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TEXT LABELS FOR HYPERTEXT NAVIGATION BUTTONS

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ABSTRACT

Instructional hypermedia programs, which include both hypertext and multimedia, typically use selectable hot spots on the computer screen (buttons) to represent the various options available at a given time to the users of those programs. When those options involve moving from one screen display state to another, the buttons representing them are usually called II navigation buttons." The design of navigation buttons influences the ease with which they may be recognized and interpreted, and consequently the ease with which such programs may be used.

A prior study in which some of the authors participated [1], conducted in the context of a simulated HyperCard(TM) stack, found that subjects were significantly less able to perceive the functions of navigation buttons displaying pictorial information only than of buttons displaying text labels, with or without pictorial information. The current study addresses the authors' concern that the previous findings might have been affected by contexual elements provided to the subjects. Ninety-three college students responded to matching tests in which button functions were taken out of context. The number of incorrect responses for buttons with pictorial representations only was nearly three times greater than for buttons with text and pictorial representations, or buttons with text only. These findings indicate that buttons with text labels do reduce user confusion concerning their functions.

NAVIGATION BUTTONS IN HYPERMEDIA

Computer programs in common use today, including instructional hypermedia programs, do not have any tangible presence for users beyond their screen displays, audio signals, or printed output. Designers of hypermedia must provide a means for users to manipulate these "intangible" programs. Those means typically include visual elements on the computer screen, since current delivery environments for instructional media rely heavily on visual displays coupled with some form of input hardware, such as a mouse, joystick, touch screen or keyboard. A typical and pervasive type of visual element used to manipulate programs is the button, or rectangular "hot spot" on the screen that can be programmed to carry out actions when users touch them or point to them with a cursor and click a mouse button [2].

Buttons as Objects in the Human-Computer Interface

Allen and Otto [3] describe interface elements as functioning like objects in the physical world in that they possess stable properties (among them appearance) that indicate to users their "affordance," or what may be done with them. In the same way that a door handle possesses the affordance "turn-ability", a document icon on a computer screen possesses the affordance "clickability." Allen and Otto also describe embedded clusters of affordances; a hypertext's "browse-ability" is an affordance cluster composed in part of "navigate-ability" which is composed partially of "click-ability." These affordances, while they rely on our perceptual systems for recognition, are actually learned through repeated interactions with our environments. Thus when hypermedia users click on a button and something happens, they come to recognize that the "button objects" in an interface afford clicking.

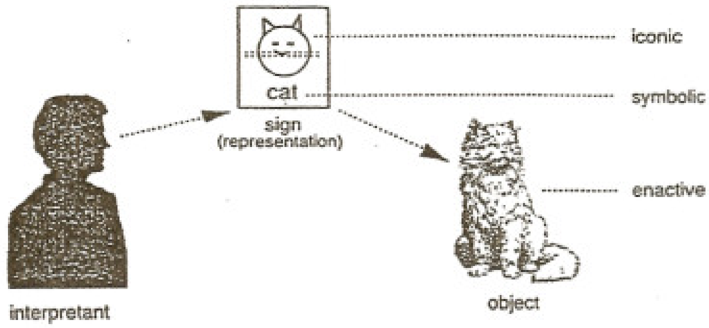
McKnight, Dillon, and Richardson [4] report that users find their way around hypermedia programs in ways similar to physical navigation, and that visual elements on screen, frequently buttons, function as the "physical movers" that get users from one place to another. Buttons that allow users to move back and forth between displays or locations in a program, to return to the beginning of the program, or to leave the program are called "navigation buttons" [5]. Navigation buttons may or may not be the only kind of buttons present in a given program.

Visual Representations of the Functions of Buttons

Users attempting to navigate through an instructional program the first time may very well apprehend the affordance of navigation buttons generally, but they do not automatically know what individual navigation buttons will do for them. Buttons are almost always augmented with some kind of representation of their individual functions. Representation of function may be completely integrated into a button, as when a button is designed to look like the corner of a page that may be "flipped" in order to reveal the next available screen display. More often, however, navigation functions are represented by pictorial images or text labels applied to the surface of a button.

