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Testing Recognition of Computer-generated Icons

ABSTRACT: Icons have been popularized by modern Graphical User Interface (GUI) software, however, an individual's use and reaction to icons varies. Our purpose was to demonstrate that a computerized recall and recognition survey of icons could produce measurable results that could be used to better design and choose icons for common microcomputer applications. Icons with better recognition would also aid in student learning of common software tools. For this pilot survey, 125 MIS students viewed a projected five-minute computerized VGA slide show in a darkened classroom. Looking at a sequence of 30 colored screens shown for only 10 seconds each, they indicated their preferences for and their ability to discriminate, recall, and recognize 48 icons. The results indicated individuals can make icon choices quickly, certainly have icon preferences, and can recognize icons that they saw for only 10 seconds. Computerized projected surveys can provide preferences and measurable performance (number correct per time period) for icons, trademarks, logos, and signals much quicker than a series of individual trials or surveys.

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INTRODUCTION

Human-Computer Interaction (HCI) can take many forms. This article discusses an automated survey performed on the particular HCI called icons. Icons represent packets of information that people understand in certain contexts. Icons have been popularized by modern Graphical User Interface (GUI) software, such as Microsoft Windows (1), OS/2, and the Macintosh environment. These icons are communication pointers for people interacting with computer software. If this medium is designed correctly, students will not be misdirected in the use of software tools, increasing the time that can be spent on productive tasks. This survey was an attempt to find icon designs that trigger correct responses and consistent interactions. More important, in training and education, the survey methodology has implications in testing large groups where performance (correct responses per time period) is a consideration.

THE HISTORY AND BACKGROUND OF ICONS

An icon can be defined as a picture, image, or other representation (2). Icons are visual symbols that have been used throughout history to overcome language barriers (3). They present people with an understandable visual image of an activity or object. Icons have a universality that has made them useful since early civilization (4). An example of ancient icons is seen in coins. Chinese coins appeared around the 7th Century B.C. Those coins first resembled farming tools which were understood to have value. This value was transferred to acceptance of the intrinsic value of the coins themselves (5). The evolution of coins of characteristic shapes and iconic symbols is a good example of the universally understood communications medium that icons are.

Although iconic forms are used in nearly every GUI, there is little recent empirical research (6) that actually documents the advantages and disadvantages of icon use. Guides for iconic design currently exist (7) (3) (8), however, much of the design information has also not been empirically tested for the general computing population let alone the student computing population. It is generally believed that icon use leads to faster man-machine communication and that the training time for users, especially new users, is significantly decreased. However, icons can be difficult for users to understand (9) and may be ambiguous without a context (10).

On the positive side of icon use, Easterby (11) stressed the advantages of symbolic displays over language-based displays for international communication. Horton (3) states that icons speed up searches, allow immediate recognition and better recall, save space, describe graphical concepts, and have visual appeal. The last item is important when considering users "with artistic, right-brained, holistic, intuitive personalities (8)". Finally, Kline notes that icons are certainly comprehended better than text (12). Conversely, Manes (13) asserts that icons can be confusing and ineffective in dealing with a large array of commands, files, or concepts. He also considers them to be arbitrary, inconsistent, and occasionally incomprehensible (14). Icons are culturally anchored (10) and require learning and remembering (15). In the ideal computing environment, an icon should be obvious to users that are experienced on the system while being evocative and self-evident to new users. Unfortunately, many icons fail to meet the former criterion, and most fail to meet the latter criterion.

In the perfect icon representation, no logos or script should be needed and human recognition of the image should only require minimal right brain pro-

cessing. Icons that represent familiar and straightforward actions, such as a open file, file erase or copy file, should combine the object and its activities for optimal right-brain processing. Unfortunately, complex activities are normally performed with more powerful software and extensions to the GUI environment.

