Multimedia Tasks and User Cognitive Styles

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***Abstract*- This paper proposes a new definition of cognitive style based on the way individuals perceive different types of media. The Cognitive Styles Analysis (CSA) package (Riding, 1991; Riding, 1998) assesses cognitive style based on how individuals perceive information that is presented visually. The original aspect of this paper is the proposal of an extension to the CSA definition of cognitive style that reflects the way individuals perceive information that is presented using audio. An experiment was conducted that directly compared the performance of subjects in a visual version of the CSA test with a purely auditory version. This paper first defines cognitive style, then describes the audio experiment and discusses the findings.**

INTRODUCTION

A cognitive style is the consistent underlying method of an individual's thinking and perceiving that subsequently affects the way they perceive and respond to events and ideas (Tennant, 1988; Riding, 1991; Riding & Rayner, 1998). There are a wide range of different labels and methods of measuring cognitive style (Kotteman, 1988; Riding & Cheema, 1991; Green et al., 1994; Rayner & Riding, 1997). Riding and Cheema (1991) reviewed over 30 of the methods of defining cognitive style and concluded most could be grouped within two fundamental independent cognitive style dimensions; the Wholist-Analytic dimension and the Verbal-Imagery dimension (figure 1). A person's position along the Wholist-Analytic dimension reflects whether they understand situations as a whole or see things in parts, while their position along the Verbal-Imagery dimension reflects the manner in which they represent information while thinking, either as words or mental pictures.

The Cognitive Styles Analysis (CSA) program was produced as a computerised test that automatically calculates an individuals' position on both dimensions (Riding, 1991; Riding, 1998). The test presents a series of questions that reflect the way individuals with different cognitive styles perceive and process information. Individuals are expected to perform the questions that suit their cognitive style faster than the opposite style of questions thus the relative speed in which individuals answer the different styles of question reveals their cognitive style (Riding & Staley, 1998).

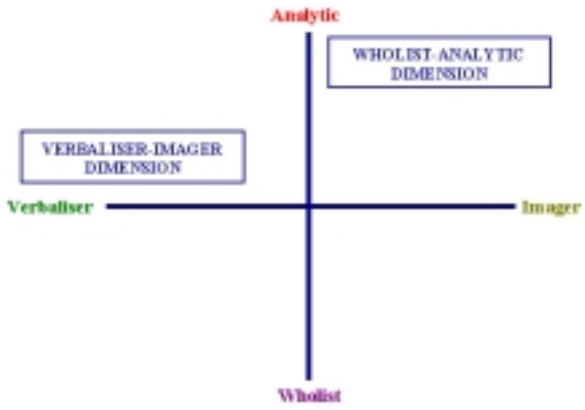

Figure 1: The two cognitive style dimensions

The CSA definition of cognitive style has been found to explain the behaviour of subjects performing simple tasks where the presentation of information used the same media as used in the CSA test (Riding & Ashmore, 1980; Riding & Calvery 1981; Riding et al. 1989; Riding & Sadler-Smith 1992; Douglas & Riding 1993; Riding & Douglas 1993; Riding & Watts 1997). The CSA classification of cognitive style has been less successful in accurately predicting the performance of individuals in complex tasks using multimedia (John & Boucouvalas, 1999; John & Boucouvalas, 2002). The lack of success of predicting the performance of tasks that present information using multimedia can be explained by differences in the way users perceive different computerised media. Information from different media are received by different sensory organs and processed by different parts of the brain. Visual information from the screen, including text, images and video images are sensed by the eye and audio information, including speech and non-speech sounds, are sensed by the ear (Figure 2).

