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User Preference Modeling for Customised Dynamic Electronic Catalogs Generation Based on Web Shoppers' Brain Hemisphericity/Cognitive Style

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ABSTRACT

This study examined the impact of online shoppers' brain hemisphericity/ (cognitive style) on their preference for different aspects of information presentation via electronic catalogs. Two instruments were used to measure participants' cognitive styles/brain orientations. Pearson's correlation indicates that verbal and visual scores obtained by using two different questionnaires are congruent. One e-commerce survey instrument was used to measure user preferences for different features of electronic catalogs. One-way ANOVA *analysis has been conducted to find out whether different* VARK *(visual, auditory, read/write, and kinesthetic) score groups differ significantly based on their preference for different aspects of information presentation via electronic catalogs.* ANOVA *results indicate that Web shoppers' preference for text-oriented catalogs, visually-oriented catalogs, audio enabled catalogs, customisable animated catalogs, virtual trial, and online shopping differs significantly. In addition to* ANOVA*, regression analysis has also been conducted to reaffirm the findings of the* ANOVA *analysis. As expected, most of the findings in regression analysis are inline with the* ANOVA *results.*

ABSTRAK

Kajian ini meneliti kesan hemisfera otak (gaya kognitif) pembeli dalam talian terhadap kecenderungan mereka untuk pelbagai aspek persembahan maklumat melalui katalog elektronik. Dua alat pengukur telah digunakan untuk mengukur stail kognitif dan orientasi otak peserta. Korelasi Pearson menunjukkan bahawa skor lisan dan visual yang diterima dengan menggunakan dua soal-selidik yang berbeza adalah selaras. Satu alat ukur tinjauan e-komers telah digunakan untuk mengukur kecenderungan pengguna untuk ciri-ciri katalog elektronik yang berlainan. Analisis ANOVA *sehala telah dilaksanakan untuk mengetahui sama ada skor kumpulan* VARK *(visual, audio, membaca/menulis, dan kinetik) yang berbeza menunjukkan perbezaan signifikan berdasarkan kecenderungan mereka untuk aspek-aspek persembahan maklumat melalui katalog elektronik. Keputusan* ANOVA *menunjukkan pembeli-belah Web*

mempunyai kecenderungan untuk katalog berorientasikan teks, katalog berorientasikan visual, katalog audio, katalog beranimasi mengikut kebiasaan, percubaan maya, dan pembeli-belah dalam talian berbeza secara signifikan. Tambahan kepada ANOVA*, analisis regresi telah dilaksanakan untuk mengesahkan lagi dapatan analisis* ANOVA*. Seperti yang telah dijangkakan, sebahagian besar dapatan analisis regresi adalah selaras dengan keputusan* ANOVA*.*

INTRODUCTION

Electronic commerce is becoming more popular with the advancement in multimedia transfer through the World Wide Web (WWW). We have already seen extensive use of the Web for providing information on product and services via electronic catalogs. These catalogs allow users to shop in virtual malls, browse a library or car dealer's collection, and place an order, without leaving home or office. However, most of the Web-based electronic catalogs are static in nature, and are not able to be tailored to the individual user's knowledge, needs, abilities or preference (Milosavljevic and Oberlander 1998). This may limit the usefulness of the catalogs because users may get lost in hyperspace or may not understand how one particular product meets their needs. In order to resolve this problem, the online sellers may have to provide multiple versions of documents, or documents with varying levels of descriptions for all the conceivable questions a user might have.

Researchers believe brain hemisphericity has significant influence on human information processing preference and decision-making. The purpose of this research is to determine whether brain hemisphericity influences the preference for information presented via electronic catalogs. If supported, this finding may lead us to develop dynamic catalogs based on the users' brain orientation or preference. Some technical possibilities are also discussed to eliminate the difficulties related to information presentations via electronic catalogs. Implementations of these technologies will make the online shopping experience more convenient for Web shoppers.

