THE IMPORTANCE OF COGNITIVE STYLE IN INFORMATION RETRIEVAL TASKS

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ABSTRACT

The purpose of this project was to investigate the impact of user characteristics (e.g., cognitive style, professional field, age, gender, and educational expertise) on an information retrieval task. A laboratory experiment explored the effect of the data model representations (relational versus entity-relationship), query languages (SQL versus QBE) and user's characteristics (e.g. cognitive style) on query writing task performance. User characteristics were found to play a significant role in the experiment's participants regardless of their professional field. In particular, the wholist-analytic cognitive style dimension was significant for the query task completion time. However, the tendency to think visually or verbally did not impact on user performance. These findings have implications for education and training.

INTRODUCTION

Accounting and business decisions often require database applications to convert raw data into useful business information (Hayes and Hunton, 2000). Modern accounting information systems use relational databases (Hooper and Page, 1996). Accounting academicians and professionals generally agree that accountants and auditors must become proficient with information systems technology, such as database management systems (DBMS) and information retrieval techniques (Borthick, 1996), particularly so they will not need to rely as heavily on the expertise of computer professionals (Hooper and Page, 1996). The AICPA information technology section also has identified database technology as one of the top ten information technologies with which accountants must be familiar (Anonymous, 1994). In addition, the CPA exam recognizes the importance of Information Technology (IT) topics and focuses a large part of the Business Environment Concepts exam on IT subjects relating to business (AICPA, 2010).

Formerly, information systems (IS) professionals were responsible for query tasks on behalf of end-users (Borthick, 1992). Today, however, accounting system queries can be easily performed by end-users because current database technology is more user friendly (Hooper and Page, 1996). In order to perform these query tasks, these end-users (such as accountants, auditors, and managers) must understand both the database structure and the available query language (Leitheiser and March, 1996).

The availability of accounting data is communicated through the use of a database structure representation (Dunn and Grabski, 2002). This representation details the stored data items and their logical organization. Examples of such representations are the entity-relationship (ER) model and the relational model. Ability to access data of interest also requires knowledge of a database query language. Examples of such languages are query-by-example (QBE) and structured query language (SQL).

Prior research on end-user performance in query construction tasks has not resulted in clear conclusions about the effect of database representation type, query tool type, and user characteristics. According to Dunn and Grabski (2002), this is a relatively new research field and these factors should be studied further to determine their combined effects on query writing performance.

Users of accounting information are not homogeneous. Neither are the database technologies used in accounting information systems homogeneous. Different users possess particular user characteristics that can impact their performance in writing queries (e.g., age, gender, educational background, experience, and cognitive style).

Therefore, this study uses both accounting participants and MIS participants as a proxy for the groups of potential end-users. This is the first study to explicitly include user characteristics in the research model.

Only one study attempted to manipulate both the database structure representation and the query language (Chan et al., 1993). Similarly, the current study manipulates both the data model and the query language. No prior studies have investigated the interaction between the two factors or included user characteristics as part of the research model. The current study solves this problem by measuring user cognitive styles and analyzing the main effects as well as the interaction of the different factors affecting the end-user query performance.