Images and text labels on computer buttons are signs, or intermediaries between the user and the program [6]. A sign is part of a three-way relationship consisting of the sign, which is a representation of something; the object, or that which the sign represents; and the interpretant, or the person who recognizes the sign as a representation of the object [7]. The object in this relationship may be tangible or intangible, so in a hypermedia program the sign may be an arrow on a navigation button, the object may be a concept, or function, ("moving forward through the displays in this program"), and the interpretant will be the user of the program.

FIGURE 1. SIGN, OBJECT AND INTERPRETANT RELATIONSHIP



Users of a program must either memorize each button, or they must interpret any representations of function designed into the buttons by applying previous knowledge from many domains [8, 9, 6]. New users of a program have to interpret every sign as it is encountered, which automatically places a burden on their cognitive processing resources over and above that required by attending to and learning whatever the instructional content of the hypermedia program may be [10]. Repeat users do learn to recognize buttons fairly quickly and easily [11], but unless they use only one or two programs consistently over a period of time they can forget or confound the meanings of buttons in large sets, or confuse meanings between programs that they use frequently. The visual representations of function on navigation buttons should therefore convey their meanings as easily and accurately as possible to all users of hypermedia programs.

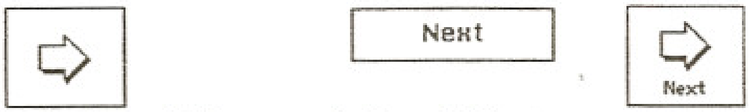
Modes of Representation

Bruner's [12] three modes of representation, enactive, iconic and symbolic, are useful as a starting point for describing the representations of function frequently applied to hypertext navigation buttons. Enactive representation is demonstration, used for things like playing tennis or riding a bike which are not adequately represented in words or pictures. Iconic representation is pictorial (pictures), and symbolic representation is verbal (words or text). Both iconic and pictorial representations are types of signs in that they signify objects but are not the objects themselves, and both types of representations are used to communicate the functions of navigation buttons.

Single Modality and Mixed Modality Buttons

Authoring environments for instructional software development generally support the creation of rectangular buttons that contain symbolic representation only (single modality text), iconic representation only (single modality pictorial), or both symbolic and iconic representation (mixed modality). Although designers may create "invisible" buttons and other variations, these three are very commonly used and are commonly illustrated in design texts [13, 14, 15, 8].

FIGURE 2. THREE TYPES OF REPRESENTATION APPLIED TO BUTTONS SHARING THE SAME FUNCTION



single modality pictorial — single modality text — mixed modality

Icon Studies Comparing Single Modality and Mixed Modality Designs

For the purpose of this study buttons are considered to be similar to the class of visual interface elements called "icons," since both buttons and icons function as control mechanisms at the interface [8, 10, 14, 16]. In terms of the appearance of the elements on the computer screen, or formal terms, icons are always pictorial (iconic) elements, often with text (symbolic) labels appearing nearby [13]; while buttons are bounded shapes which may contain pictorial representations, text labels, or both [8]. Studies comparing the design of icons were reviewed as directly relevant to the design of buttons, given the functional similarity of these elements. The authors discovered six studies in which mixed modality and single modality designs for computer icons were directly compared, and one study in which mixed modality and single modality "symbols" for photocopier operations were directly compared (see Table 1).

TABLE 1. SUMMARY OF ICON TYPES AND FINDINGS IN REVIEWED EXPERIMENTAL STUDIES

STUDY	TYPES OF ICONS			TYPES OF ICONS YIELDING BEST PERFORMANCE		
	pictorial	text	mixed	pictorial	text	mixed
Brewley, Roberts, Schroit & Verplank [11]	x		x	x (after learning)		x
Brems & Whitten [31]	x	x	x			x
Edigo & Patterson [17]	x	x	x			x
Guastello, Traut & Koreinek [28]	x	x	x			x
Kacmar & Carey [26]	x	x	x		x	x
Chambers, et al. [25]	x	x	x		x (familiar functions)	x (unfamiliar functions)
King, et al [1]	x	x	x		x	x