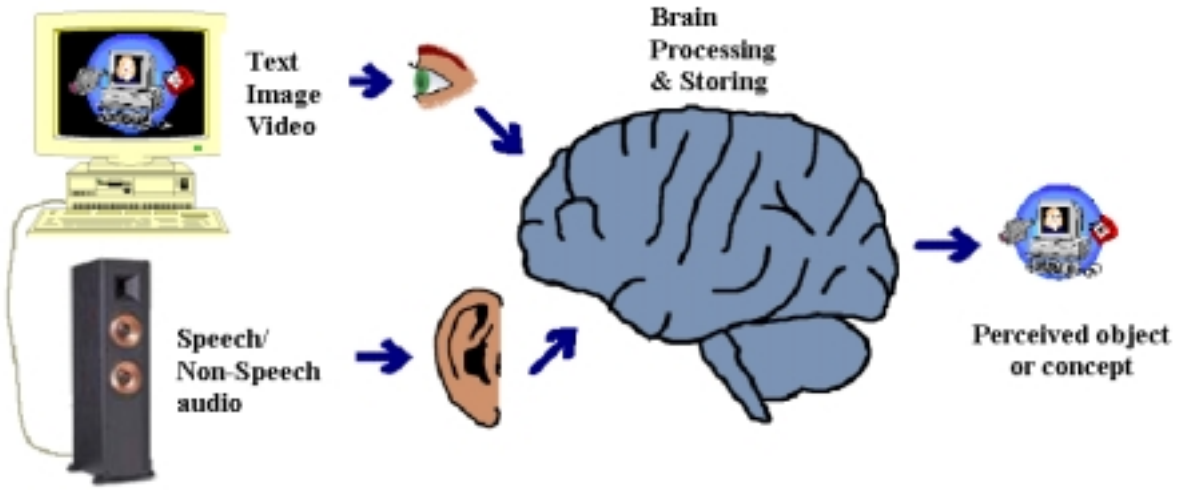

Figure 2: Perception of Multimedia information

Some of the information is processed in media specific parts of the brain while other information is processed in media non-specific parts (Anderson, 1995; Goldstein, 1989; Gross 1996).

A new experiment was devised by the authors to test whether the same cognitive style influenced individuals' perception of both visual and auditory information.

DESIGN OF THE EXPERIMENT

The performance of subjects in a visual test was compared against their performance in an audio version. The visual test used the same questions and the same interface design as the original CSA test while the audio version used new questions that were designed by the authors. The Verbal-Imagery (VI) classification of subjects is assessed in a series of 48 questions. Half of the questions were designed to suit Verbalisers (V) and half were designed to suit Imagers (I). Imager style questions used high-imagery words such as the names of objects that could be easily visualised while the words used in the Verbaliser questions used low-imagery content such as the names of concepts (the names of sports, careers etc.). The questions that assessed the classification of the Wholist-Analytic (WA) dimension used images rather than words. Wholist (W) style questions asked subjects to identify differences in the overall appearance of objects while the Analytic (A) questions asked subjects to identify whether simple objects (rectangles and polygons) were contained within other more complex objects. The audio version used a different but equivalent set of questions to the visual experiment. The Verbal-Imagery questions were spoken instead of displaying text and the Wholist-Analytic questions used sound effects instead of using graphics.

The simple objects in the visual version were replaced by sound effects (gun shots, breaking glass etc.) while the complex objects were replaced by a number of sound effects played at the same time.

Twenty-four subjects were chosen from the staff and students of Bournemouth University who performed both versions of the test. The performance of subjects was calculated in each style of question as a ratio of score (the percentage of questions answered correctly) divided by duration (the median time taken to answer one question). For both dimensions a ratio was created from the performance ratios of each style of question. This ratio indicated the subjects' cognitive style. Wholist-Analytic ratios of less than 1 indicated Wholists users while ratios of greater than 1 indicated Analytics. Verbal-Imagery ratios of less than 1 indicated Verbalisers while ratios of greater than 1 indicated Imager users. If one cognitive style influenced individuals' perception of both visual and auditory information there would be a strong correlation between the ratios achieved in both versions of the test.

RESULTS OF THE EXPERIMENT

The performance of subjects in the visual experiment was compared to the performance in the audio experiment. Both experiments used equivalent questions so any difference in performance that occurred between the two experiments would be due

to differences in way the media used in the presentation are perceived.

The main area of interest for the comparisons between the performance of the visual and auditory versions was not whether one was performed better than the other but whether the relative performance between the different styles of question were the same or not in both versions of the test.

Table 1 shows the correlation between the performance ratios achieved in the visual experiment (Vs_) with the audio experiment (Au_). The performance of subjects in each style of question (W, A, V and I) and the ratios derived for each dimension (WA and VI) in both experiments are compared against each other. The lighter highlighted backgrounds indicate a significant correlation while the darker highlighted background indicates a marginally significant correlation.