BRAIN HEMISPHERICITY AND COGNITIVE STYLE

Considerable evidences support the functional asymmetry of the human brain (Bryden 1982). Data from numerous experiments suggest that the left hemisphere tends to be associated with sequential and analytic operations. On the other hand, right hemisphere includes spatial and holistic operations, and such skills relate to stimulus integration (visual, tactile and auditory). Even though one side of the brain may be dominant for an individual, brain hemispheres are not functionally independent. It is perhaps more accurate to think of the hemispheres as working collaboratively and sharing in the processing of stimuli (Bogen 1973). Levy (1985) in his article '*Right Brain, Left Brain: Fact or Fiction*' described how in the process of reading, the right hemisphere might play a special role in decoding visual information, maintaining an integrated story structure, appreciating human and emotional content, deriving meaning from past associations and understanding metaphors. The left hemisphere plays a dominant role in understanding syntax, translating written words into phonetic representations and deriving meaning from complex relations among work concepts and syntax. Although we all do both, there exist differences in individuals' skill and preference that affects their decision-making process (Ariely 2000).

Brain Hemishericit, Cognitive Style, and Decision-Making

After reviewing many researches on split-brain experiments and subsequent studies of hemisphericity and lateral dominance, Smith (1984) concluded that clear relationship exists between left and right hemisphere modes of information processing and certain aspects of decision-making. Ornstein (1973) mentioned that the cerebral cortex of the brain is divided into two hemispheres, joined by a large bundle of interconnecting fibers called corpus callosum. The right side of the cortex primarily controls the left side of the body, and the left side of the cortex largely controls the right side of the body. The structure and function of these two 'half-brains' influence the two modes of consciousness. Left hemisphere is predominantly involved with analytic thinking, especially language and logic. This hemisphere seems to process information sequentially that is necessary for logical thoughts (Ornstein 1973). The right hemisphere, by contrast, appears to be primarily for our orientation in space, artistic talents, bodily awareness and recognition of faces. It processes information more diffusely than the left hemisphere does, and integrates material in a simultaneous, rather than linear fashion (Ornstein 1973).

A comprehensive review of research in cognitive psychology has indicated that people exhibit significant individual differences in cognitive processing styles that they adopt in problem solving and other similar decision-making activities (Robertson 1985). As for individual differences, different researchers have different definitions and conduct research from different perspectives accordingly. However, findings from both qualitative and quantitative research have indicated several consistent major dimensions of individual differences (Dunn et al. 1981). Of these dimensions, cognitive style is a major one. The construct 'cognitive style' was originally proposed by Allport (1937), referring to an individual's habitual or typical way of perceiving, remembering, thinking, problem solving and information processing. Since then, especially in the last few decades, there has been considerable research in this area and psychologists have extensively investigated cognitive style. Messick (1976) identified as many as 19 cognitive styles. Smith (1984) also tabulated at least 17 learning style inventories.

There are many different definitions of cognitive style. Riding et al. (1993) termed cognitive styles as "a fairly fixed characteristic of an individual." Summarising different definitions, we can refer to cognitive styles as individual's consistent and characteristic predispositions of perceiving, remembering, organising, processing, thinking and problem solving. Different researchers emphasise different aspects of cognitive styles. There are various terms encountered in the literature related to this area. These terms include deep-elaborative versus shallow-reiterative (Schmeck 1983), divergent versus convergent (Hudson 1966), field dependence versus field independence (Witkin 1962), impulsive versus reflectivity (Kagan 1965), objective versus nonobjective (Leithwood & Montgomery 1982), right versus left-brained (Torrance & Rockenstein 1988), risk-taking versus cautiousness (Kogan 1971), scanning versus focusing (Gardner 1961), verbaliser versus imager (Riding & Taylor 1976), verbaliser versus visualiser (Richardson 1977), visual versus haptic perceptual type (Lewenfeld 1945); holist versus analytic (Peters 1977), and holist versus serialist (Pask 1972).

In most situations, cognitive styles and learning styles are used interchangeably. Generally, cognitive styles are more related to theoretical or academic research, while learning styles are more related to practical applications. A major difference between these two terms is the number of style elements involved. Specifically, cognitive styles are more related to a bipolar dimension while learning styles are not necessarily either/or extremes. Cognitive/learning styles measures conventionally lie somewhere between aptitude measures and personality measures. In addition, cognitive/learning styles in literature have been viewed in three major respects; structures, process, or both structure and process (Wilson 1981).

