THE EFFECT OF AFFECT:
THE HEDONOMIC EVALUATION OF HUMAN-COMPUTER INTERACTION

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We evaluated the use of color in a human-computer interface to investigate how affective cues influence usability judgments. Yellow and green, were found to enhance performance on a cognitive flexibility task as compared to white and gray. Such an outcome suggests that color promotes positive affect. The aesthetically designed interface that promoted positive affect was also found to enhance perceptions of interface usability. This relationship, however, was only found when underlying usability was effective. When usability was poor, aesthetics made users more cognizant of the usability weaknesses. The results suggest that designers consider incorporating color into designs to help elicit positive emotion in users but that they must be aware that incorporation of aesthetics comes with the potential cost of disposing users to be more discerning of usability.

INTRODUCTION

Affects have significant effects which need elucidation so that a full portraiture of human-machine interaction can be generated. All operational domains have experienced a significant change as workload has shifted from largely physical to largely cognitive composition. The transition in work has changed the 'form' of the demand but not the 'perception' of the demand, which it is still viewed as 'work' and thus not enjoyable (Hancock, 1997). In the evolution of human-technology interaction a movement is now emerging that seeks to promote pleasure through design (Jordan, 2000; Helander, 2002). Until recently the design of artifacts was independent of the explicit consideration for aesthetics and with a few odd exceptions, ubiquitously placed usability goals ahead of enjoyable interaction (Norman, 1990). Today's advances in technology enable the flexibility to achieve usability goals as well as promote pleasure in users (Jordan & Servaes, 1995). Hedonomics, a term coined by Hancock (2002), proposes to dissolve what we conceive as the adverse or unpleasant attributes of work by aiming to facilitate the design of work, and all aspects of it, to be intrinsically enjoyable.

In the realm of Hedonomic research, the present study investigated the relationship between aesthetics and usability by incorporating color into design with the intent to promote positive affect in the user and by concomitant measures the user's perceived usability of the system.

Attribution Theory

The relationship between aesthetics and perceived usability is congruent with the social phenomenon of inferring personality traits from physical attractiveness. Dion, Berscheid, and Walster (1972) found that people that were viewed as physically attractive were assumed to possess more socially attractive traits than those that were viewed as unattractive. A possible explanation for this phenomenon is the halo effect, which proposes that the most obvious or salient characteristic (in this case, attractiveness) is perceived first and tends to bias perceptions and inferences that come after. Furthermore, social psychology research reveals that initial perceptions persevere even after presentation of contrary evidence (Gilbert, Krull, & Malone, 1990). Based on this halo effect, users may attribute more desirable traits (such as ease of use, ease of learning) to interfaces that are designed to be aesthetically pleasing compared to interfaces that are not aesthetically pleasing. Users may even continue to attribute desirable traits to aesthetically pleasing interfaces even after they are presented with evidence to be contrary.

Aesthetics is a concept that is defined subjectively and therefore difficult to manipulate systematically in an experimental setting. There

are clear usability guidelines in interface design but no clear aesthetic guidelines. A rule of thumb is that aesthetics should promote pleasure by eliciting positive affect in the human (Hancock, 2002; Norman 2002). According to Norman one way of viewing aesthetics can be through color. Switching from black and white displays to color displays doesn't have an obvious affect on the usability of the display but does have an obvious effect on the aesthetics of the display. Most people prefer color displays. Color may have some emotional affect on the user rendering them to prefer a color to black and white display.

Positive affect and cognitive flexibility

While color has still to be shown to directly relate to affective state (Sinclair, Moore, Lavis, & Soldat, 2002), it has already been shown to differentially affect information-processing strategy. More specifically, negative and neutral affective colors have been shown to lead to more systematic, discerning processing, while positive affective colors render a more accepting, indiscriminate processing approach. Thus, negative affect may lead to greater cognitive flexibility, where an individual perceives and interprets information from multiple perspectives and in greater detail. Yet, cognitive flexibility has been shown to increase with the presentation of a stimulus used to elicit positive affect in a person (Isen, 2000; Isen et al., 1987). Several studies (Estrada et al, 1994; Isen et al, 1987) have found that promoting positive affect improves cognitive flexibility.

This presents a conundrum. Will positive color in a design lead people to process information in less detail and thus potentially gloss over usability weaknesses or will it lead to greater cognitive flexibility and a more discerning assessment of usability? If the former is true, products should liberally incorporate color as it could mask usability weaknesses. If the latter is true, incorporating color could render usability of utmost importance, as users would readily perceive any weaknesses. The objective of the current study was to resolve this question by determining how affective color cues influence usability judgments.

METHOD

Participants

Participants were 12 undergraduate students, between the ages of 19 to 26, seven males and five females, enrolled in a psychology course, and who participated in the experiment for extra credit. Participants were screened to ensure color vision capacity.

Task

Participants were asked to compute 15 multiplicative calculations on one of two computer-programmed calculator designs. One of the designs had a white background and gray keys, the other had a yellow background and green keys (see Terwogt & Hoeksma, 1995; Peretti, 1974). Thereafter the participants were asked to fill out an evaluation form of the calculator interface using a modified satisfaction questionnaire (Shneiderman, 1991). The final task was to perform a Remote Associate Test (RAT), which can be used to assess cognitive flexibility (Mednick. 1962).

Procedure

Participants were randomly assigned into either the experimental group or the control group. Participants in the experimental group were presented with the yellow and green calculator display (on the computer interface) twice, one display with high usability (no delay in feedback) and one with low usability (75 ms delay in feedback). Each time the calculator display was presented, participants were asked to perform a multiplication task. These tasks consisted of multiplying a string of 15 different numbers. In the second multiplication task, the numbers changed but still remained as a string of 15 different numbers. After the participants completed their multiplication task they were asked to rate the calculator display's general usability via the satisfaction questionnaire. Then participants were asked to complete the RAT.

