of the above four ratios. To utilise the industry information the bars were each represented as "the number of standard deviations above/below the mean", so that "good" (i.e. better than average) performance was represented by a profile "above the line" and "poor" performance (i.e. worse than average) by a profile below the line.
3. Trend diagrams – provided the same data as above, but in the form of a continuous

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line, joining the equivalent of the top mid-points of the corresponding bars in the profiles. Colour graphics were used for both "trend" and "bar charts" to ease respondent differentiation.

4 Schematic faces – representing the four financial ratios with a common assignment[7] (following Smith and Taffler, 1996) of ratios to facial features:
   - profitability on mouth length and curvature;
   - gearing on eyesize (and pupil position);
   - liquidity on eyebrow length and slant;
   - working capital on nose height and width.

The ordering of the administration of the tasks (for accuracy, time and effort) has been shown to be a factor in previous studies, so six different orders were established, being all possible order combinations consistent with tabular ratio data being the first format employed.

Each of the test instruments was administrated in turn. Respondents were asked to make failed/healthy decisions for each of their 20 cases[8], and to give a numerical indication (on a seven-point Likert scale) of how confident they were in each decision, as well as self-reporting the time necessary to undertake each of the four parts of the task[9].

5. Results

5.1 Decision-making task

Each person has the opportunity to make 20 errors: 6 missed failure classifications (Type I errors) and 14 over-predictions of failure (Type II errors), with each of the four processing media. Table I details the number of misclassification errors per person[10].

The number of misclassification errors was significantly lower for the schematic faces than for any of the other media, and the processing was completed in a shorter time period. However, for the incidence of Type I errors there was no significant difference in respondent performance with either faces or bar charts. Given the differences in misclassification costs for Type I and Type II errors (estimated by Altman, Haldemann and Narayanan (1977), to be of the order 40:1) these findings provide only guarded support for *H1*.

Table I
Misclassification errors per person with four media

	Type I	Average Type II	Time (mins)	Mean confidence score
Ratios	1.31	3.66	20.0	3.43
Bar charts	0.52	4.26	10.5	3.28
Trends	1.00	3.48	11.6	3.18
Faces	0.56	2.84	7.9	3.02

5.2 Gender Differences

Interestingly females made significantly fewer Type I errors on all media, but especially on the bar charts, and significantly fewer Type II errors too with the schematic faces and trend diagrams (Table II). The findings provide support for *H2* which extends beyond schematic faces to alternative forms of graphical display. Neither the differences in time nor confidence scores attributable to gender were significant.

The investigation of gender influences was extended beyond biological gender to consider the extent and influence of gender stereotyping (i.e. the degree to which males/females possessed the characteristics perceived to be typical of their gender). The 60-question BEM inventory instrument was administered to respondents and generated the matrix of Figure 1. Interestingly the number of females demonstrating a "female stereotype" was extremely low – providing confirmation of US practitioner findings (Davidson and Dalby, 1993) of attributes of independence, self-reliance and tough mindedness, more common among female accountants than among females generally.

Higher female scores (i.e. respondent closer to a female stereotype) were associated with fewer Type I errors when using both financial ratios and bar chart graphs. Higher male scores (i.e. respondent closer to a male stereotype) were associated with more Type II errors with the schematic faces and lower processing times with the bar charts. The findings provide further support for those already reported above in relation to biological gender differences.

5.3 Ambiguity tolerance

The "AT-20" test instrument measures tolerance of ambiguity with a 20-question instrument, to give possible scores varying between 0 (intolerant) and 20 (tolerant).

Table III details the ambiguity tolerance scores; 70 per cent of the whole group scored lower than 50 per cent ambiguity tolerance, showing a preference for certainty among respondents. There was little difference attributable to gender: 70 per cent of males, and 69 per cent of females scored lower than 50 per cent on the scale. Overall the findings for ambiguity tolerance did not support *H3*; the measure was not associated with the levels of accuracy observed for any of the decision making media.

5.4 Field dependence

The Group Embedded Figures Test (GEFT) was employed to measure field dependence, with respondents faced with 25 progressively more difficult geometrical figures in which they have to locate and specify another different geometrical figure. Table IV details the accuracy of outcomes for the GEFT figures.