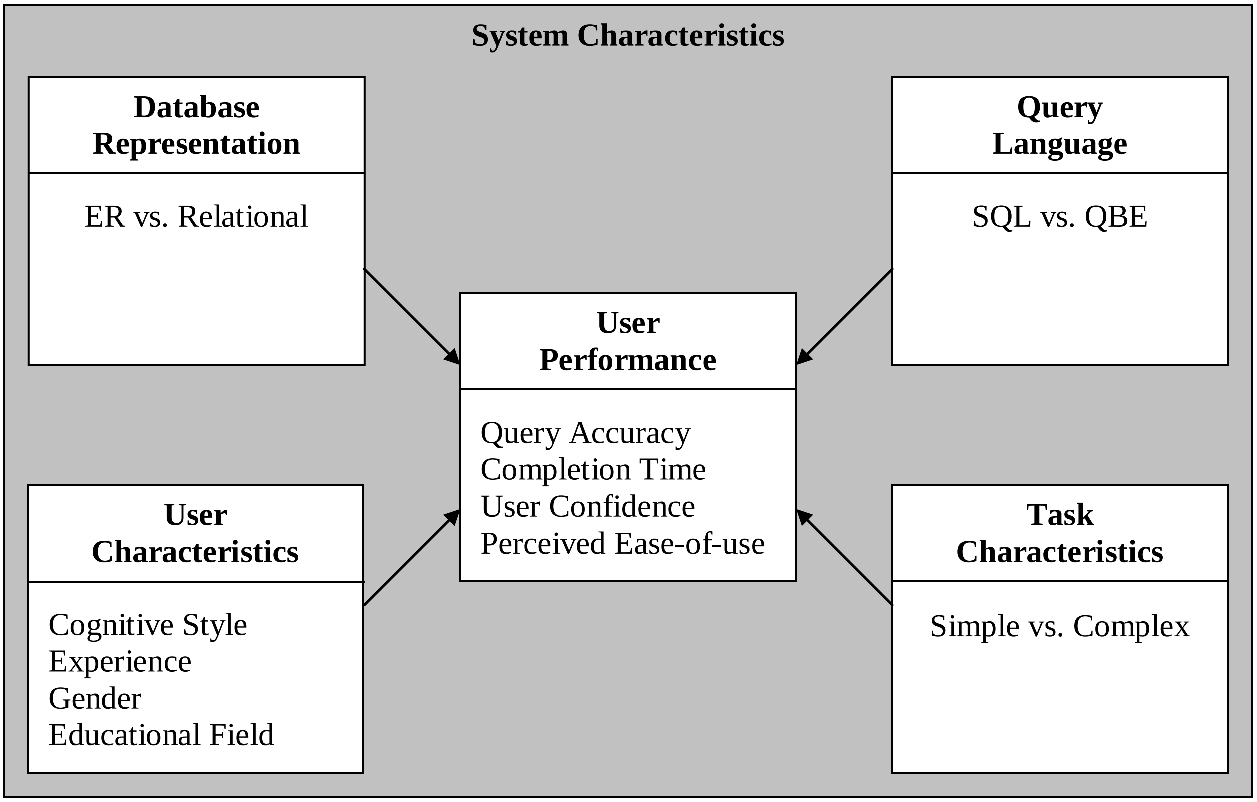
By better understanding how the end-user's cognitive style affects performance organizations can improve the way in which they train their employees on database concepts. By implementing separate sessions based on user's cognitive styles organizations would be able to more efficiently and effectively train employees. This would enable end-users to perform query tasks at a higher level with a lower investment in training. Also by understanding what effect cognitive styles can have on query performance professionals can improve their abilities by understanding what best suits their own particular. This study investigates the influence of database structure representation, query language, and user characteristics on user performance in the information retrieval process. In particular, this research project investigates the following research question: What is the impact of user characteristics (e.g., cognitive style) on the information retrieval task?

The rest of the paper is organized as follows. The next section describes the research model and cognitive styles literature and presents the research question. The third section explains the research methods. The fourth section reports the experimental results. The last section discusses the study results, conclusions, limitations and future research.

RESEARCH QUESTION

Based on the IS data model and query language literature, the current study developed a research model to explain user's performance in query writing tasks. Database representations, query languages, task characteristics, and user characteristics are identified as important factors influencing the user's performance (see Figure 1). Dunn and Grabski (2002) have suggested a similar research framework.

Figure 1
Query Writing Performance Research Model



Prior IS and decision making literature suggests that individual differences may explain differences in user performance (Hoffer, 1982; Gul, 1984; Reisner, 1981; Yen and Scamell, 1993). Benbasat and Dexter (1979) emphasize that knowledge of individual differences can improve information system design based on an understanding of user characteristics.

Cognitive styles refer to the preferred way an individual receives, stores, processes and transmits information (Pratt, 1980; Gul, 1984; Riding and Rayner, 1998). Cognitive style is described as a personality dimension which influences attitudes, values, and social interaction. A number of cognitive styles have been identified and studied over the years (e.g., verbalizer-imagery, Paivio, 1971; adaptor-innovator, Kirton, 1976; field dependent-independent, Witkin et al., 1971; assimilator-explorer, Kaufmann, 1989).

The embedded figure test (EFT; Witkin et al., 1971) is a well-known style construct. The EFT measures field independence versus field dependence. A person categorized as field independent perceives a field in terms of its component parts; parts are distinguished from the background (e.g., analytic). A person possessing the field dependence cognitive style perceives a field as a whole; parts are fused with the background (e.g., wholist). EFT has a major problem in distinguishing style from ability (Rayner and Riding, 1997). A major criticism of field independence as assessed by the EFT is that it is, at least in part, a measurement of ability. Grigerenko and Sternberg (1995) have argued that the EFT actually measures an individual's intellectual capacity. Grigerenko and Sternberg (1995, 209) concluded that "field dependence is a deficit rather than a style."

With the exception of the Witkin et al. (1971) field-dependence-independence style construct, few examples of the practical application of style in education, training, business or personal development can be found. Unfortunately, the Witkin et al. (1971) approach is apparently flawed because field-dependence-independence is correlated with ability (i.e., Riding and Rayner, 1998, 22-23). Both style and ability may affect performance on a given task. The basic distinction between them is that, as ability increases, performance on all tasks will improve, whereas the effect of style on performance for an individual will either be positive or negative, depending on the nature of the task.

Richardson (1977) developed the verbalizer-visualizer questionnaire (VVQ) to measure individual differences in cognitive style of imaging. Results of several studies (Edwards and Wilkins, 1981; Parrott, 1986; and Boswell and Pickett, 1991) demonstrated problems with the construct validity of the VVQ.