Experimental Design and Manipulation

The experiment used a 2x2 mixed design. Aesthetics level (high [color] vs. low [no color]) of the calculator interface was the between-subject variable. The within-subject variable was interface usability level (high [no delay in feedback] vs. low [75 ms delay in feedback]). Tractinsky, Katz, and Ikar (1999) used similar manipulations. Participants were shown either the color or the no-color interface, once with high usability (no delay) and once with low usability (75 ms delay), with the order of

feedback presentation being randomized among participants. After each exposure to the calculator, participants rated the usability of the calculator display and completed five items from the RAT. Thus, the dependent variables of the study include "ease of use" or the user's perceived usability of the system, and "positive affect" or degree of cognitive flexibility.

RESULTS

The first objective was to investigate if color elicits greater cognitive flexibility in users. If color is an affective stimulus in interface design then participants from the experimental group (those receiving the color design) should score higher on the RAT than participants in the control group (those receiving the no color design). ANOVA results revealed a significant effect of color on the participants' RAT scores, $F(1,9)=4.285$, $p=.05$. Participants that received the colored calculator displays ($M=51$, $SD=3.27$) performed significantly better on the RAT compared to the participants that received the non-color displays ($M=47$, $SD=2.79$). These data indicate that the incorporation of color into a design can enhance cognitive flexibility.

The next objective was to determine how greater cognitive flexibility influenced usability judgments. ANOVA results revealed no significant main effect for aesthetics (i.e., color), but a significant main effect for usability level (see Figure 1) on the participants' perceived usability scores ($F(1,9)=9.085$, $p=.01$), and a significant interaction between aesthetics and usability ($F(1,9)=7.279$, $p=.01$), see Figure 2.

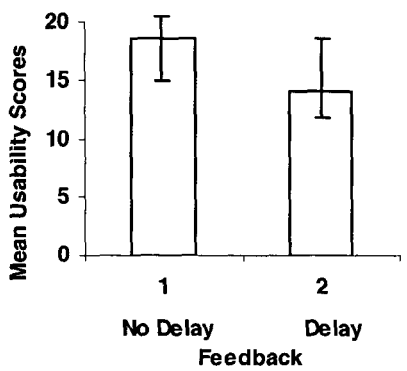

Figure 1. *A graphic display of the perceived usability means for the IV-delay in feedback, where '1' indicates no delay in feedback and '2' indicates delay in feedback.*

Pairwise comparisons indicated that participants rated the color calculator with a delay in feedback (CD) significantly ($P=.05$) lower in usability than all other displays. The color calculators with no delay (CND) in feedback were rated significantly ($p=.05$) higher in usability than all other displays. There was no significant difference in perceived usability between the delay in feedback (NCD) and no delay in feedback (NCND) conditions for the non-color calculator (see Figure 2).

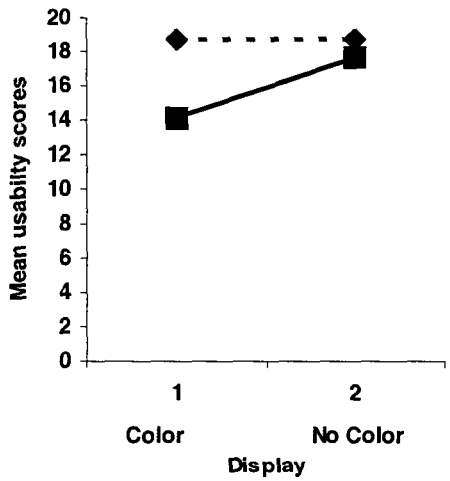

Figure 2. *A graphic representation of the means for the interaction between aesthetics (1 = color and 2 = no color display) and usability level (dashed line = no delay in feedback and solid line = delay in feedback.*

DISCUSSION AND CONCLUSIONS

This study has contributed two new findings toward the promotion of pleasure in human-technology interaction. First, aesthetically pleasing designs may only promote pleasure in the user when coupled with good usability criteria. As revealed in Figure 2, despite the aesthetic manipulation, color displays were not pervasively rated higher in usability than non-color displays when the two designs (both with and without delay) were compared. Interestingly, it appears that participants became the most frustrated with poor usability when a color display was used as compared to a non-colored display. This finding contradicts the hypotheses and previous findings that reported an increase in perceived usability of aesthetically pleasing designs regardless of their actual usability (Kurosu & Kashimura, 1995; Tractinsky, Katz,

& Ikar, 1999). Generally, participants preferred the color display with no delay over the other displays until the delay of feedback was incorporated into the design, then participants preferred the non-colored display. The results suggest that aesthetically designed interfaces may enhance perceptions of usability only when underlying usability is strong. When usability is weak, aesthetics may make users more perceptive of usability weaknesses. Thus, if a product has known usability flaws, it may be best to minimize product aesthetics. Second, colors such as yellow and green were shown to enhance performance on cognitive flexibility tasks (i.e., RAT), suggesting that they have the potential to promote positive affect in users.

Therefore, designers should consider incorporating color into designs to help elicit positive emotion in the user. Designers must be aware, however, that incorporation of aesthetics comes with the potential cost of disposing users to be more discerning of usability. It is thus essential that designers fully understand the affective consequences of their designs. With today's advances in technology we now have the flexibility to achieve both usability goals as well as promote pleasure in the user. The findings from this study confirm the importance of both in good human-technology design.

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