With 48 per cent of males, compared to only 14 per cent of females, recording a perfect score on this test, the findings suggest a lower field dependency among males. However, no significant relationship between these outcomes and performance regarding accuracy, processing time or confidence levels on the four financial decision tasks was apparent. Thus there was no support from the experimental findings for *H4*.

Table II
Misclassification errors per person by gender

	Type I		Type II		Time (mins)		Confidence	
	M	F	M	F	M	F	M	F
Ratios	1.35	1.19	4.00	4.36	19.4	19.8	3.51	3.33
Bar charts	0.67	0.33	4.46	4.69	9.10	10.20	3.24	3.33
Trends	1.20	0.86	3.82	3.39	11.30	11.20	3.33	3.26
Faces	0.65	0.42	3.10	2.94	6.50	8.20	3.13	3.22

Figure 1
The BEM inventory for gender stereotyping

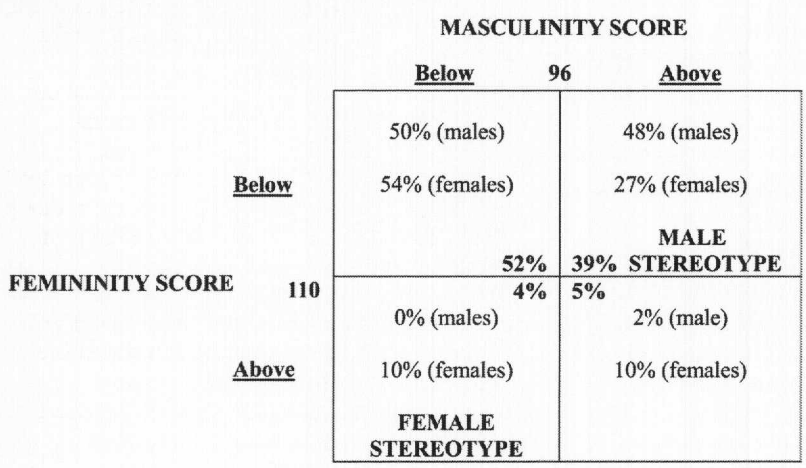

Table III
The "AT-20" ambiguity tolerance score

	Males (%)	Females (%)	Total (%)
Lowest ambiguity tolerance			
0-2	4	2	5
3-4	12	5	12
5-6	18	5	16
7-8	22	7	20
9-10	14	8	17
11-12	12	5	12
13-14	10	4	10
15-16	6	2	6
17-18	2	1	2
19-20	0	0	0
Highest ambiguity tolerance			

5.5 Cognitive style

Table V shows the outcome types from the Myers-Briggs instrument.

Table VI details the correlations between the MBTI dimensions and each of the decision quality measures (Type 1 errors, Type 2 errors, time and confidence) for each of the four processing media: financial ratios (FR), bar charts (BC), trend diagrams (TD) and cartoon faces (CF).

Correlations significant at the 0.05 level are asterisked. Fewer Type II errors when using the schematic faces are associated with individuals with higher scores on the J-P and S-N continua (i.e. associated with high J (judgment) and S (sensing) scores). Though significant, these findings do not support *H5*, the latter anticipating a facility with graphic displays to be associated with high N (intuition) and F (feeling) scores.

6. Conclusions

The experimental findings provide support for only *H1* and *H2*. Schematic faces and bar chart graphs produce superior performance to both financial ratios and trend diagrams in both decision accuracy and processing time, but there is no significant difference for confidence levels. Gender and gender-type are the only variables supported in the literature where a significant impact on decision outcomes is observed. Cognitive style, field dependence and tolerance for ambiguity appear to have a limited impact on outcomes. However, although more limited in its scope than anticipated, there is evidence to support more attention being devoted in the decision making process to the matching of data presentation media with the attributes of the decision maker. The potential task specificity of these outcomes remains an area for future research into management decision making.

Notes

1 Important task characteristics in information processing include task type and task complexity (Jarvenpaa and Dickson, 1988). Important subject characteristics can be grouped under four major categories: cognitive style, cognitive ability, personality variables and demographic variables (Benbasat and Taylor, 1982).