	Correlation		Correlation
Vs_W – Au_W	0.395	Vs_V – Au_V	0.313
Vs_A – Au_A	0.531	Vs_I – Au_I	0.465
Vs_WA – Au_WA	-0.085	Vs_VI – Au_VI	0.324

Table 1: Correlation of performance between the visual and audio tests

The performance in the Analytic style questions (Vs_A - Au_A) was strongly correlated between both versions of the test, however the performance in the Wholists style questions (Vs_W - Au_W) was only marginally correlated and there was a low correlation between the Wholist-Analytic classification (Vs_WA - Au_WA). Similarly the performance in the Imager style questions (Vs_I - Au_I) was strongly correlated between both versions of the test, however there was low correlation between the performance in the Verbaliser style questions (Vs_V - Au_V) and between the Verbal-Imagery classification calculated by each version of the test (Vs_WA - Au_WA).

DISCUSSION

There was low correlation between the cognitive style classifications calculated in the different versions of the test. The differences in performance between the two versions reflect the differences in sensing and processing the visual and audio information. Differences in performance may occur in either the sensing or processing although this experiment was not able to distinguish between the two processes.

The sensors used by subjects are different in each test, involving the eyes in the visual experiment and the ears in the audio experiment. These activities are affected by the parts of the brain that receive the information and the rate in which the information arrives. Different parts of the brain are dedicated for receiving visual and auditory information. Auditory information is presented serially at a rate that is determined externally to the individual. Visual information in contrast is gathered by the scanning movements of the eye which allows information to be gathered in a non-serial manner and at a rate that is determined by the individual.

The processing of the information involves the individual making sense of the stimuli. Processing of language is expected to be handled by the same part of the brain whether the information is input visually or using audio, while non-speech sounds and images are handled in different parts of the brain.

The difference in performance between the visual and audio experiments indicates that the CSA classification of cognitive style does not explain the performance of users when information is presented using a combination of visual and audio components. A person's cognitive style appears to be more complex and a more complete description should take into account a Wholist-Analytic and Verbal-Imagery classification for visual information and a Wholist-Analytic and Verbal-Imagery classification for audio information.

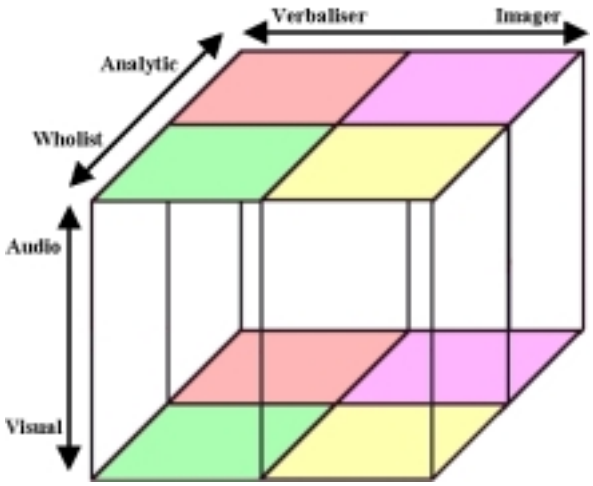

Figure 3: Adding a Visual and Audio dimension to the cognitive style model

Figure 3 shows the effect of adding a visual and audio dimension to the CSA definition of the cognitive style model. A person's cognitive style can be calculated by performing the CSA test augmented with the audio test. The first half produces two ratios for the Visual-Wholist-Analytic dimension and Visual-Verbal-Imagery dimension (the bottom plane in figure 3) and the second half produces two ratios for the Audio-Wholist-Analytic dimension and Audio-Verbal-Imagery dimension (the top plane in figure 3).

CONCLUSION

This paper described an experiment that measured whether the same cognitive style governed the performance of subjects when listening or viewing information presented by a multimedia computer. The conclusion of the experiment was that there are differences in performance when information is presented visually or using audio. The perception of visual and audio information appears not to be governed by one cognitive style, therefore an auditory extension to the CSA definition of cognitive style is proposed. The classification of an individual's cognitive style is extended from the original visual assessment to include an auditory assessment of cognitive style.

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