

**Chromatic Scales on our Eyes: How User  
Trust in a Website Can Be Altered By Color  
Via Emotion**

**Jean-Eric Pelet**  
**IDRAC International School of Management**  
**University of Nantes**  
**16 rue Laurence Savart**  
**F - 75020 Paris**  
**jepelet@yahoo.com**

**Christopher M. Conway**  
**IÉSEG School of Management (LEM-CNRS)**  
**1, parvis de la Défense**  
**F - 92044 Paris-La Défense cedex**  
**c.conway@ieseg.fr**

**Panagiota Papadopoulou**  
**University of Athens**  
**Department of Informatics and Telecommunications**  
**Panepistimiopolis, GR - 15784, Athens, Greece**  
**peggy@di.uoa.gr**

**Moez Limayem**  
**College of Business, University of South Florida**  
**Tampa, Florida**  
**mlimayem@usf.edu**

## **Abstract**

Establishing customer trust on an e-commerce website possibly requires the provision of an environment in which customers can overcome their fear and reluctance about shopping transactions by forming trust and positive perceptions about the online vendor. This research concentrates on color as a central factor in the design of web pages that enhance users' positive emotional reactions as well as trust states and behaviors. Drawing on existing theories and empirical findings in the environmental psychology, human-computer interaction, as well as in the marketing and information systems research literature, a research model is developed to explain the relationships among background and foreground colors of a webpage, induced emotional responses in users, and users' trust toward the website as mediated by users' emotional states. A laboratory experiment was conducted to test the model and its associated hypotheses. This permitted assessment of the influence of background and foreground colors on user emotions and trust under varying brightness and saturation levels. Sixteen different graphic charts were evaluated based on various contrast ratios. We use the PAD (Pleasure Arousal Dominance) scale from Mehrabian and Russell (1974) and find that color can increase arousal, leading to stronger trust. Color leads to higher trust levels when arousal states are present at a high level. Our empirical findings provide valuable theoretical and practical implications regarding the effect of websites color on trust.

## **Keywords**

Color, trust, trusting beliefs, e-commerce, arousal

## 1 Introduction

Although e-commerce keeps on growing exponentially, designing interfaces still remains strategic for companies regarding their e-commerce website's ROI. Whether it comes from human-computer interaction (HCI), psychology and cognition, or from the marketing research, questions remain unanswered about the reason why consumers will trust a particular e-commerce website. As users have several options for shopping online, considering the huge number and variety of e-commerce websites, they may choose their preferred interface on the base of emotional responses. This places emphasis on the color of the webpage interface, and stresses the need for interfaces that promote engagement, pleasure, and delight rather than just functionality or ease-of-use (Marcus 2002; Wright *et al.*, 2001).

This paper aims to study the impact of the colors of e-commerce websites on customer trust. The effect of the colors of e-commerce websites on customer trust has only been indirectly examined in terms of website characteristics, such as website quality and usability, where color is viewed as a key interface attribute. In addition, despite the increased attention on affective aspects of user interface design (Dillon, 2001; Norman, 2003) and their importance for online shopping (Eroglu *et al.*, 2003), little is known about the emergence of trust thanks to greater experienced affective states. Affect is closely linked to attitudes, cognitions, and motivations. It influences and mediates specific aspects of interaction with a user interface (Deng and Poole, 2010).

The paper presents an empirical study of the effects of e-commerce website background and foreground colors on customer emotions and trust. Unlike most empirical studies dealing with color by comparing warm and cold colors, we examine color by focusing on its hue, brightness and saturation, following the recommendations of Gorn *et al.* (2004) and Pelet and Papadopoulou (2012) so as to demonstrate that its influence varies according to the intensity of each of these three components.

The structure of the paper is as follows. In the next section, the theoretical background and research model linking e-commerce, color, emotions and trust aspects are provided. The following section presents the research model and hypotheses. The empirical testing of the model is described next. The section that follows presents our results. The paper ends with the conclusions, implications for theory and practice, limitations and future research.

## Theoretical Background and Research Model

The “Stimuli – Organism – Response” (SOR) environmental psychology model proposed by Mehrabian and Russell (1974), synthesized with the work of Engel *et al.* (1978) and Filser, (1994), is used as the framework in this study for understanding web users’ emotional and trust responses to the foreground and background colors of a website. Our proposed model explains how the background and foreground colors of an e-commerce website and specifically their components - hue, brightness and saturation - can have an impact on the buyer’s affective state of emotion and cognitive states of trust. Specifically, we use color as stimulus, the emotional state as arousal induced by the stimulus, and trust is the response.