ICON PROCESSING

There are a number of psychological models that can be applied to icons to attempt to explain human image processing and recognition. Spoehr (16) presents the following models:

Template Model
The human visual system forms a picture of the presented image and recognition occurs when a match is found with a stored memory image.

Prototype Model
Similar to the template model but more flexible because it incorporates variability within single classes of patterns.

Feature Model
The visual system scans various features of the image such as orientation, spatial frequency, color, etc. A match is again found with a stored memory image.

Other models describe the human processing of images as a series of processing stages, and it appears that the overall structure of an image and its form does influence feature extraction. The organization of the image and the grouping of the information constructs will affect its recognition factor.

SURVEY METHOD

Purpose and Objective

The purpose of this the survey was to evaluate 1. icon representations by a group looking at a projection of a computerized icon survey and 2. automated survey methodology.

One hundred twenty-five MIS students enrolled in either the AACSB junior level Information Systems classes or the freshman Introductory MIS classes, took part in the survey. The demographics of the group is shown in Table 1.

We previously announced that the survey would be taken in class. The participants looked at the survey in a 60-seat, tiered classroom during evening classes in a medium-sized Southwestern university. The survey was an automated sequence of 30 screens that was shown once. Each screen was displayed for 10 seconds. The screens design incorporated the following:

- Simplicity - The same general format was carried throughout the survey. White lettering of the same size and font was used on a blue background. Except for the last recognition screen, choices were made from a selection of six icons.
- Similarity - Icons were constructed in a 36 by 36 matrix of various colors and there were only virtual curves projected.
- Choice restriction - Preferences were limited to just one or two choices, such as like best and like least.
- Consistency - For the discrimination screen, the most similar icon had only one color change in one cell of the matrix. The remaining icons had an increased number of contrast changes (the complexity issue) and color changes. For the recall screen, one or two icons were quite similar; however, one was an exact copy. For the recognition screen, very dissimilar icons with multiple exact copies were displayed.

To collect the answers to the survey, the participants circled or crossed out icons on paper sheets that were almost unreadable copies of the screens. We made them unreadable so the icons would be scanned from the screen and not the sheets.

Table 1: SURVEY POPULATION

Students Surveyed:	125
Gender:	
Female	66
Male	59
Age:	
Over 25	35
25 and under	90
Used Windows:	78
Used Macintosh:	59
Used Windows and Mac:	87
Prefer to use icons:	70

Survey Software and Hardware

The survey resides in Lotus's *Freelance Graphics for Windows*, Release 1.0 (17) and requires 178K of storage. The included icons require an additional 700K of storage. Many of these icons are about 25 times larger than the normal 1K icons, because we believed that enlarging them would enhance their graphic quality. We captured 19 icons from Microsoft *Windows*, Lotus *Freelance*, and The Software Labs *Icon* Library. Most of these were modified using Microsoft **Paintbrush** (18). Applications Techniques *Pizazz +Plus* (19) captured the images of most of the icons and converted their files. Twenty icons were created using The Software Labs *Icon* (20), a DOS icon designer. The computer that ran the survey was a Gateway 2000 486/33C, which had a TeleVideo PC to TV Super VGA card. The projector was a ceiling mounted Sony VPH 1041Q color video projector.

SURVEY RESULTS

Within the 7 figures on the following pages are tables showing the responses to the seven questions in the survey.

This survey clearly showed that, given a short list of icons, people have distinct preferences for certain icons. For word processors, the icon (w6) was the least liked while (w4) was the best liked. For spreadsheets, the icon (s5) was least liked while icons (s2) and (s3) were liked. The icon (e5) was liked most for E-mail and the icon (e3) was liked least.

Sixty-two of 124 people could discriminate among the icons, and a single color change did not disturb their observation skills. The best match was between the two most simple icons with the least number of changes in contrast. Among the more complex icons, finding which icon was least similar proved more difficult.