Riding and Cheema (1991) found over 30 labels relating to cognitive/learning style and, after reviewing the descriptions, correlations between them, methods of assessment, and effect on behavior, grouped them into two principal cognitive style dimensions; the wholist-analytic (WA) style dimension and the verbal-imagery (VI) style dimension. Further reviews by Rayner and Riding (1997), and Riding and Rayner (1998, chapter 2), support this conclusion. The two basic dimensions of cognitive style may be summarized as follows:

1. The WA style dimension is defined as whether an individual tends to organize information into wholes or parts.
2. The VI style dimension is defined as whether an individual is inclined to represent information during thinking verbally or in mental pictures.

Riding and his colleagues (Riding and Cheema, 1991; Rayner and Riding, 1997; Riding and Rayner, 1998) argue that the various cognitive style labels likely can be accommodated in a two-dimensional model of style. The two-dimensional model reduces cognitive style to a manageable construct and, if accurate, greatly enhances the potential of cognitive style to be considered in further research.

This approach resulted in the development of an instrument, the Cognitive Styles Analysis test (CSA thereafter; Riding, 1991), which provides relatively direct measures for each of the two fundamental dimensions. The rationale behind the CSA is described by Riding and Cheema (1991), Rayner and Riding (1997), Riding and Rayner (1998, 44-47).

Therefore, the CSA was used in this study to measure each participant's cognitive style. Based on this literature and the recommendation of prior IS research, the following research question is formulated.

RQ *What is the impact of end-user's characteristics (e.g., cognitive style) on performance in a query writing task?*

The main reason for formulating a research question instead of directional hypotheses is that this is the first study to include user characteristics as an important factor in user performance completing query writing tasks.

METHOD

The research question was investigated using a 2x2x2 factorial design laboratory experiment. Participants were undergraduate accounting and MIS students with no prior exposure to data modeling and query writing. Participants were randomly assigned to four training groups (ER/SQL, ER/QBE, Relational/SQL, and Relational/QBE) and they wrote eight queries using the query tool and database representation for which they were trained.

Experimental Protocol

The experiment was divided into four phases: registering, training, testing, and completing the CSA. Training, testing and CSA phases were conducted using computers. Participants received class credit for completing all parts of the experiment.

A web application was designed for the training and testing phases. Standard database management textbooks (e.g., McFadden et al., 1999; Pratt, 2001; Pratt and Adamski, 2002) were consulted to create the experimental materials, which were then reviewed by expert faculty. The final experimental procedures reflect their recommendations.

The training and testing phases required two different sessions separated a week apart. During the training phase, participants were given general instructions and a demographic questionnaire, which included age, gender, major, and level of experience with databases and query languages. Participants then received instruction on understanding a database structure representation, either ER or relational. Afterward, participants answered a series of multiple-choice questions to measure their understanding of database structure concepts. They also received explanatory feedback on each of their answers.

After the database structure representation training, participants received either QBE or SQL database query training, including topics such as simple retrieval, conditional selection, compound conditions, aggregate functions, sorting, grouping, and joining tables. These topics are the major parts of select queries. For each topic, participants viewed a sample query which illustrated the concepts.

At the end of each query topic, participants practiced their query procedures, receiving explanatory feedback with correct answers and explanations. According to Bonner and Walker (1994), practice with explanatory feedback increases procedural knowledge. At the end of training, a summary of the database structure representation characteristics and query language syntax and procedures was provided to each participant.

The testing phase consisted of four parts. First, the participants reviewed the training material. Second, they received a description of a database structure used by a company to store its sales order transactions and the relevant database structure representation they learned in the training phase. Third, the participants provided answers to eight different randomized queries using the query language they learned in the training phase. For each query, they indicated their confidence level regarding their answer and their opinion about the query complexity. Finally, participants completed a questionnaire measuring perceived ease-of-use.

A week after the testing phase, all participants completed the CSA to determine their cognitive style type. They also received a debriefing on the experiment and the correct answer for each query.

Independent Variables

Query language and data model are the between-subjects independent variables manipulated in this study. Query complexity is the within-subjects independent variable. Query complexity is based on Reisner's (1981) measurement scheme. A simple query requires the use of simple mapping, simple selection, and/or simple condition. A complex query requires using two or more tables to obtain the information, compounding criteria, and/or grouping.

Covariates

The participant's cognitive style, as measured by the CSA score, is included as a user characteristic variable. The CSA score indicates the position of an individual on each of the fundamental style dimensions (WA and VI) by means of a ratio. The CSA is explained fully in Riding and Rayner (1998, 44-46). The ratios typically range from 0.4 through to 4.0 with a central value around 1.0. Multiple studies have found cognitive style to be a significant predictor of performance on decision making and data modeling task (Dunn and Grabski, 2001; Gul, 1984; Hoffer, 1982). Age, gender, major, and experience also are included as covariates.