One of the most important outcomes of the human brain orientation/ cognitive style is the sensory modality preference. According to Bissell et al. (1971), a sensory modality is a system that interacts with the environment through one of the basic senses. The most important sensory modalities are visual, read/write, auditory and kinesthetic. The concept of sensory preference can be traced back to Galton (1883). According to his research, visual imagery is infrequent among scientists and seems to be incompatible with scientists' abstract thinking. Later, Bartlett (1932) found similar results. In order to provide relatively comprehensive information about the distinguishing features of verbal and visual thinkers, Smith (1964) published his spatial ability. Another term similar to verbaliser versus visualiser is verbaliser versus imager cognitive style, which was proposed by Riding and Buckle (1990). Riding and Douglas (1993) supported this dimension. According to these researchers, the imagers are better in performance than the verbalisers in the text-plus-picture condition, while the verbalisers are better than the imagers in the text-plus-text conditions. In addition, the imagers more often use diagrams to illustrate their answers than the verbalisers.

Electronic product catalogs provide shoppers with virtual experience. Through virtual experiences, electronic catalogs can generate certain stimuli for the Web shoppers'. As soon as a stimulus is received, human brain begins to "assemble" a learning process to respond to the stimuli. Unless this is a novel stimulus, it is highly likely that the human will call on existing mental models (verbal or visual), or models and knowledge representing similar or identical stimuli (Spence 1995). Spence (1995) argued that, at this stage, human cognition could either interact with learning process in the form of 'making sense' of the stimulus and extracting information which is useful, or interact with decision process to develop a response and decide whether the response is sufficiently developed to execute.

ELECTRONIC CATALOGS

Electronic catalog refers to online display and descriptions of products and services. Electronic cataloging is a special form of creating visual display that provides strong visual connection between human and computer, starting with the display that provides visual stimuli to the eye (Alt and Noda 1998). One goal of the electronic display/catalog research is to match the information output of catalogs to the information capacity of human visual system (HVS), so that humans can process those information efficiently to make their buying decisions. Too little information from the display slows down the human-computer interaction, while sending too much information from the display than the HVS can absorb is, at best, poor engineering (Wullert and Nelson 1997). Most of the time, information overload causes hindrance for decision-making. Therefore, this study aims to find out whether human cognitive styles have any impact on Web shoppers' preference for presenting information via electronic catalogs. A definitive answer to the following research question will help catalog designers to design customised catalogs for Web shoppers' based on their cognitive preferences.

RESEARCH QUESTION

The above discussion on brain hemisphericity, cognitive style, decision-making, and electronic catalogs indicates potential relationship between Web shoppers' brain hemisphericity/cognitive style and their preference for different features of electronic catalogs (e.g. 3-D versus 2-D catalogs, visually-oriented catalogs, text-oriented catalogs, etc.). A definitive answer to the research question '*Is there a relationship between Web shoppers' brain hemisphericity/cognitive style and their preference for different features of electronic catalogs?*' will help catalog designers to design customised catalogs for Web shoppers' based on their preferences.

Hypotheses

In this study, we examined the impact of Web shoppers' brain hemisphericity/ cognitive style on their preference for presenting information via electronic catalogs. The following hypotheses are proposed to test the potential relationships assumed by the above research question.

H_1 : There is a relationship between Web shoppers' brain hemisphericity/ cognitive style and their preference for different aspects of information presented via electronic catalogs.

H_{1a} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for text-oriented catalogs.

H_{1b} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for visually-oriented catalogs.

H_{1c} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for 2-D versus 3-D catalogs.

H_{1d} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for including animation in catalogs.

H_{1e} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for including audio description in catalogs.

H_{1f} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for including custom animation in catalogs.

H_{1g} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for virtual trial of the products.

H_{1h} : Web shoppers' brain hemisphericity/cognitive style has significant influence on their preference for online shopping.