Color has been identified as a pivotal component of e-commerce websites (Gorn *et al.*, 2004), supporting a positive customer experience. It contains three principal components (Trouvé, 1999):

- The hue (or chromatic tonality), which is the attribute of the visual sense defined according to the colors denominations such as blue, green, red;
- The saturation, which provides the proportion of chromatically pure color contained into the total sense;
- The brightness, which corresponds to the component according to which a surface illuminated by a source seems to emit more or less light.

To this day, the effects of the three color components on websites have been but seldom documented. Color has mainly been addressed in terms of warm and cold hues (Coursaris *et al.*, 2008; Papachristos *et al.*, 2005) and has not been examined with respect to its components, hue, brightness and saturation. Most of the studies linking color and e-commerce take into account balance or brightness as variables of colors (Brady and Phillips, 2003) or combinations of colors (Humar *et al.*, 2008), which do not allow for comparing the effects of the components of the colors. As Valdez and Mehrabian (1994), Drugeon-Lichtlé (2002), Camgöz *et al.* (2002), Gorn *et al.* (2004) and Pelet and Papadopoulou (2012) show about the brightness component of color, an experiment involving color should compare hue and brightness rather than warm and cold colors in order to understand its effects on consumer.

On a website, the interface represents a graphic chart, which refers to a collection of website elements. A graphic chart includes two colors, the foreground color and the background color, both of which constitute the color scheme. These colors create the contrast, which corresponds to the opposition between the foreground and the background colors, as defined by W3C (W3C, 2008). Its main function relies on facilitating the readability of the displayed information, and *a fortiori* the memorization process.

Aware of the significant and widely known impact of the atmosphere inside stores on the prospective buyers' activities and behavior in a traditional shopping context (Kotler, 1973; Donovan and Rossiter, 1982; Filser, 1994, 2003a, 2003b; Lemoine, 2003), there is a need to investigate how emotions and trust are affected by color, as an atmospheric variable and as a component of e-commerce interfaces. The role of color has been shown to be important for the readability and memorization of information, information seeking and navigation within a web vendor site (Pelet, 2008, 2010). These color-dependent factors constitute or are closely intertwined with antecedents of trust, which are associated with an e-commerce web site. This implies that color could be related to emotions, as it is a key attribute of website characteristics that have an effect on trust. Thus, we can hypothesize:

- H1A: An increase in contrast increases arousal
- H1B: An increase in foreground brightness increases arousal
- H1C: An increase in foreground saturation increases arousal
- H1D: An increase in background brightness decreases arousal
- H1E: An increase in background saturation decreases arousal:

However, color has only been implicitly associated with trust (see Pelet and Papadopoulou, 2011). The relationship between color itself and trust remains largely unaddressed. Color, as an important interface variable in e-commerce, is expected to be an important antecedent of customer trust in an online vendor.

There is also a lack of research on the effects of colors of e-commerce websites on consumer's trust, by considering the impact of affective states as a mediating variable of the link. The effect of color on emotions has been the research topic of several studies such as Valdez and Mehrabian (1994) and Lichtlé (2007) but not in an online context. Eroglu *et al.* (2001, 2003) investigated the effects of atmospheric cues of the online store on shoppers' emotional and cognitive states, showing that they affected their shopping outcomes. Similar to traditional in store stimuli, online colors can provide information about the retailer (e.g., the quality or type of retailer, the target audience of the retailer) as well as influencing shopper responses during the website visit (Eroglu *et al.*, 2003). The consumer's affective states can directly affect the website visit duration. It is then possible to presume that consumer's emotions affect the website visit trust of the consumer.