Dependent Variables

This study measured the following dependent variables: query accuracy, query task completion time, user confidence, and perceived ease of use. For query accuracy, query solutions were developed, and a specific grading protocol was applied by two independent graders. Each participant's query solution was evaluated relative to the correct solution by both graders. Individual scores from both graders were compared. Concerning inter-rater reliability, Cohen's (1960) Kappa statistics for each query (all >0.8) and overall kappa (0.91) reflect almost perfect agreement between the two raters (Landis and Koch, 1977).

Query task completion time was measured as seconds spent completing each query. User confidence was measured separately for each query using an 11-point scale anchored at 0% (extremely unconfident) and 100% (extremely confident).

Perceived ease of use was measured using five 7-point Likert scale questions adapted from Davis (1989). The original instrument and adaptations have been used in prior studies with high reported reliability (Cronbach's alpha has ranged from 0.83 in Batra et al. [1990] to 0.93 in Amer [1993]). Cronbach's (1951) coefficient alpha (0.84) assessed the level of internal consistency reliability for the perceived ease-of-use construct as comparable to prior studies.

RESULTS

One hundred sixty-one undergraduate students majoring in accounting and MIS participated in the experiment. Accounting students were registered in their first introductory AIS course. MIS students were registered in their first introductory database course. After completion of the experiment, data for 123 participants were usable for analysis. The reduction in the number of participants is attributable to technical problems when implementing the experimental materials and to some participants who did not fully complete the experiment nor provide answers to every question.

Demographic Statistics

Demographic data of the accounting participants for the four different groups are reported in table 1. The number of participants in the four groups is similar ($\chi^2 = 0.84$, p = 0.358). No differences in gender are found among the four groups ($\chi^2 = 1.28$, p = 0.733). In each of the four groups, female participants form the majority. Concerning age, data for a 47 year-old participant were deleted from the sample because of their large effect. After the elimination, no significant differences in age are found among the treatment groups (F = 3.02, p = 0.087). The means range between 20 and 22 years of age. Also, no significant differences among groups exist based on the number of courses taken prior to the experiment that deal with productivity software, programming languages, databases design, and databases software. The most experience that accounting participants received prior to the experiment is in the number of courses with productivity software as the main topic (one or two courses).

Table 1
Participant Demographic Statistics

Accounting		ER/SQL	ER/QBE	Rel/SQL	Rel/QBE	Test statistic	p-value
Number of participants		22	16	19	21	0.84[†]	0.358
Gender:	Male	10	6	7	11	1.28[†]	0.733
	[Female]	[12]	[10]	[12]	[10]		
Age:	Mean	20.5	20.87[*]	21.7	20.5	3.02[‡]	0.087
	(StDev)	(1.79)	(1.13)	(3.04)	(1.25)		
	[Median]	[20]	[21]	[21]	[20]		
Course #1[a]:	Mean	1.4	1.5	1.6	1.6	0.24[‡]	0.624
	(StDev)	(0.66)	(0.97)	(0.83)	(1.03)		
	[Median]	[1]	[1.5]	[2]	[2]		
Course #2[b]:	Mean	0.5	0.5	0.2	0.3	0.16[‡]	0.693
	(StDev)	(0.86)	(0.73)	(0.42)	(0.56)		
	[Median]	[0]	[0]	[0]	[0]		
Course #3[c]:	Mean	0.3	0.4	0.3	0.4	0.02[‡]	0.894
	(StDev)	(0.55)	(0.72)	(0.58)	(0.59)		
	[Median]	[0]	[0]	[0]	[0]		
Course #4[d]:	Mean	0.0	0.2	0.0	0.1	2.05[‡]	0.156
	(StDev)	(0.00)	(0.408)	(0.00)	(0.22)		
	[Median]	[0]	[0]	[0]	[0]		
WA CS[e]:	Wholist	4	4	4	6	3.92[†]	0.688
	Intermediate	7	2	7	7		
	Analytic	11	10	8	8		
VI CS[f]:	Verbalizer	7	5	3	9	10.03[†]	0.123
	Bimodal	5	9	7	5		
	Imager	10	2	9	7		

[a] Number of courses - main topic: productivity software
[b] Number of courses - main topic: programming languages
[c] Number of courses - main topic: databases design
[d] Number of courses - main topic: databases software
[e] Wholist-Analytic Cognitive Style
[f] Verbalizer-Imager Cognitive Style
[†] χ^2-statistic
[‡] F-statistic
[*] One observation with a value of 47 for age was deleted from the sample because of large effect on the sample. Including this data will change the mean (standard deviation) to 22.5 (6.62) and change F (p-value) to 3.96 (0.05)

