

THE EFFECTS OF COLOUR ON USERS' COMPLIANCE WITH WARNING BANNER MESSAGES ACROSS CULTURES

Research in Progress

Silic, Mario, University of St Gallen, St Gallen, Switzerland, mario.silic@unisg.ch

Silic, Dario, Zagreb School of Economics and Management, Zagreb, Croatia, dsilic@zsem.hr

Oblakovic, Goran, Zagreb School of Economics and Management, Zagreb, Croatia, goblakov@zsem.hr

Abstract

The objective of this research in progress is to understand how colour affects users' decision-making processes in the context of warning banner messages. So far, little research has examined this complex psychological and cognitive process wherein the psychology of colour can play an important role in the relationship between the warning message and the user's decision-making process (the decision to continue or to exit). We aim to close the existing research gap by studying the effects of colour on users' decision-making processes across different cultures. More precisely, we intend to understand: 1) how different colour applications (black, blue, yellow, red, green, white) influence users' decision-making processes; 2) how diverse cultural groups are affected by different colour applications and 3) how warning messages impact the users' decision-making processes during the first and successive event occurrences. We build our work on the theory of psychological reversals to colour, supported by the Cognitive-Affective model of communication. We intend to conduct online experiments across different cultures, measuring actual users' behaviour. The results of this study will reveal new factors that influence users' attention. This could advance our understanding of the psychological process that precedes the decision itself and may offer important theoretical and practical implications.

Keywords: psychology of colour, warning banner message, user compliance, culture.

1 Introduction

Human decisions are often guided by colour inputs. Drivers will stop at traffic red lights as red suggests that there is danger ahead. Colour affects our cognitive systems (Elliot and Maier 2007; Kaya and Epps 2004), human perceptions, psychological and emotional reactions and ultimately, our behavioural intentions (Valdez and Mehrabian 1994). The relationship between colour and cognitive functioning has mostly been studied in the field of Psychology. For instance, red was found to be linked to performance attainment (Elliot et al. 2007), which suggests a strong relationship with the emotions whereby diverse psychological reactions can be observed, such as anxiety or pleasure (Valdez and Mehrabian 1994). One such example, wherein first impressions play an important role, is the online context, in which the majority of studies have focused on the impact of colours on website design (Cyr et al. 2010), seeking to understand the behaviours of internet shoppers (Bhatnagar et al. 2000; Menon and Kahn 2002). Overall, past studies have tried to understand how to better capture the user's attention through more appealing website content. In the computer digital world, a warning message on the computer represents communication designed to prevent users from hurting themselves or others (Silic et al. 2015; Wogalter 2006). In general, warnings have been found to be quite efficient in preventing hazards and reducing negative outcomes (Coleman 2007; Goldstein et al. 2008; Schultz and Tabanico

2009). However, and similar to the real-life situation, in the computer context, digital warnings are quite often ignored. Several different explanations have been provided to explain users' non-compliant behaviour, such as: 1) users are habituated to warning messages and consequently, do not read them (Egilsman and Bohme 2006); and 2) users ignore warnings due to their content (Akhawe and Felt 2013; Sunshine et al. 2009). Warning standards and guidelines, such as those put forth by the ANSI – American National Standards Institute – recommend that warnings should be composed of the terms Danger, Warning or Caution combined with a specific colour – red, orange and yellow and an alert symbol (ANSI 2015). Consequently, the majority of software makers have adopted these guidelines with red being used as a predominant colour. For instance, the latest versions of the Chrome and Internet Explorer web browsers use a red background (Figure 1) to inform the user about the potential risk that the user may experience if he/she decides to continue with his/her action.

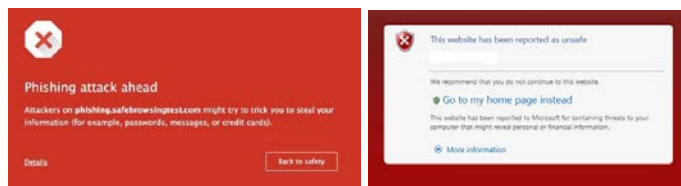


Figure 1. Warning messages for Chrome and Internet Explorer

Past research has concluded that red warnings yield higher adherence rates than black or green warnings in the alcoholic beverage containers context (Laughery et al. 1993). However, only few studies have tried to understand whether red is really the most efficient colour for computer warning messages when it comes to drawing the user's attention. Sunshine et al. (2009) argued that SSL warnings should be red in order to make users "scared". A study done by Egelman and Schechter (2013) investigated the way in which the choice of the background colour (red vs white) in the warning affects the user's decision to comply with the warning. Overall, the number of studies that have investigated the relationship between the colour and the user's cognitive decision-making process is still relatively low. Little is known about the impact of the colour on user's trust (Cyr et al. 2010). Moreover, to the best of our knowledge, there are no studies that have investigated how warning messages in the computer context affect users' attention in culturally distinct groups. In other words, does red, for instance, have a different meaning, interpretation and impact in one culture when compared to another one? According to Noiwan and Norcio (2006, pp. 103-104): "empirical investigations on the impacts of cultural factors on interface design are absolutely vital... Interface designers need to understand [the] colour appreciation and colour responses of people in different cultures and regions". Another challenge with past studies is that they have been poorly supported by the theory. They have mostly used findings from other fields, such as the tobacco industry, in order to implement the same results in the computer warning context. This has resulted in seemingly contradictory and often inconclusive results when it comes to the efficiency of the computer warning message. Indeed, only one-third of Google Chrome users adhere to the SSL warning message (Akhawe and Felt 2013).