Single Modality Pictorial Representations

Edigo and Patterson [17] put forth two psychological arguments suggesting that pictorial content in computer icons will be beneficial to users: 1) people process pictorial information faster than they process textual information, and 2) people have impressive recall for images they have seen before and retain this recall over long periods of time. They also assert that people's recall of educational and presentation materials is somewhat enhanced by the use of pictures, a position supported by Pettersson [18], Rieber [19], and Fleming & Levie [20].

These arguments primarily support the design premise that pictorial representations make icons easy to remember and recognize. None of the authors reviewed claimed that pictorial content alone is sufficient for users to identify the functions of icons or buttons. In fact, several authors of pragmatic design guidelines caution that pictorial content alone is not sufficient for accurate identification of icons (13, 21, 22]. Furthermore, the design of visual representations for interfaces usually hinges on simplifying and abstracting pictorial information until it is easily recognizable [6, 13] and understood by viewers to have a general rather than a specific meaning [23]. This process degrades the semantic precision of pictorial representations, increasing their dependence on contextual cues to convey the correct meaning to viewers.

Of the seven studies reviewed, only the [11] found that subjects performed as well with single modality pictorial icons as they did with any other design (in this case only mixed modality icons), and this performance was only observed after users learned the functions of the icons through using the program.

Single Modality Text Representations

In contrast to the perceptual advantages claimed for pictorial representations (easy to discriminate, remember, and recognize), the primary advantage of text is semantic precision. Whereas pictorial representations are highly susceptible to different interpretations depending on the context in which they are encountered [23, 24, 9], text labels can be significantly less so because they typically contain the exact words that an image is attempting to portray.

Chambers [25] report three studies of symbols on "equipment control panels," automated teller machines, and "various office equipment" respectively which found that subjects made more accurate identifications of functions from words than they did from symbols.

Of the seven studies reviewed by the authors, one found that subjects performed best with mixed modality icons for unfamiliar functions and single modality text icons for familiar functions [25], and two found that there was no significant difference between subjects' ability to correctly identify the function of single modality text icons and mixed modality icons [26, 1].

Mixed Modality Representations

Two primary arguments suggest that there may be advantages in using mixed modality navigation buttons over single modality buttons. Both arguments hold that processing of iconic (pictorial) and symbolic (text) representations happen in two different, although related, mental systems as depicted in Paivio's dual coding model [27, 20, 18]. Complementary stimuli presented to both these systems simultaneously may allow individuals to use their dominant system to process stimuli [28]. There may also be an additive effect of using both systems to process stimuli of different modalities [20], as is apparently assumed when researchers speculate that either text labels serve to clarify the meaning of pictorial representations [11, 29, 30] or that pictorial representations help specify the meaning of text labels [17]. Unfortunately, since most of the studies reviewed include either a mixture of concrete pictorial images (pictures of pencils, pieces of paper, paint brushes) and highly abstract images which might as well be letter forms or any other highly abstract symbol (geometric forms, arrow forms), the research on illustrative images [20, 18, 28] may not be appropriate to support hypotheses regarding dual encoding applied to the visual design of icons.

Although Edigo and Patterson [17] tentatively attribute the better performance of subjects in their study using mixed modality icons over either text or pictorial icons to the "disambiguating role that pictures play for verbal category labels" (p. 132), other authors postulate that pictorial content is inherently ambiguous, particularly when it represents abstract rather than concrete functions, and that text labels may serve to disambiguate pictorial content [11, 29, 30]. Petterson [18] describes a number of studies he has conducted to show that subjects vary widely in the key words and descriptions they assign to visual stimuli, and that the use of verbal labels or descriptions can narrow the range of responses subjects make. Although Petterson's research treats illustrative imagery rather than symbolic imagery, the authors consider it applicable in this discussion because the more abstract images become the more generalized they are presumed by viewers to be [23], and the more ambiguous they therefore become.