Table 1 (cont.)
Participant Demographic Statistics

MIS		ER/SQL	ER/QBE	Rel/SQL	Rel/QBE	Test statistic	p-value
Number of participants		12	7	14	11	0.23[†]	0.632
Gender:	Male	8	5	12	7	1.88[†]	0.598
	[Female]	[4]	[2]	[2]	[4]		
Age:	Mean	20.3	20.7	22.0	21.2	0.43[‡]	0.518
	(StDev)	(1.56)	(1.50)	(4.49)	(2.14)		
	[Median]	[20]	[20]	[20]	[20]		
Course #1[a]:	Mean	1.1	1.0	1.3	0.9	0.31[‡]	0.582
	(StDev)	(0.79)	(0.82)	(0.73)	(1.04)		
	[Median]	[1]	[1]	[1]	[1]		
Course #2[b]:	Mean	2.9	2.3	2.6	3	2.91[‡]	0.096
	(StDev)	(0.90)	(0.76)	(1.22)	(0.89)		
	[Median]	[3]	[2]	[3]	[3]		
Course #3[c]:	Mean	0.1	0.3	0.1	0.4	0.00[‡]	0.950
	(StDev)	(0.29)	(0.49)	(0.36)	(0.67)		
	[Median]	[0]	[0]	[0]	[0]		
Course #4[d]:	Mean	0.0	0.1	0.1	0.1	1.12[‡]	0.296
	(StDev)	(0.00)	(0.38)	(0.36)	(0.30)		
	[Median]	[0]	[0]	[0]	[0]		
WA CS[e]:	Wholist	1	2	2	3	9.11[†]	0.168
	Intermediate	8	1	3	4		
	Analytic	3	4	9	4		
VI CS[f]:	Verbalizer	3	2	1	2	4.36[†]	0.628
	Bimodal	4	2	7	2		
	Imager	5	3	6	7		

[a] Number of courses - main topic: productivity software
[b] Number of courses - main topic: programming languages
[c] Number of courses - main topic: databases design
[d] Number of courses - main topic: databases software
[e] Wholist-Analytic Cognitive Style
[f] Verbalizer-Imager Cognitive Style
[†] χ^2-statistic
[‡] F-statistic

Table 1 also presents the demographic data for the four MIS groups. Nonparametric tests, to evaluate the equal sample sizes among the four groups, resulted in no significant differences in terms of number of participants ($\chi^2 = 0.23$, $p = 0.632$). No significant differences were found among the four groups based on gender, age, and prior educational experiences.

In contrast to the accounting participants, more MIS participants are males. Compared to the accounting students, MIS students have more programming background ($median_{course\#2,\ MIS} = 3$, $median_{course\#2,\ Acc} = 0$). This finding should impact participant performance in completing the query task. MIS groups who used SQL as a query tool may be more comfortable typing the SQL code than using the mouse. These differences in educational experience and gender between the accounting and MIS participants are the reason for separating the two groups when investigating the results.

Finally, table 1 reports the cognitive styles of the accounting and MIS participants. The data are reported for the WA cognitive style dimension and the VI cognitive style dimension.

Accounting and MIS participants are not different in terms of their WA cognitive styles (χ^2 = 0.756, p = 0.685). Overall, 47 percent of the accounting participants are analytics, compared to 23 percent that are wholists. Similar results are found for the MIS participants (46 percent analytics and 18 percent wholists). No differences between accounting and MIS participants exist based on their VI cognitive style (χ^2 = 2.684, p = 0.261). In term of their VI cognitive styles, the accounting groups are equally divided. More MIS students are imagers (48 percent) than verbalizers (18 percent).

CSA Construct Validity and Reliability

In considering psychological assessments, the most important features of a test are its construct validity and its reliability. With research into the CSA, the primary emphasis has been to demonstrate its validity. Considerable evidence is now available to support the validity of the CSA. This was previously reviewed by Riding and Rayner (1998). The CSA is also culture-free in nature, and it has been used in a number of countries (Riding and Rayner, 1998).

An indication of reliability is built into the CSA. The CSA output shows both a speed index and the percentage correct for each of the dimensions of style. These indices are an indication of how carefully individuals completed the CSA, and whether they were able to complete it. Table 2 reports on the means (standard deviation) of these indices for each manipulation group, combining accounting and MIS participants together. The speed indices for the WA cognitive style and VI cognitive style across all manipulation groups are less than 10. This finding suggests that the participants took the test seriously. The percentage correct is also above 70 percent. This indicates that the CSA is reliable

Table 2
CSA Construct Reliability

Variable	Group	Mean	Median	StDev	Minimum	Maximum
WA Speed Index	ER/SQL	5.48	5.14	1.67	2.81	8.89
	ER/QBE	5.47	5.06	1.72	3.06	8.27
	Rel/SQL	5.65	5.16	2.19	2.33	12.13
	Rel/QBE	5.74	5.20	1.95	1.96	9.23
VI Speed Index	ER/SQL	3.25	3.09	0.79	1.66	5.39
	ER/QBE	3.02	2.94	0.80	1.50	4.99
	Rel/SQL	3.23	2.93	0.95	2.16	6.07
	Rel/QBE	3.17	2.88	0.88	1.55	4.92

Table 2 (cont.)
CSA Construct Reliability

Variable	Group	Mean	Median	StDev	Minimum	Maximum
WA Percentage Correct	ER/SQL	97	98	4	85	100
	ER/QBE	97	98	4	88	100
	Rel/SQL	98	98	2	93	100
	Rel/QBE	97	98	5	80	100
VI Percentage Correct	ER/SQL	93	94	5	79	100
	ER/QBE	91	92	5	79	98
	Rel/SQL	93	94	6	79	100
	Rel/QBE	91	93	7	60	98

ANOVA Results

The research question was analyzed using a repeated measures general linear model. The factors data model and query language are crossed factors while complexity is a repeated measures factor. User characteristics defined by age, gender, experience, and cognitive styles are included in the model as covariates. Experience is the total number of courses with productivity software, programming languages, database design and software as topics. Query accuracy, task completion time, user confidence, and perceived ease-of-use were each analyzed separately.