Methodology

The overall approach taken to empirically test the relationships implied by the research model and the consequent hypotheses was a field study using a survey methodology for data collection.

Sample

Data were collected from student subjects enrolled at a large Southwestern state university in the United States. In this case, convenience sampling strategy was used to collect data. Students enrolled in a junior level Information Systems course (BCIS 2610) in the college of business were surveyed. This target sample is appropriate for our study for various reasons. First, this course is required for all college of business students, as well as, for many other majors outside the college of business. Thus, it represents a cross-section of wide-range of majors in the university. Second, a significant portion of the students at this university is non-traditional students (full-time working people who take one or two courses per semester) who represent different age groups. Finally, because the university is located near a major metropolitan area, most of the students are very familiar with Internet and Internet-based commerce. Survey participants were instructed to take the survey as candidly as possible, that there would be no right or wrong answers. Eighty five percent of the survey participants answered that they had shopped online at least once. Each participant received extra credit for participation. Of the 186 participants, 141 answered all three questionnaires, representing 75.80% response rate. No significant difference was found between male and female demographics (see Table 1).

TABLE 1. Survey participants' demographic information

All Participants				
	Mean	Std. Dev	Median	Range
Sex (M=1, F=2)	1.48	0.50	1.00	1-2
Age	23.73	4.96	22.00	17-43
GPA	2.60	1.01	2.75	0-3.75
Level (FR=1, SO=2, JR=3, SR=4, GR=5)	3.34	0.87	3.00	1-5

	All Participants
Employment:	
Not employed (0)	28.4%
Employed (1)	71.6%
Average length of employment (months)	33.25
Ethnicity:	
Asian (0)	16.7%
Black (1)	11.7%
Hispanic (2)	6.2%
White (3)	59.3%
Other (4)	6.2%
Major:	
Accounting (0)	11.7%
BCIS/IT (1)	30.9%
FINA/REAL (2)	12.3%
LOGI/MKTG (3)	17.9%
MGMT/POM (4)	13.0%
Other (5)	14.2%

INSTRUMENTS

Three separate questionnaires had been used for the study. The first questionnaire was VARK questionnaire. The acronym VARK stands for Visual, Aural, Read/Write (verbal) and Kinesthetic sensory modalities that are used for learning information. Fleming and Mills (1992) suggested four categories that seemed to reflect the experiences of their students. It is a short, simple inventory that has been well received because its dimensions are intuitively understood and its applications are practical. It has helped people understand brain orientations measured. Visual (V) preference includes the depiction of information in charts, graphs, flow charts, symbolic arrows, circles, hierarchies and other devices. Aural (A) perceptual mode describes a preference for information that is 'heard.' People with this modality report that they learn best from lectures, tutorials, tapes, and talking to other people. Read/Write (R) refers to preference for information displayed as words. By definition, Kinesthetic (K) modality refers to the perceptual preference related to the use of experience and practice (simulated or real). Although such an experience may invoke other modalities, the key is that the person is connected to reality, "either through experience, example, practice or simulation" (Fleming and Mills 1992).

The second questionnaire was an e-commerce survey questionnaire which consisted of 10 questions related to different types of electronic catalogs. Data collected through this questionnaire were used to analyse the shoppers' preference for different features of electronic catalogs based on their cognitive styles/brain orientations.

The final questionnaire was a verbaliser-visualiser questionnaire (VVQ). The questionnaire consisted of a total of 28 questions. Likert type scales had been used to get the participants' responses. The aim of this questionnaire was to determine the style or manner participants' use (i.e. verbal versus visual) when carrying out different mental tasks. Participants' answers to the questions reflect the manner in which they typically engage in each of the tasks mentioned.

DATA COLLECTION

The entire survey was conducted in one session which was approximately 25 minutes in duration. For the VARK questionnaire, data had been collected using an online program based on the participants' responses. The built in program that had been used to get participants VARK scores is available at this website (http://iliad.cats.ohiou.edu/vark/questionnaire.htm). For other two questionnaires, participants' responses were collected through paper and pencil questionnaire fill up. Verbal and visual scores acquired through VVQ questionnaire was used only to check the reliability of the VARK scores.