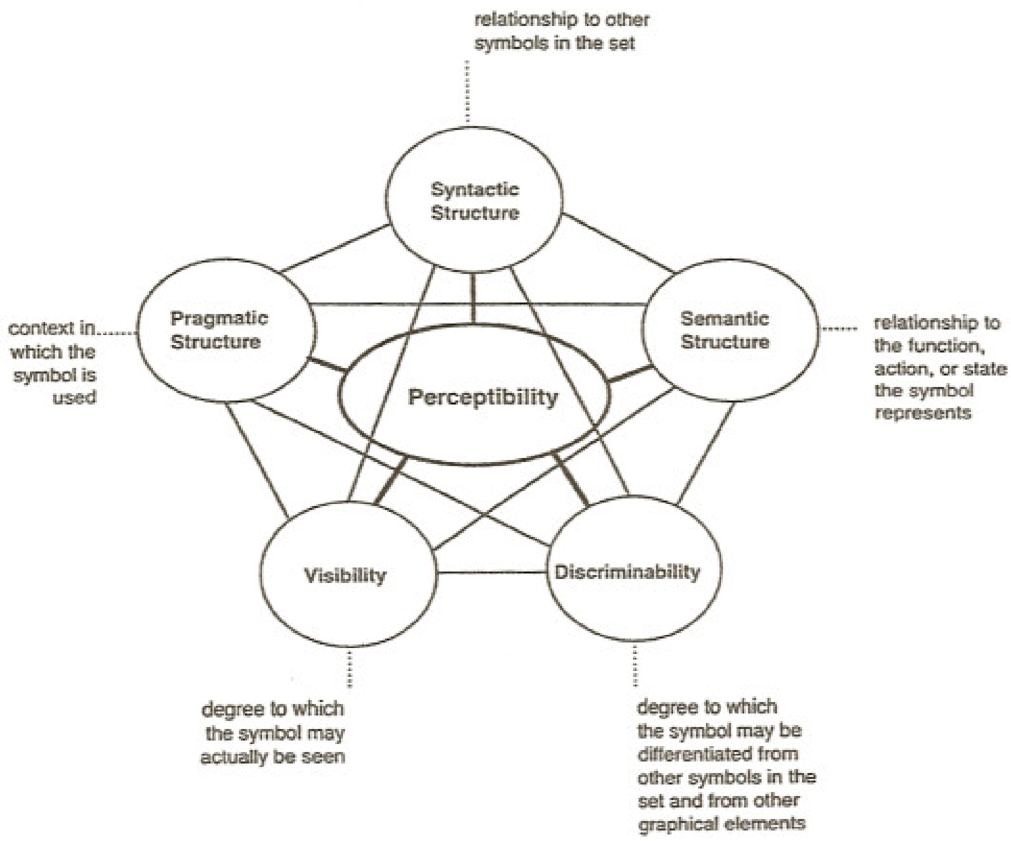
In five of the studies reviewed mixed modality icons were identified more accurately by subjects than were single modality icons, either pictorial or text. In one study [11] mixed modality icons were identified more accurately by subjects than were single modality pictorial icons until the subjects learned the pictorial icons, after which there was no difference. In the Brems and Whitten study [31] mixed modality icons were learned more easily than were single modality icons, either pictorial or text (a separate measure of accurate identification was not made).

Methods Used for Icon Studies

Most of the studies reviewed required subjects to carry out some form of matching/sorting, ranking, or direct identification of candidate icons. In matching/sorting type studies the subjects match the provided icons to supplied descriptions of their functions, or sort icons to reflect the "best match" with supplied descriptions. In ranking type studies subjects rank individual icons as very appropriate, somewhat appropriate, and so on, in relation to a single, supplied description of the icon's function. The descriptors in such studies may differ, and this method is used to discover subjects' preference for various designs as well as their opinion of the appropriateness, or sometimes the understandability, of individual icons. In direct identification type studies, subjects view a candidate icon and supply their own description of its function after having been told the general context (word processing, photocopier panel) in which the icon would be used.