Statistical analysis was computed first by including both accounting and MIS participants as part of the sample. Major was one of the covariates and was significant for query accuracy, user confidence, and perceived ease-of-use ($p = 0.003$, $p = 0.001$, $p<0.001$, respectively). General linear model was computed to see the existence of a three-way interaction among data model, query language, and major. Only the three-way interaction is significant for perceived ease-of-use ($F = 5.88$, $p = 0.017$). The following paragraphs present the results for each type of participant treated separately.

Table 3, panel A presents ANOVA results with query accuracy as the dependent variable for the accounting participants and the MIS participants. For the accounting participants, no interaction or main effects for data model and query language were found ($F = 0.14$, $p = 0.706$). Gender and experience have a marginally significant impact on the complex query accuracy performance ($F = 3.03$, $p = 0.086$; $F = 2.92$, $p = 0.092$, respectively). For the MIS participants, the data model and query language interaction effect was significant ($F = 5.63$, $p = 0.023$ for simple queries; and $F = 3.90$, $p = 0.057$ for complex queries). Only gender was significant at the 0.055 level when MIS participants completed complex queries. No cognitive styles had a significant impact on query accuracy performance.

Table 3
Analysis of Variance

Panel A – Query Accuracy as Dependent Variable

		Task Complexity							
		Simple Queries				*Complex Queries*			
Source	d.f.	*F*-Statistic		*p*-value		*F*-Statistic		*p*-value	
Independent Variables:		Acc	MIS	Acc	MIS	Acc	MIS	Acc	MIS
Data Model	1	0.04	1.69	0.839	0.202	1.95	1.54	0.167	0.224
Query Language	1	1.91	3.62	0.172	0.066*	1.74	5.05	0.192	0.031**
Data Model x Query Language	1	0.14	5.63	0.706	0.023**	1.17	3.90	0.283	0.057*
Covariates:									
Age	1	1.04	0.83	0.312	0.368	0.81	0.61	0.371	0.438
Gender	1	2.57	1.38	0.113	0.248	3.03	3.95	0.086*	0.055*
Experience	1	0.47	0.18	0.494	0.676	2.92	1.25	0.092*	0.271
WA Cognitive Style	1	1.34	0.02	0.252	0.880	0.14	0.61	0.709	0.440
VI Cognitive Style	1	0.65	0.37	0.421	0.547	1.85	1.07	0.178	0.309

Panel B – Time Completion as Dependent Variable

		Task Complexity							
		Simple Queries				*Complex Queries*			
Source	d.f.	*F*-Statistic		*p*-value		*F*-Statistic		*p*-value	
Independent Variables:		Acc	MIS	Acc	MIS	Acc	MIS	Acc	MIS
Data Model	1	0.42	0.71	0.521	0.407	0.34	0.90	0.565	0.349
Query Language	1	17.12	29.21	0.000**	0.000**	5.30	11.46	0.024**	0.002**
Data Model x Query Language	1	0.07	8.79	0.794	0.006**	1.31	0.19	0.256	0.663
Covariates:									
Age	1	0.56	2.53	0.457	0.121	0.52	0.47	0.475	0.497
Gender	1	0.89	0.33	0.348	0.568	0.42	0.55	0.521	0.464
Experience	1	0.42	2.57	0.519	0.118	0.68	0.05	0.411	0.817
WA Cognitive Style	1	8.03	5.06	0.006**	0.031**	4.33	5.50	0.041**	0.025**
VI Cognitive Style	1	0.12	0.35	0.734	0.558	3.10	0.01	0.083*	0.920

Panel C – User Confidence as Dependent Variable

		Task Complexity							
		Simple Queries				*Complex Queries*			
Source	d.f.	*F*-Statistic		*p*-value		*F*-Statistic		*p*-value	
Independent Variables:		Acc	MIS	Acc	MIS	Acc	MIS	Acc	MIS
Data Model	1	1.90	0.00	0.173	0.957	0.54	0.90	0.465	0.349
Query Language	1	0.65	0.06	0.422	0.803	2.47	11.46	0.121	0.002**
Data Model x Query Language	1	0.04	8.91	0.846	0.005**	0.88	0.19	0.351	0.664
Covariates:									
Age	1	1.04	2.08	0.312	0.159	0.17	0.47	0.685	0.497
Gender	1	1.03	0.23	0.314	0.635	0.47	0.55	0.494	0.464
Experience	1	2.96	0.43	0.090*	0.515	0.75	0.06	0.388	0.817
WA Cognitive Style	1	0.62	0.00	0.433	0.996	1.47	5.51	0.230	0.025**
VI Cognitive Style	1	0.09	0.38	0.761	0.543	0.89	0.01	0.349	0.919

* Significant at 0.10 level.
** Significant at 0.05 level.