We develop the research hypotheses proposing links among the color, emotions and trust variables. Hence, we suggest the following hypotheses:

- H2A: An increase in pleasure increases trust
- H2B: An increase in arousal increases trust
- H2C: An increase in dominance decreases trust

## Research Method

The research hypotheses have been empirically tested with a quantitative study in a laboratory experiment. This involved the use of a mock e-commerce site on which we manipulated the foreground and background colors. We used a single website for the experiment, so that our results would not be confounded by differences in the site. Consumers react well to tangible goods; therefore, the development and use of an e-commerce website selling CDs seemed appropriate, similar to the type of e-commerce website they might usually visit. In order to focus on only hue, brightness, and saturation, we decided to vary the site with only two hues, and two levels each of saturation and brightness. While this may reduce the strength of the effect observed, we felt that keeping the plan simple, in order to avoid confounds, was more important. After respondents interacted with the site, they filled out a questionnaire which we used to measure their emotional reactions and trust.

A laboratory experiment was necessary to allow for controlling and neutralizing the three major elements that should be taken into account when conducting a study focusing on color, namely the screens, the ambient light, and, the participants' color perception (Fernandez-Maloigne, 2004; Pelet and Papadopoulou, 2012). Since, these elements cannot be controlled in a distance study carried out over the Internet, a controlled laboratory setting had to be used for our experiment. Screens were calibrated using a probe to ensure that the colors were displayed as defined. The color of the walls was neutral grey. The grey color of the walls prevents a bad reflection of ambient light on the screens, which avoids color distortion on the screen. By neutralizing the colors of both the ambient light and the walls we were confident that we avoided any distortion. The brightness of the room was then set at 1000 lux to guarantee that the colored appearance of the websites used for the experiment would not be biased by a too dim or a too bright room light. On the website, foreground and background colors were controlled in order to provide the desired stimuli. Hues have been chosen in order to provide adequate contrasts for easy reading, following Hill and Scharff recommendations (1997). We made small changes to the saturation and brightness of both the foreground and background colors in the experiment. With low and high levels of both saturation and brightness, and both foreground and background colors, this resulted in 16 possible color combinations.

The laboratory experiment was conducted with 190 participants, recruited from undergraduate business classes and were offered course extra credit for participation. A respondent would visit the website and browse the available CDs. There were 57 available CDs in 19 categories (3 CDs/category). For each CD, participants could see the CD cover, the album title, the artist name, and seven information items: music category, online store price, music company price, sale per-

centage, delivery time, state (new or used) and delivery charge. This detailed information was displayed by clicking on the cover image or the title of a CD. In addition, the detailed information included a short description of around 20 words, next to the CD cover.

Participants could select a category on the left side of the webpage and see the 3 CDs of this category on the right side of the same webpage. They had to look into the details of a minimum of two CDs of their choice. They could look at more than two CDs if they wanted to, and add them to their shopping cart, but they could not conduct real purchases.

Each participant visited the website with colors which were randomly selected among the 16 graphic charts prepared for the experiment, as explained previously. A balanced distribution of the graphic charts among all respondents was ensured. After viewing at least two CDs, an easy to see link appeared and respondents were asked to complete a questionnaire with questions about emotions and trust. We used previously validated measures for trust and affective responses. The trust measures were based on the Pavlou and Gefen (2004) and McKnight *et al.* (2002) scales. Emotions were measured with the Mehrabian and Russell Pleasure, Arousal, and Dominance (PAD) scale. Participants were not able to proceed to the questionnaire unless they had visited at least two CDs, in order to ensure that they had viewed adequate information for responding to the subsequent questions. Then, each participant was asked to go to another room to take an Ishihara test, the most common test for detection of color blindness. It was conducted in a different room from the experiment, as suggested by Lanthony (2005) to ensure that participants were in a position to respond to the stimulus. It also prevented hypothesis guessing.

## **Analysis and results**

We collected the survey responses by including pages in the mock website in standard fonts and colors without ornamentation. After discarding questionnaires that were incomplete or filled by color blind respondents, 190 valid responses were used for the analysis, with each color scheme being visited by about 12 respondents. There were 16 color deficient participants, which account for approximately 8% of the sample. This percentage is equal to the actual percentage of color deficient males in the world (Brémond, 2002).

Because respondents do not always respond carefully to studies, we cleaned the data prior to analysis. We imported the data into R version 2.15.1 (R Development Core Team, 2011) for this process. We cleaned the data by visually comparing the scatter plot of the Mahalanobis distance versus a chi-square distribution using a diagonal as a visual referent, removing extreme data points incrementally until the

distributions matched. Most deleted points were invalid responses. While a few may have been valid, though extreme, responses, we were interested in finding the average person's response, so deleting extreme points is justified as well. After cleaning, 138 data points remained.