RESULTS AND CONCLUSION

Eighty-five percent of the survey participants are already online shoppers or potential online shoppers. Pearson's correlation between the visual scores that have been recorded using the VARK and VVQ questionnaires shows that they are highly correlated (0.869, $p < .001$). The same is true for the verbal or read/write scores (.777, $p < .001$). These results indicate that visual and verbal scores acquired through two different questionnaires are congruent and reliable.

One-way ANOVA analysis has been conducted to test the stated hypotheses. Dependent variables of interest are Web shoppers' preference for text-oriented catalogs, visually-oriented catalogs, 2-D versus 3-D catalogs, animated catalogs, audio enabled catalogs, customisable animated catalogs, virtual trial and online shopping. The primary factor of interest is the learning groups (visual, aural, read/write, kinesthetic and multimodal). ANOVA results show that the learning groups are significantly different based on their preference for text-oriented catalogs (H_{1a}), visually-oriented catalogs (H_{1b}), animated catalogs (H_{1d}), customisable animated catalogs (H_{1f}), virtual trial (H_{1g}), and online shopping (H_{1h}). On the other hand, learning groups can not be differentiated significantly by their preference for 2-D versus 3-D catalogs (H_{1c}) and audio enabled catalogs (H_{1e}). Summary of the ANOVA results are stated in Table 2.

TABLE 2. ANOVA results summary

Dependent Variable	Conclusion	F-value	P-value
Text-oriented catalogs	H_{1a} Supported	2.464	0.048
Visually-oriented catalogs	H_{1b} Supported	2.016	0.096
2-D versus 3-D catalogs	H_{1c} Not supported	0.723	0.577
Animated catalogs	H_{1d} Supported	13.584	0.000
Including audio description	H_{1e} Not supported	1.121	0.349
Including custom animation	H_{1f} Supported	6.477	0.000
Virtual trial	H_{1g} Supported	3.907	0.005
Online shopping preference	H_{1h} Supported	2.310	0.061

Multiple regression analysis have also been conducted to find out relationships between VARK scores and different preference aspects of electronic catalogs. For regression analysis, we have considered VARK scores as independent variables and preference aspects (text-orientation, visual-orientation, animation, custom animation, audio, 2-D versus 3-D catalogs, virtual trial, and online shopping) as dependent variables. Summary of the regression results are given as in Table 3.

In the first regression analysis, 'preference for text-oriented catalogs' has been used as dependent variable. The model is not significant at 5% level of significance (F-value 1.294; $p < 0.276$). Only one coefficient i.e. kinesthetic has been found significant ($p < 0.099$). Positive coefficient value indicates

TABLE 3. Summary of the regression results

Model	Dependent Variable	F-value	Significant Coefficient			
			Visual	Auditory	Read/Write	Kinesthetic
1	Preference for text-oriented catalogs	1.294	-	-	-	0.085*
2	Preference for visually-oriented catalogs	5.494**	0.127*	- 0.153*	-	-
3	Preference for 2-D versus 3-D catalogs	1.235	.043*	-	-	-
4	Preference for animated catalogs	7.332**	-	0.275*	0.079*	-
5	Preference for audio enabled catalogs	1.556	-	-	-	-
6	Preference for customisable animation	7.092**	0.244*	-	-	0.188*
7	Preference for virtual trial	4.133**	-	- 0.130*	- 0.159*	-

** All F values are significant at .05 level of significance.
* All coefficients are significant at .05 level of significance.

that as kinesthetic scores increase, participants' preference for text-oriented catalogs also increases.

'Preference for visually-oriented catalogs' has been used as dependent variable in the second model. The model is significant (F-value 5.494; $p < 0.000$) with two significant coefficient values for visual ($p < 0.008$) and auditory ($p < 0.000$) scores. Positive relationship between visual scores and preference for visually-oriented catalogs confirms previous research finding that visually/right brain oriented people learn better from visual displays than from textual descriptions.