Recall of the icon shown on the title page (c3) was poor. Even though this computer icon was the only one with a white screen, the 230 second lapse between viewing appears to have led to a lessening of recall. The recall of the icon shown for word processing (p3) was good. The recognition of the icons shown throughout the experiment was also good, but certainly not perfect. Did people prefer, recall and recognize icons in this survey? Yes, they made selections that were far from random (equal choice of icons). The null hypotheses that they could not make choices were rejected, except in recognition. Table 2 lists the results.

CONCLUSION

This first survey resulted in identifying issues that should be investigated further. For instance, the students appeared to like icons designed with horizontal and vertical lines and having high contrast. Conversely, they did not appear to like icons designed with lines of text. In recall, one simpler

Figure 1: PREFERENCE QUESTION 1

Preferences in Word Processor Icons

Icon Number	Liked Best	Liked Least
W1	15	14
W2	25	5
W3	19	14
W4	33	10
W5	27	7
W6	15	8

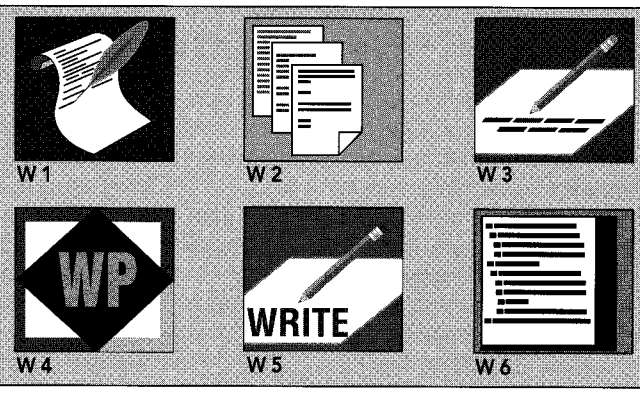


Figure 2: PREFERENCE QUESTION 2

Preferences in Spreadsheet Icons

Icon Number	Liked Best	Liked Least
S1	21	20
S2	53	6
S3	33	5
S4	7	10
S5	5	57
S6	2	14

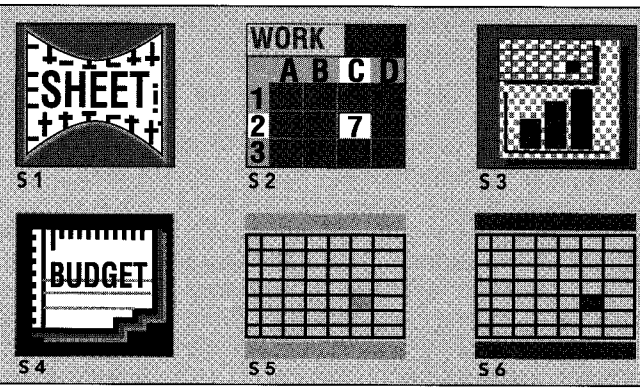
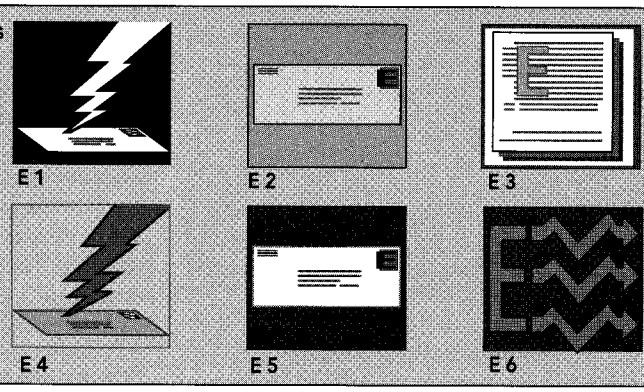


Figure 3: PREFERENCE QUESTION 3

Preferences in E-Mail Icons

Icon Number	Liked Best	Liked Least
E1	20	8
E2	13	15
E3	5	46
E4	23	6
E5	49	5
E6	13	39



designed distracter did not significantly affect finding the original icon. However, several icons of the same object, such as a computer, may make one particular icon difficult to recall. Icons that are quite diverse may aid in recognition.