We loaded the cleaned data into SmartPLS version 2.0.3 for analysis (Ringle, Wende and Will, 2005). We used a first-order model, using the default PLS algorithm options, to obtain the latent variable scores for the trust variable. The measures were reliable, with composite reliability ranging from 0.83 (integrity) to 0.96 (competence). Average variance extracted (AVE) ranged from 0.46 (integrity) to 0.77 (competence). The AVE for integrity was a little below the threshold of 0.50. An examination of the item loadings indicated that there was some cross loading between benevolence and integrity. This is not a serious problem for our results, particularly since they were going to be loaded onto the same second-order factor.

We constructed the final model with trust as a second-order factor, using the default PLS options, and ran a bootstrap with 138 cases for 1000 iterations to estimate the standard errors. The results are presented in Table 1 and Figure 1. The AVE for arousal was a little low; however, we judged this not to be a serious problem, since reliability is good, and the discriminant validity is still good. Since the color components and contrast are single-indicator values, and trust is a formative construct, there are no reliability figures associated with them.

Table 1 : Convergent and discriminant validity

Variable	AVE	Composite Reliability	Correlations (diagonal is sqrt (AVE))			
			Pleasure	Arousal	Dominance	Trust
Pleasure	0.991	0.998	0.995			
Arousal	0.470	0.830	0.332	0.686		
Dominance	0.767	0.950	-0.407	-0.051	0.876	
Trust	Not applicable		0.603	0.367	-0.387	Not Applicable



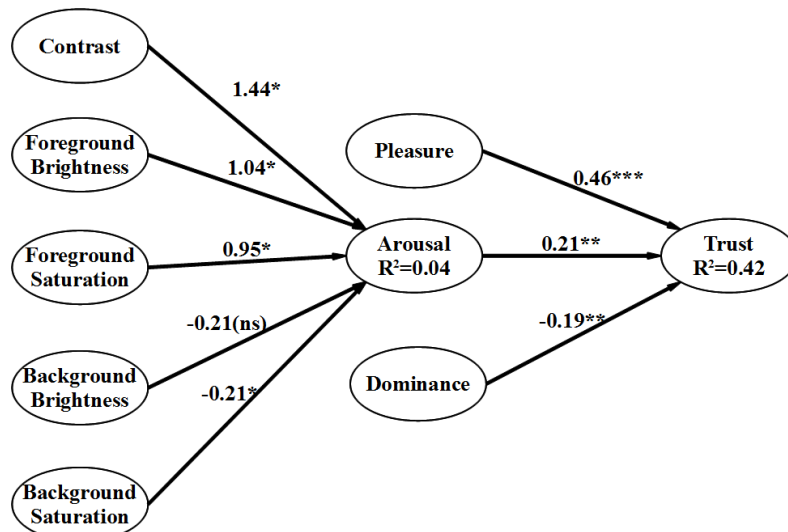


Figure 1 : Results – (\*p<0.05, \*\*p<0.01, \*\*\*p<0.001)

Our results support the hypotheses, as seen in Figure 5. Contrast, foreground saturation, and foreground brightness have a significant positive relationship with arousal; higher values of these variables lead to higher arousal, supporting H1A, H1B and H1C. Higher values of background saturation reduce arousal supporting H1E. However, there is no significant relationship between background brightness and arousal, thus H1D is not supported.

It is interesting to note that there are significant effects of both contrast and color components independent of each other. In models which do not include contrast, no color components are significant; and, likewise, if the color components are not included, then contrast is not significant. Thus, there is a suppression effect, in which not including both types of variables yields inconclusive results.

Increase in pleasure or arousal result in an increase in trust, confirming H2A and H2B. A person who feels more pleased or aroused when navigating a website is more willing to trust it. An increase in dominance results in a decrease of trust, confirming H2C. An increase in dominance means that the person feels more in control of the relationship between themselves and the website. In these circumstances, the person feels less need to trust the object of their attention, because of that feeling of control. With less need to trust, the person will not expend cognitive effort in determining trust, leading to a lower overall level of trust.