Table 3 (cont.)
Analysis of Variance

Panel D – Perceived Ease-of-Use as Dependent Variable

Source	*d.f.*	*F*-Statistic Acc	*F*-Statistic MIS	*p*-value Acc	*p*-value MIS
Independent Variables:					
Data Model	1	0.03	1.16	0.870	0.289
Query Language	1	0.64	0.05	0.427	0.833
Data Model x Query Language	1	1.87	13.19	0.176	0.001**
Covariates:					
Age	1	0.01	0.00	0.924	0.957
Gender	1	6.92	0.15	0.011**	0.697
Experience	1	5.10	1.02	0.027**	0.320
WA Cognitive Style	1	10.83	0.90	0.002**	0.348
VI Cognitive Style	1	0.38	0.14	0.541	0.709

* Significant at 0.10 level.
** Significant at 0.05 level.

Query task completion time ANOVA is reported in table 3, panel B for accounting participants and MIS participants. For the accounting participants, no interaction effect was found. A main effect of query language was observed for both levels of query complexity (F = 17.12, p < 0.001; and F = 5.30, p = 0.024, respectively). The WA cognitive style is significant at the 0.05 level for both type of queries. The VI cognitive style is marginally significant for complex queries (F = 3.10, p = 0.083). For the MIS participants, an interaction effect was found for simple queries (F = 8.79, p = 0.006) and a main effect of query language for complex queries (F = 11.46, p = 0.002). Similar to the accounting participants, the WA cognitive style was significant at the 0.05 level for both levels of complexity.

Table 3, panel C reports the ANOVA with user confidence as the dependent variable for both types of participants. For the accounting participants, the results do not show any interaction and main effects for both level of complexity. Only experience is marginally significant at the 0.1 level. For the MIS participants, the data model and query language interaction effect was found to be significant for simple queries (F = 8.91, p = 0.005). None of the user characteristics was found to have an effect on the user confidence for writing simple queries. For complex queries, a main effect of query language was observed (F = 11.46, p = 0.002). The WA cognitive style played a role in the user confidence (F = 5.51, p = 0.025).

ANOVA with perceived ease-of-use as the dependent variable is reported in table 3, panel D for accounting and MIS participants. No interaction effect or any main effect was observed for the perceived ease-of-use for the accounting participants. Gender, experience, and WA cognitive style were found to have a significant effect on the perceived ease-of-use (F = 6.92, p = 0.011; F = 5.10, p = 0.027; F = 10.83, p = 0.002, respectively). Table 3, panel D shows an interaction effect of data model and query language for the MIS participants (F = 13.19, p = 0.001). None of the MIS user characteristics covariates were found to be significant.

DISCUSSION AND CONCLUSION

User characteristics were found to play a significant role in the experiment's participants regardless of their professional field. In particular, the WA cognitive style dimension was significant for the query task completion time. Table 4 shows the mean (standard deviation) time for each accounting manipulation group and for each WA cognitive style. Table 5 shows the same type of information for the MIS participants. Regardless of the level of complexity, the wholist cognitive style groups completed the query task consistently faster than the analytic cognitive style groups.

Table 4
Accounting Participants Query Task Completion Time per WA Cognitive Styles

Panel A: Complexity Level – Simple Queries			
	WA Cognitive Style Dimension		
Groups	Wholist	Intermediate	Analytic
ER/SQL	05:42 (00:51)	07:08 (02:31)	09:04 (01:46)
ER/QBE	04:45 (01:11)	04:46 (02:24)	06:07 (05:05)
Rel/SQL	07:24 (02:08)	07:28 (03:23)	09:50 (02:46)
Rel/QBE	03:59 (01:41)	05:47 (01:17)	05:49 (02:16)
Overall	05:18 (01:56)	06:37 (02:32)	07:44 (03:36)
Panel B: Complexity Level – Complex Queries			
	WA Cognitive Style Dimension		
Groups	Wholist	Intermediate	Analytic
ER/SQL	09:14 (03:52)	11:41 (04:37)	12:32 (03:13)
ER/QBE	09:47 (03:10)	12:11 (03:55)	09:50 (04:49)
Rel/SQL	13:40 (06:09)	12:17 (06:19)	14:20 (03:17)
Rel/QBE	05:55 (02:38)	09:44 (03:54)	11:24 (06:13)
Overall	09:14 (04:40)	11:19 (04:46)	11:57 (04:35)