King [1] used a different method than any of the other studies reviewed. The authors of that study used a model derived from Easterby [9], who was instrumental in developing the ISO (International Organization for Standardization) procedure for testing public information symbols [32, 33), to describe five interrelated components of visual symbols (see Figure 3). They make the argument that since these five components are interdependent the accuracy with which a subject may identify a button as the correct one to accomplish a certain goal, should be studied within the context of an entire screen display and a description of the task the subject is doing. Consequently, they used a simulated HyperCard (TM) stack on paper and relevant task statements as the stimulus items for their study.

FIGURE 3. VISUALIZATION OF THE INTERDEPENDENT COMPONENTS OF SYMBOLS AS DESCRIBED BY EASTERBY (1970)



Purpose of the Present Study

King [1] found that subjects made 2 - 3 times more errors interpreting the meaning of single modality pictorial navigation buttons compared to single modality text buttons and mixed modality buttons. Although these results were similar to those of Edigo and Patterson [17] and Chambers [24], and nearly identical to those of Kacmar and Carey [25], and although the researchers themselves argued that contextual elements might be important in determining the perceptibility of navigation buttons, one criticism of the King [1] study was that the unique contextual elements displayed on the simulated screens containing the navigation buttons may have confounded the results. Would their results obtain if the contextual information and task descriptions were removed? The authors sought to answer this question in the present study. If the results were the same, the criticism regarding contextual elements in the stimulus items for the King study would not be supported. Likewise, the argument for including contextual elements and task descriptions in the stimulus items for the purposes of obtaining generalizable findings (as opposed to findings related to the usability of specific designs) would not be supported.

METHOD

Subjects

The subjects for this study were graduate (n=35) and undergraduate (n=63) students in education. Approximately 20 percent of the subjects were non-Native speakers of English, and almost 60 percent reported that they had no previous experience with programs similar to the sample reproductions of HyperCard screens they were shown.

Instrument Design

An matching type instrument was designed which included pictures of navigation buttons and textual descriptions of the functions represented by the buttons. The seven navigation buttons included were the same buttons used in the King study: 11 go back," "help," "main menu," "more detail," " next," "previous," and "quit."

The instrument consisted of four sections. To increase reliability, each button appeared in three of the four sections in different orders and with different textual descriptions. Four variations of textual descriptions were used for each button type. None of these variations included the exact terms for the buttons themselves so that it was not possible to match the functional descriptions directly to button text in either the single modality text treatment or the mixed modality treatment. To increase the reliability of the matching instrument, there were more descriptions than buttons in each section of the instrument, and only one description matched each button shown.