## Discussion and conclusion

Traditional e-commerce websites use a similar, almost sterile, design solution, with muted colors and standard placement of navigational aids. For example, Dell, Microsoft, Facebook and so, on use almost interchangeable designs, making us more accustomed to these functional, stereotypical websites. Our research indicates that this approach may not be optimal; that rather than not upsetting users, web designers and organizations might be more successful if they aim for inspiring users. Among the characteristics of an e-commerce website, colors have a significant influence on the reaction of the consumers. These colors can make them comfortable, but also uninspired, and their response is correspondingly weak. Our research indicates that using more saturated and brighter foreground colors can motivate consumers to feel excited or energized by a website. Naturally occurring color combinations with bright, saturated foreground colors that are reminiscent of natural environments lead the consumer to more positive reactions to the site. These kinds of colors make the site more memorable and more pleasant for the consumer to use. These are all positive emotions, and consumers naturally try to justify their positive emotions by attributing more positive characteristics to a website which induces these emotions. Our research further shows that arousal is an important component of those reactions, which can lead to an increase in trust. Increasing trust is an important goal of website design, as trustworthiness is well known to improve the success of an e-commerce website.

Obviously, the color is only one component of the characteristics that lead a consumer to react positively to and trust a website. Other elements which affect the atmospherics of a site, such as familiarity (*“the navigation bars and important cues of the website are where I expect them to be”*), clarity of interface (*“the controls do what I expect them to do and do not increase my cognitive load”*), and transparency of information use (*“I have assurances that my data privacy will be respected and my data will be used to my benefit”*) are also critical (Eroglu *et al.* 2003). When an organization properly uses all these components, including color, it can create a truly memorable and satisfying experience for the consumer. Further research will help to identify which of these components will stand with color as determinants of those positive consumer reactions.

## References

- Bellizzi J.A. and Hite R.E. (1992). Environmental Color, Consumer Feelings, and Purchase Likelihood, *Psychology and Marketing*, 9, September-October, 347-64.
- Brady L., and Phillips C. (2003). Aesthetics and usability: a look at colour and balance. *Usability News*, 5(2), <http://www.surl.org/usabilitynews/112/pdf/Usability%20News%20112%20-%20Phillips.pdf>
- Brémond, É., (2002). *L'intelligence de la couleur*, Paris, éd. Albin Michel.
- Brengman, M., and Geuens, M. 2004. "The Four Dimensional Impact of Color on Shopper's Emotions.," *Advances in Consumer Research* (31:1), pp. 122–128.
- Camgöz N., Yener N. and Güvenç D. (2002). Effects of hue, saturation, and brightness on preference, *Color Research & Application*, 27, 3, 199-207.
- Deng L. and Poole M.S. 2010. Impacts of Web Page Visual Complexity and Order, *MIS Quarterly* Vol. 34 No. 4 pp. 711-730.
- Dayal, S., Landesberg, H., & Zeisser, M. (2001)., "Building trust online". McKinsey Quarterly (October). Available at: [www.mckinseyquarterly.com/ab\\_g.asp?ar=1138](http://www.mckinseyquarterly.com/ab_g.asp?ar=1138).
- Dillon, A., (2001). "Beyond Usability: Process, Outcome and Affect in Human–Computer Interactions," PANTIN-SOHIER G (2004) Le rôle de la couleur dans la perception des traits de personnalité de la marque : une étude comparative Etats-Unis / Suède, 1ère journée de recherche AFM-AUDENCIA sur le Marketing et le Design - Janvier. (26:4), pp. 57-69.
- Dunn B. (1992). Choice of Color for Product Can Be Critical Factor, *The Gazette*, August 10, 6.
- eMarketer (2008). "US Consumers Wary of Online Payments". Available at: [http://www.emarketer.com/SiteSearch.aspx?arg=tr ust&src=search\\_go\\_welcome](http://www.emarketer.com/SiteSearch.aspx?arg=tr ust&src=search_go_welcome)
- Engel J. F., Kollat, D. T. and Blackwell R. D., (1978). *Consumer Behavior*, 3rd edition, Hinsdale, Dryden Press, II.
- Eroglu S. A., Machleit K.A. and Davis L.M., (2001). Atmospheric qualities of online retailing: a conceptual model and implications, *Journal of Business Research*, special issue on Retail Strategy and Consumer Decision Research, 54, November, 177-184.
- Eroglu S. A., Machleit K.A. and Davis L.M., (2003). Empirical Testing of a Model of Online Store Atmospherics and Shopper Responses, *Psychology & Marketing*, 20, 2, 139-50.
- Fernandez-Maloigne C., (2004). *Quelle métrique pour l'évaluation de la qualité couleur d'une image numérique ?* Application à la compression JPEG2000, CAM Conférence, Paris, octobre.
- Filser M., (1994). *Le comportement du consommateur*, Précis Dalloz, Paris.
- Gefen, D., Karahanna, E. & Straub, D. W. (2003). Trust and TAM in Online Shopping: An Integrated Model. *MIS Quarterly*, Vol. 27, No. 1, pp. 51-90.
- Gorn G., Chattopadhyay A., Sengupta J. & Tripathi S. (2004). Waiting for the web : how screen color affects time perception, *Journal of Marketing Research*, XLI, May, 215-225.
- Hill A. & Scharff L. V. (1997). Readability of websites with various foreground/background color combinations, font types and word styles, *Proceedings of 11th National Conference in Undergraduate Research*, 2, 742-746.
- Howard Hughes Medical Institute, (2006). Breaking the Code of Color: Color Blindness: More Prevalent Among Males, Retrieved from the Internet at <http://www.hhmi.org/senses/b130.html> the 25/09/2012
- Humar I., Gradisar M. and Turk T. (2008). The Impact of Colors on the Speed of Reading Web Pages on a CRT monitor, *International Journal of Industrial Ergonomics*, 38, 885-899.
- Lichtlé M.-C., (2007). The effect of an advertisement's colour on emotions evoked by an ad and attitude towards the ad The moderating role of the optimal stimulation level, *International Journal of Advertising*, 26(1), 37–62.