The third model uses 'preference for 2-D versus 3-D catalogs' as dependent variable. The model is insignificant at 5% level of significance (F-value 1.235; $p < 0.299$). However, coefficient for visual scores is significant ($p < 0.071$), which is an important research finding congruent with previous researches. As expected by the theory proposed by Fleming and Mills (1992), there is no any significant positive relationship between kinesthetic scores and preference for 2-D versus 3-D catalogs.

'Preference for including animation in catalogs' is used as the dependent variable for the fourth regression model. The model is highly significant with an F-value of 7.332 ($p < 0.000$) with two significant positive coefficients for auditory ($p < 0.0000$) and read/write ($p < 0.100$) scores which implies high auditory or read/write learners' preference for including animation in electronic catalogs.

The fifth regression analysis has been conducted using the dependent variable 'preference for including audio description'. The model is not significant at 5% level of significance (F-value 1.556; $p < 0.187$). It has also been found that none of the coefficients for independent variables are significant, which infers that Web shoppers' preference for including audio in catalogs is not affected by their cognitive style/brain hemisphericity. This finding is also supported by the previous ANOVA result.

'Preference for custom animation' has been used as the dependent variable for the sixth regression analysis. Results show that the model is significant (F-value 7.092; $p < 0.000$) with two significant coefficients for visual ($p < 0.01$) and kinesthetic ($p < 0.002$) scores are positively correlated with the dependent variable. This finding is congruent with Fleming and Mills' theory (1992) which is used as a basis for VARK questionnaire.

In the seventh regression analysis, 'preference for virtual trial' has been our dependent variable of interest. As expected, the model is significant (F-value 4.133; $p < 0.003$) with two significant negative coefficients for auditory ($p < 0.041$) and read/write ($p < 0.002$) scores. Although the model fails to confirm visual or kinesthetic learners' preference for virtual trials, it indicates auditory and read/write learners' disliking for virtual trial.

Finally, a regression analysis has been conducted to find out about the learning groups' preference for online shopping. This model is significant with an F-value of 7.038 ($p < 0.000$). The coefficient for visual scores is marginally significant ($p < 0.117$), meaning that visual learners have a higher preference for online shopping.

Since the findings support six out of eight hypotheses, it can concluded that Web shoppers' brain hemisphericity/cognitive style do have significant impact on their preference for different aspects of information presentation via electronic catalogs. However, the results of this study can be further strengthened by using better (validated) instruments. The most important weakness of this study lies primarily in the instruments design. One of the instruments (i.e. the e-commerce questionnaire) was not a validated instrument in any previous research. More consistent and useful results may have been obtained had a validated and reliable instrument been used for the e-commerce questionnaire. The questionnaire used for measuring learning styles can also be replaced by Kolb's Learning Style Inventory (KLSI), which is considered as the most reliable instrument for measuring learning styles.

DISCUSSION

Based on this study's findings and conclusion, it is clear that Web shoppers' brain orientation (cognitive style) do influence their preference for different features of electronic catalogs. To overcome the problems of information mismatch and to facilitate Web shoppers' electronic shopping experience, systems which will allow more interactive, personalised and dialogue-based means of exploring information online are needed. By utilising natural language generation (NLG) technology, server-side systems can be built which provide users with personalised electronic catalogues aiming to please them (Milosavljevic and Oberlander 1998). These systems can utilise information about users' preference in order to provide information in most preferred way. Thus, the limitations of static hypertext documents could be overcome by exploiting NLG techniques to create dynamic hypertext documents that can be tailored on the basis of individual users' preference model generated based on the information provided by them.

Dynamic hypertext systems can automatically construct entire hypertext networks and the nodes (or documents) of those networks at run-time, and adapt these to individual user's preference and needs. The textual content of the documents may be constructed either from an existing database (Milosavljevic and Oberlander 1998), from a knowledge base consisting of facts, or from individual textual fragments of an existing document which need to be pieced together appropriately. Thus, each user may be presented with a highly personalised catalogue that can make references to, or comparisons with, other catalogue items relevant to the current discourse context. The catalogs are virtual and do not exist in any form until the user requests some information, nor are they stored for later reference. However, the system can keep track of the interactions made with the user in order to avoid repetition, and to reason about his/her needs.

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