Computerized surveys of icons appear to work in a controlled setting with adequate equipment - the methodology works. Our first conclusion is that these type of surveys can get samples quickly, without the tedium of getting a string of people to view a single CRT. In an educational or training setting, computerized surveys certainly reduce the blizzard of paper that testing generates. Additionally, the use of icons may be a method of testing people with reading disorders, such as dyslexia.

All of the icons in this survey had to be captured from one software package, converted and transferred to another, and modified in between. Many of the icons lost their original colors when transferred, yellows became blues. Moving icons often changed their sizes. Our method for making surveys needs to be refined, but the effort can support numerous surveys and variations of surveys. Using one company's set of software, such as Microsoft, allows a common thread of icon transfer between each software package.

Our future surveys will include preferences for different corporate icons (OS/2, New Wave, and Microsoft Windows) for the same object. We also see the need for studies on colors, complexity, proximity, perspective, context, animation, and size and shape of icons. Adding demographics to the surveys will possibly direct the design of customized user interfaces for people in different situations, with different abilities, or particular national and ethnic groups. Finally, we are curious about comparing icon surveys between ethnic groups such as Orientals and Occidentals because most Orientals learn to read far more symbols than Occidentals.

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Figure 4: DISCRIMINATION QUESTION 4

Discrimination among Icons

Icon Number	
D1	1
D2	54
D3	2
D4	2
D5	62
D6	3

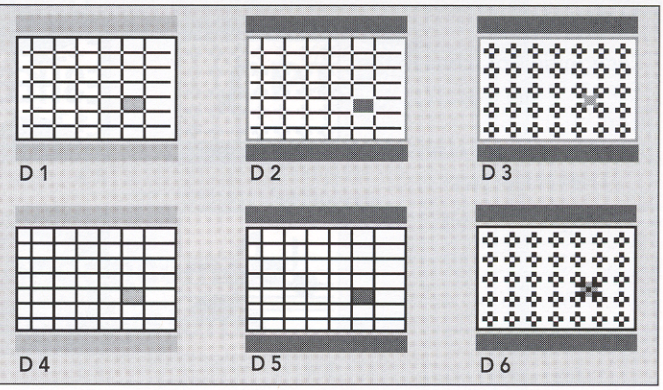

Figure 5: RECALL QUESTION 1

Recall of Title Page Icon

IconNumber	Recalled
c1	22
c2	32
c3	32
c4	14
c5	10
c6	6

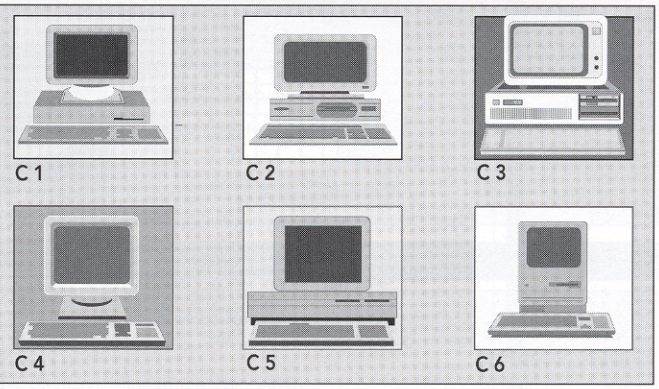

Figure 6: RECALL QUESTION 2

Recall of Icons for Word Processing

Icon Number	Recalled
P1	16
P2	14
P3	53
P4	5
P5	30
P6	4

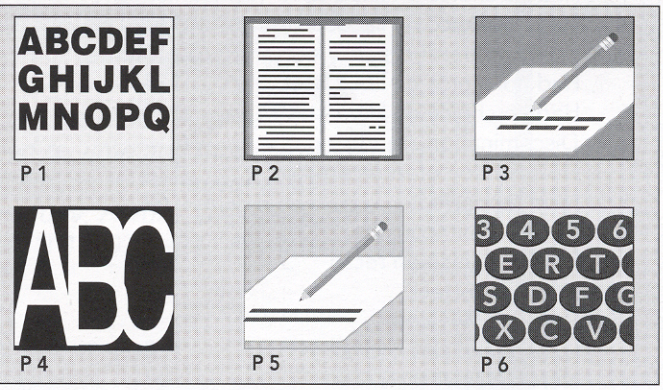

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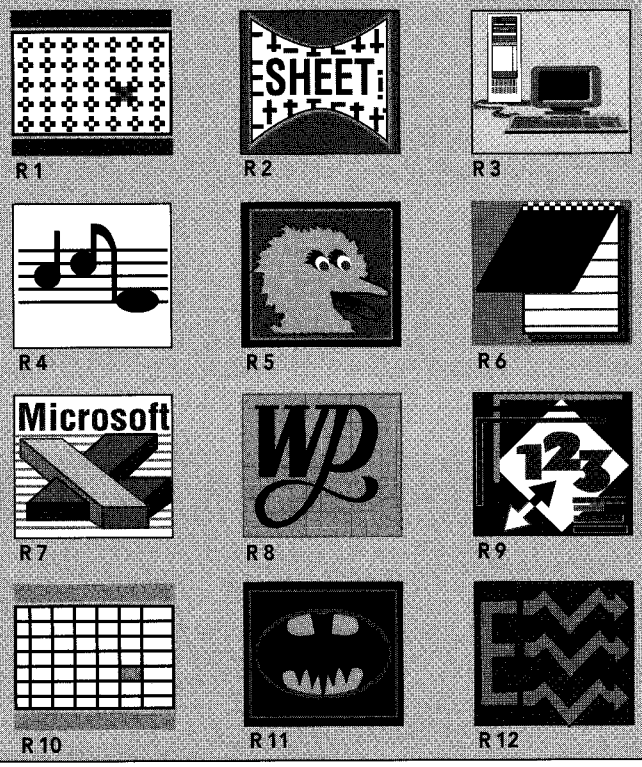
Figure 7: RECOGNITION QUESTION

Recognition of Icons in the Survey

Icon Number	Recalled
R1	104
R2	98
R3	17
R4	4
R5	3
R6	1
R7	4
R8	16
R9	1
R10	110
R11	2
R12	111



CHI-SQUARE GOODNESS- OF-FIT TEST

HYPOTHESIS	N	t-Score	Significance
H01: Word processing preferences			
Had no choice on liked best	120	14.2	p<0.05
Had no choice on liked least	108	110	p<0.05
H02: Spreadsheet preferences			
Had no choice on liked best	121	78.8	p<0.05
Had no choice on liked least	112	103	p<0.05
H03: E-mail preferences			
Had no choice on liked best	123	57.1	p<0.05
Had no choice on liked least	119	82	p<0.05
H04: Discrimination among icons			
No selection of most similar	124	204	p<0.05
Number correct	62		
H05: Recall of 1st icon			
Had no choice on recall	116	32.1	p<0.05
Number correct	32		
H06: Recall of WP icon			
Had no choice on recall	122	66.3	p<0.05
Number correct	53		
H07: Recognition within survey			
Perfect	125	0.004	ns
Number correct	62		
Added icons	125	31.4	p<0.05
People who added	31		

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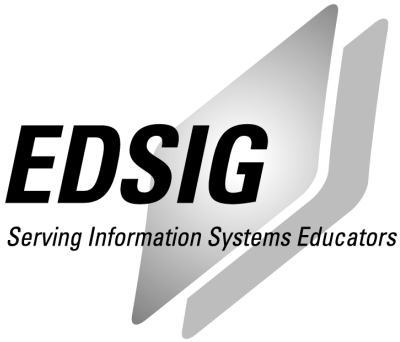

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