- Marcus, A., (2002). "The Cult of Cute: The Challenge of User Experience Design," *Interactions* (9:6), pp. 29-34.
- McKnight, D. H., Choudhury, V. & Kacmar, C. (2002). "The Impact of Initial Consumer Trust on Intentions to Transact with a Web Site: A Trust Building Model", *Journal of Strategic Information Systems*, Vol. 11, pp. 297-323.
- Mehrabian, A., and Russell, J. A., (1974). *An Approach to Environmental Psychology*, MIT Press.
- Munsell A. (1969). *The Munsell Colour Atlas*, Munsell Color Corp.
- Norman, D. A., (2003). *Emotional Design: Why We Love (Or Hate) Everyday Things*, New York: Basic Books.
- Pantin-Sohier G. (2004) *Le rôle de la couleur dans la perception des traits de personnalité de la marque : une étude comparative Etats-Unis / Suède*, 1ère journée de recherche AFM-AUDENCIA sur le Marketing et le Design - Janvier.
- Papachristos E., Tselios N. and Avouris N. (2005). *Inferring relations between color and emotional dimensions of a Web site using Bayesian Networks*, Proceedings of Interact 2005.
- Pavlou, P. A., and Gefen, D. 2004. "Building Effective Online Marketplaces with Institution-Based Trust.," *Information Systems Research* (15:1), pp. 37–59.
- Pelet J.-É. et Papadopoulou P., (2012), The effect of colors of e-commerce websites on consumer mood, memorization and buying intention, *European Journal in Information Systems* (EJIS), Special Issue: "Information Research, Education and Policy in the Mediterranean Region".
- Pelet J.-É. et Papadopoulou P., (2011), The Effect of E-commerce Websites' Colors on Customer Trust, *International Journal of E-Business Research*, 7(3), 1-18, July-September 2011.
- R Development Core Team., (2011). R: A Language and Environment for Statistical Computing, Vienna, Austria: R Foundation for Statistical Computing.
- Ringle, C. M., Wende, S., and Will, A., (2005). SmartPLS 2.0 M3 (beta), Hamburg, Germany: University of Hamburg.
- Trouvé A. (1999). *La mesure de la couleur*, Paris, CETIM, éd. Association française de normalisation (AFNOR).
- Valdez P. and Mehrabian J. (1994). Effects of color on emotions, *Journal of Experimental Psychology, General*, 123, 4, 394-409.
- W3C (2008). Publication Version 1.1 of the *AccessiWeb repository created by the W3C*, of the June 9, 2008, available at: <http://www.w3c.org/>.
- Wright, P., McCarthy, J., Marsh, T., (2001). "From Usability to User Experience," *British HCI Group Members Magazine* (46), pp. 4-11.