FIGURE 4. NAVIGATION BUTTONS USED FOR TREATMENT GROUPS

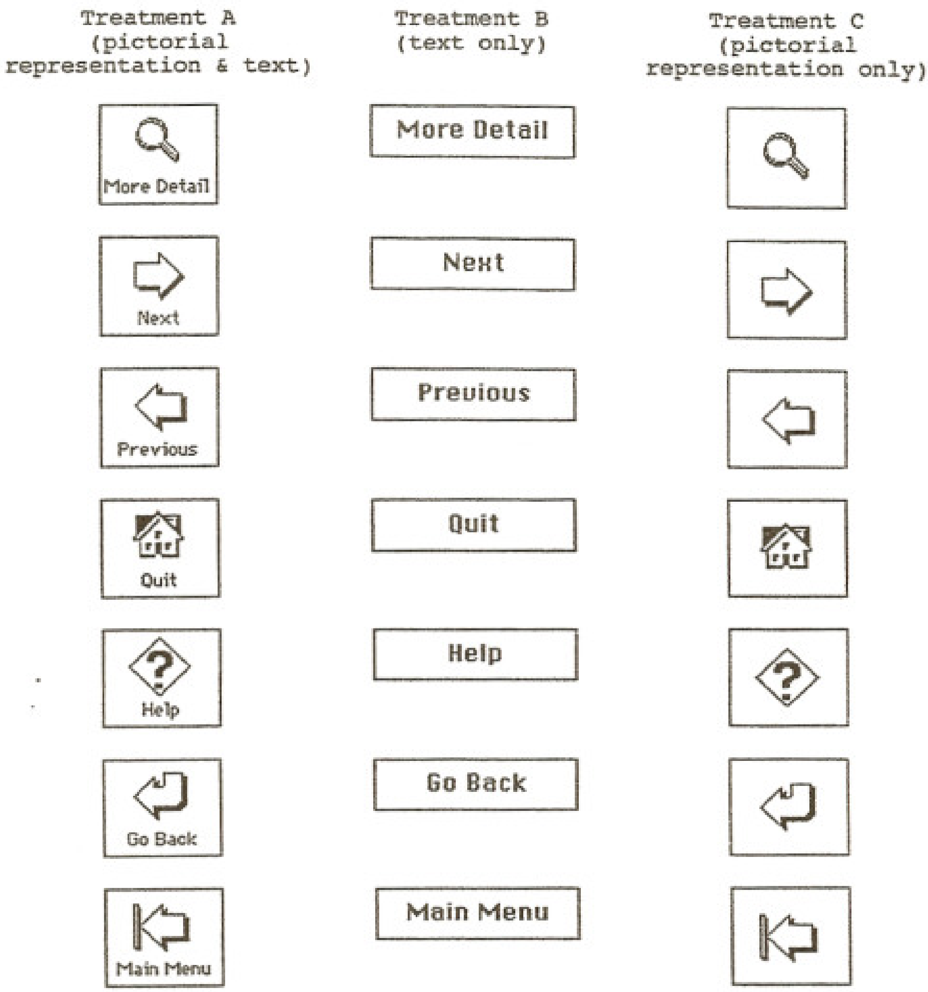


FIGURE 5. SAMPLE TREATMENT PAGE FOR TREATMENT A (PICTORIAL REPRESENTATION AND TEXT)

Write the letter of the corresponding definition in the blanks provided.

___ 1 

___ 2 

___ 3 

___ 4 

___ 5 

a go to the program's initial screen

b reverse one card or screen

c advance one card or screen

d go to the beginning of the stack

e assistance

f exit the stack/program

g for a closer examination

Three versions of the instrument were used, differing only in the types of representations displayed on the buttons: single modality text representations, single modality pictorial representations, and mixed modality representations. Three subjects pilot tested the three treatments, and minor adjustments were made to the wording of two textual descriptions to make them more precise.

Testing Procedures

Subjects indicated on a blank line next to each button the letter corresponding to the description of function they thought was correct. Three groups of subjects completed the instruments (n=35, n=31, n=32). Subjects within each group were randomly assigned one of the three treatments (single modality text, single modality pictorial, and mixed modality). Most subjects completed the instruments in 15 minutes or less, and only one subject left the instrument incomplete.

RESULTS

Ninety-eight subjects were tested. Three of the ninety-eight responses were considered invalid for the following reasons: (a) one incomplete instrument, (b) multiple answers on two instruments. One additional instrument was randomly rejected from the group to ensure an equal number (n=31) of subjects for each treatment (text only, pictorial symbol and text, and text only). This procedure reduces susceptibility to biased results, and does not affect statistical outcomes [34].

The mean number of errors (see Table 2) indicated that subjects averaged over three times as many errors for treatment C (single modality pictorial) as for treatment A (mixed modality) or treatment B (single modality text).

TABLE 2. ERRORS IN BUTTON IDENTIFICATION FOR TREATMENT GROUPS

Groups	n	M	SD
Treatment A (pictorial representation and text)	31	2.84	2.16
Treatment B (text only)	31	2.13	1.94
Treatment C (pictorial representation only)	31	8.10	2.31

A one-way analysis of variance for the three treatment groups concluded that there was a significant difference between the means ($F(2,90)=71.55$, $p<.Ol$). A Tukey HSD test ($qT=1.6$, $p<.Ol$) identified a significant difference between treatments C and A (5.97) and treatments C and B (5.26); however, there was not a significant difference between treatments A and B (.71).