Table 5
MIS Participants Query Task Completion Time per WA Cognitive Styles

Panel A: Complexity Level – Simple Queries			
	WA Cognitive Style Dimension		
Groups	Wholist	Intermediate	Analytic
ER/SQL	07:15 (00:00)	06:12 (01:27)	06:22 (00:54)
ER/QBE	04:17 (00:44)	03:45 (00:00)	06:00 (03:01)
Rel/SQL	07:20 (00:46)	06:55 (01:44)	08:59 (02:25)
Rel/QBE	03:25 (00:03)	03:24 (01:10)	04:20 (00:59)
Overall	05:06 (01:55)	05:29 (01:56)	07:04 (02:47)
Panel B: Complexity Level – Complex Queries			
	WA Cognitive Style Dimension		
Groups	Wholist	Intermediate	Analytic
ER/SQL	10:16 (00:00)	12:15 (02:52)	13:01 (01:55)
ER/QBE	05:20 (02:42)	05:05 (00:00)	11:53 (05:00)
Rel/SQL	14:37 (04:01)	12:01 (02:01)	14:53 (05:04)
Rel/QBE	09:25 (01:30)	07:05 (04:35)	10:59 (03:04)
Overall	09:48 (04:03)	10:28 (03:58)	13:13 (04:24)

The VI cognitive style is marginally significant for the accounting end-users, only for complex queries. Running the general linear model with data model, query language, and VI cognitive style as independent variables, produces an interaction between the data model and VI cognitive style ($F = 4.22$, $p = 0.019$) and the main effect for the query language is still significant ($F = 6.99$, $p = 0.010$). The accounting verbalizer end-users using the relational model completed the complex tasks faster than the accounting imager end-users using the relational model ($mean_{relational,verbalizer} = 8:15$ and $mean_{relational,imager} = 14:16$). The accounting imagers using the ER model completed the task faster than the accounting verbalizer using the ER model ($mean_{ER,imager} = 10:46$ and $mean_{ER,verbalizer} = 11:49$). Verbalizers prefer information presented as words (relational model) whereas imagers represent information better with pictures (ER model). This finding indicates that matching individual end-users' preferred VI cognitive styles to the preferred database structure representation improves the task efficiency in term of completion time. Accounting DBMS should be documented so that users can reference the database structure representation that best fits their preferred cognitive style.

The WA cognitive style also affects the MIS end-user's confidence level. Overconfidence may explain the current findings, but additional research needs to be done to investigate this issue. The WA style dimension is defined as whether an individual tends to organize information into wholes or parts. Wholist groups, regardless of their educational background, consistently completed the query writing task faster than the analytic groups. This finding is not surprising because the wholist personalities can approach the problem as a whole, see the big picture, and quickly find the location of the information needed for the database query. The analytic personalities spend too much time looking at individual parts of the problem. The separation of the whole database structure representation into its individual tables means that one subset of the whole problem gets the user's attention at the expense of the other problem elements. Hence its overall importance is exaggerated.

This finding has implications for learning and training. Learning can be made more effective both by matching cognitive style to materials and presentation mode and structure, and through strategy development to maximize style effectiveness (Riding and Sadler-Smith, 1997; Riding and Rayner, 1998, chapter 4). Training can be more effective and will result in cost savings for organizations by implementing separate trainings for each cognitive style represented in the training group. Cognitive style also can be used in personal and career development since it is related to job suitability and occupational stress. The wholist cognitive style seems to be better suited to query writing tasks than the other cognitive styles. To help the trainee to form an appropriate structure of the database, a graphical representation may be provided as an aid. Riding and Sadler-Smith (1992) investigated the effect on learning performance of overviews and organizers in a computer-based learning package. The authors suggest that analytics may benefit from a global web-type organizer showing the interrelationships and horizontal linkages. Thus, the ER model could be more useful to analytic cognitive style end-users.

The study also reveals that the tendency to think visually or verbally does not impact on the user performance. VI cognitive style is not significant across dependent variables. Riding and Sadler-Smith (1992) suggest a model for the interaction of cognitive style, learning performance and the mode of presentation (images versus text). Imagers are expected to benefit more than verbalizers from the presentation of information in a diagrammatic form (e.g., ER model and QBE language). Verbalizers are expected to benefit more than imagers from a textual presentation (e.g., relational model and SQL language). When the trainee receives and uses information that is not congruent with its cognitive style, then learning performance is likely to be impaired. The current study does not support this theory for the mode of presentation.

This study contributes to both the academic arena and the professional world. This research extends the literature by expanding the research model used. As prior research has recommended, user characteristics, such as cognitive style and professional skills, are explicitly included in the research model, where these had been ignored before. Different combinations of database structure representation and query language are best suited depending on the measure of performance used and on the user characteristics. There are implications of these results in the professional world. When organizations better understand the need to match the method of training to fit the cognitive style of the trainees, they will be able to reduce costs and increase results, which in turn increase the return on the investment made in the training. Also, professionals who struggle with database technology can improve their query performance by understanding their own cognitive style and focusing their efforts on methods that are compatible.

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