2 A potential problem exists in the use of schematic faces. Since certain facial features

are more salient than others, the particular mapping/assignment used to allocate variables to facial features may have an impact on the decision quality. Smith *et al.* (2002) addressed the importance of this issue. They varied the feature assignments, but found no significant difference in the decision performance.

3 Cognitive style is an individual's preference in cognition and perception while learning style (commonly measured by Dunn, Dunn and Price's (1989) Learning Style Inventory) is an individual's preference in perceiving, interacting with and responding to the learning environment. An individual's cognitive style (e.g. analytic/intuitive) thus affects aspects of his/her learning style (e.g. analytic/holist). Curry (1983) organised "style" into an "onion" and suggested its inner core is made up of personality models, leading to a second strata of information-processing models, and then to an outer layer of learning styles. Rayner and Riding (1997) explained the analogy between cognitive styles and learning styles.

4 The MBTI categorises individuals across two further dimensions, for which there is no literature to support an association with the decision-making tasks of this study: the E-I continuum, measuring extravert/introvert and the J-P continuum, measuring overall preference for judging/perceiving.

5 The financial data employed was that used by Smith and Taffler (1996) so providing a basis for comparability.

6 Where PBIT = profit before interest and tax; TA = total assets; TL = total liabilities; NW = net worth; QA = quick assets; CL = current liabilities; WC = working capital, and NCE = net capital employed.

7 Smith *et al.* (2002) suggest that in a task of this nature, feature assignment is relatively unimportant.

8 Respondents were instructed that any number of failed cases from 0 to 20 could be in the set, although a mixture of failed/healthy cases was more likely.

9 Different numbering systems were used on each test instrument to preclude cross-comparisons of individual outcomes. However, we still recognise that pre-conceived ideas of the number of failures in the set may be biased by decisions made with the first instrument.

10 There were no significant differences attributable to the work experience of the respondents, nor to the order in which the tasks were completed.

Table IV
GEFT figure scores

	Males (%)	Females (%)	Total (%)
High field dependency			
< 14	0	0	0
14-17	20	15	18
18-22	20	29	23
23	6	14	9
24	6	28	13
25	48	14	37
Low field dependency			

Table V
MBTI type table

	Sensation (S)		Intuition (N)		
	Thinking (T)	Feeling (F)	Feeling (F)	Thinking (T)	
Judgment (J)	ISTJ 24%	ISFJ 6%	INFJ 0%	INTJ 2%	Introversion (I)
Perception (P)	ISTP 7%	ISFP 3%	INFP 2%	INTP 2%	
Perception (P)	ESTP 1%	ESFP 5%	ENFP 3%	ENTP 5%	
Judgment (J)	ESTJ 22%	ESFJ 11%	ENFJ 0%	ENTJ 7%	Extroversion (E)

Table VI
Myers-Briggs scores and decision outcomes: correlation matrix

	E-I continuum	J-P continuum	S-N continuum	T-F continuum
FR 1	- 0.036	0.137	0.089	- 0.086
FR 2	- 0.129	- 0.168	- 0.048	- 0.081
FR TIME	- 0.017	- 0.125	- 0.130	- 0.127
FR CONF	- 0.180	0.077	0.047	- 0.007
BC 1	0.080	0.091	- 0.202	- 0.132
BC 2	- 0.050	- 0.132	- 0.085	- 0.155
BC TIME	0.146	- 0.194	- 0.053	- 0.104
BC CONF	0.261*	- 0.129	- 0.038	0.000
TD 1	- 0.149	0.144	0.108	- 0.038
TD 2	- 0.048	- 0.046	- 0.025	0.021
TD TIME	0.002	- 0.171	- 0.065	- 0.191
TD CONF	0.034	0.042	- 0.034	- 0.041
CF 1	- 0.186	0.001	- 0.051	0.113
CF 2	0.043	- 0.324*	- 0.270*	- 0.035
CF TIME	- 0.069	- 0.049	- 0.049	- 0.119
CF CONF	- 0.042	- 0.016	- 0.054	0.036

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