An omega squared test was carried out to determine the relationship between the independent and dependent variables. There was a .603 strength of association between the treatment given (independent variable) and the number of user errors (dependent variable).

In order to see if there was a difference between the responses of native English speakers and non-native English speakers, the means and standard deviations were calculated for a 2x3 design using English speaking ability as a blocking variable (see Table 3). Because of the very uneven cell sizes resulting from few non-English speakers participating in the study no further tests were made. The pattern of errors does not appear to differ between the native English and the non-native English-speaking groups.

A comparison of the means and standard deviations between the variables of HyperCard experience and no HyperCard experience (see Table 4) indicates an interaction between the mean number of errors which could be masking a difference between the two groups. A two by three generalized randomized block (GRB-3, 34) ANOVA was carried out to analyze the effect of HyperCard experience.

TABLE 3. MEAN NUMBER OF ERRORS FOR NATIVE ENGLISH SPEAKERS AND NON-NATIVE ENGLISH SPEAKERS BY TREATMENT GROUP

	Native English Speakers			Non-Native English Speakers		
Groups	n	M	SD	n	M	SD
Treatment A (pictorial representation and text)	23	2.57	1.90	8	3.63	2.77
Treatment B (text only)	27	2.00	1.59	4	3.00	3.83
Treatment C (pictorial representation only)	27	8.04	2.28	4	8.50	2.89

TABLE 4. MEAN NUMBER OF ERRORS FOR HYPERCARD EXPERIENCE AND NO HYPERCARD EXPERIENCE BY TREATMENT GROUP

	HyperCard Experience			No HyperCard Experience		
Groups	n	M	SD	n	M	SD
Treatment A (pictorial representation and text)	14	2.21	2.15	17	3.35	2.09
Treatment B (text only)	13	2.62	2.26	18	1.78	1.66
Treatment C (pictorial representation only)	11	8.64	1.96	20	7.80	2.48

The unequal cell sample sizes were handled using a SAS Type III procedure (non-additive sum of squares) to compensate for the unequal cell sample sizes (see Table 5). There was not a significant source of variation from the blocking variable, Hypercard experience, and the interaction between treatment types and HyperCard experience was also not significant.

TABLE 5. ANALYSIS OF VARIANCE FOR TREATMENT TYPE AND HYPERCARD EXPERIENCE

Sources of Variation	df	F
Treatment (T)	2	70.63*
HyperCard Experience (H)	1	0.16
T x H	2	2.17

* Significant

The mean user errors of this study were also compared to the mean user errors of the King study (see Table 6) and found to be consistent.

TABLE 6. COMPARISON OF MEANS BETWEEN KING [1] AND CURRENT STUDY

Groups	King et al., 1996	Current Study
Treatment A (pictorial representation and text)	2.62	2.84
Treatment B (text only)	3.77	2.13
Treatment C (pictorial representation only)	8.23	8.10

LIMITATIONS OF THE STUDY

Since this study was designed to emulate the King study [11, it was necessary to use exactly the same button set as was used previously. Similar studies using more buttons, and buttons from different authoring systems or instructional hypermedia products, would be desirable, as would studies using larger and more diverse subject samples.

DISCUSSION

Subjects made significantly fewer errors when presented buttons containing text, or pictorial representations and text, than when presented with buttons containing pictorial representations only. The authors believe that this study taken together with the other studies reviewed, indicates the importance of using text, or text and pictorial representations both, in designing navigation buttons.

Since this study used out-of-context stimulus items and the same results obtained as in the previous study using contextualized items, the authors of this study now question the necessity of contextual elements and task descriptions in this type of research. The authors do not question the importance of using tasks and context in usability studies for specific product designs, and advocate usability testing of button designs for individual products regardless of what guidelines have been used to develop them. It may also be that including tasks and context would prove important when larger sets of buttons or more complex navigation functions were being studied, and the authors believe this issue deserves further investigation.

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