Also, the way in which colour affects the user's decision-making process over time has not been addressed by past research. In other words, an understanding of how different colours may affect the user's conscious decisions when the user is confronted by the warning message for the first time, but also during all the consecutive event occurrences, is still lacking. For instance, if the warning message colour is black, instead of red, it could be that the user, upon the third or fourth time of seeing the warning message, would be more careful and attentive to the hazard.

Overall, with this research study we aim to close the existing research gap by studying the effects of colour on the user's decision-making process across different cultures. More precisely, we intend to understand: 1) how different colour applications (black, blue, yellow, red, green, white) influence the user's decision-making process; 2) how diverse cultural groups are affected by different colour applications; and 3) how the warning message impacts the user's decision-making process during the first and successive event occurrences. We build our work on the theory of psychological reversals to col-

our (Walters et al. 1982) to understand how users behave when confronted with the computer warning message.

In the following sections we will present the theoretical background and develop our research model. Then, we will describe the approach and context chosen to empirically test our model, and report our findings. The paper concludes with a discussion on the results, implications and limitations of our study.

2 Theoretical framework

2.1 Cognitive-affective model of communication

According to the cognitive-affective model of communication suggested by (Te'eni 2001), there are three factors that affect the communication process: “(1) inputs to the communication process (task, sender-receiver distance, and values and norms of communication with a particular emphasis on intercultural communication); (2) a cognitive affective process of communication; and (3) the communication impact on action and relationship”. The model suggests that the communication medium and the form of the message will shape the receiver’s behaviour. In our content, the communication medium is the warning message itself and the message form corresponds to the colour application. During the communication process, the warning message in combination with the colour application will potentially influence the user’s decision-making process in such a way that the user will either react positively to the communication medium content or will not have any affective reaction. Overall, the model suggests that a relationship has to be established between the user and the communication medium (i.e. warning) before the user’s behaviour will lead to an action. Hence, there is a balance between relationship and action, between cognition and affect, and between message and medium (Te'eni 2001). Another dimension that is important for the cognitive-affective model of communication is the cultural aspect. As communication action is bounded by social norms and values, users may have different expectations of how the message should be represented. Hence, we could have various meanings that are associated with different colours in different cultures. In Table 1 we can see that different colours can have different meanings. For instance, red is mostly related to ‘risk’ in all countries, except in China, where it is associated with ‘happiness’.

Colour	China	Japan	Egypt	France	United States
Red	Happiness	Anger, Danger	Death	Aristocracy	Danger, Stop
Blue	Heavens, Clouds	Villainy,	Virtue, Faith, Truth	Freedom, Peace	Masculine
Green	Ming, Dynasty, Heavens	Future, Youth, Energy	Fertility, Strength	Criminality	Safety, Go
Yellow	Birth, Wealth, Power	Grace, Nobility	Happiness, Prosperity	Temporary	Cowardice, Temporary
White	Death, Purity	Death	Joy	Neutrality	Purity

Table 1. Colour-Culture Chart (adapted from (Russo and Boor 1993))

Clearly, colour impacts the user's decision-making process. One theory that is particularly useful in explaining this cognitive process is the theory of psychological reversals.

2.2 Theory of psychological reversals

The theory of psychological reversals (Walters et al. 1982) suggests two levels of preferred felt arousal: one high and one low. Although switching ("reversals") from high to low is possible, either a high or low level will be preferred at a certain point in time. There is a strong association between arousal preference and colour preference, whereby users will be excited and aroused by certain colours and relaxed by others. For instance, warm colours will generally provoke "active feelings" while cool colours are "much less likely to cause extreme reactions" (Levy 1984). Similarly, Gerard (1958) found that when a red light was projected on a diffusing screen, an increased arousal was observed in the subjects. Clearly, long-wavelength colours (e.g. red, orange) are more stimulating compared to short-wavelength colours (e.g. blue, violet), which are more relaxing (Walters et al. 1982). In the online shopping context, it was found that cool tones such as blue are preferred over warm tones such as red (Cyr et al. 2010). We expect, then, to see different levels of appeal to users who are expected to behave differently when presented with warm or cool tones. As the cognitive-affective model of communication suggests that cognition and affect will be impacted by the communication medium (i.e. warning message), in such circumstances it is likely that the user will feel either high or low arousal. Consequently, there will be a possibility that the user may switch from a high to a low level if he/she is confronted with a different colour application. This could be even more pronounced in a different cultural aspect.

2.3 Colour and decision-making

While colours were found to be linked to behavioural intentions in the online context (e.g. shopping) (Bagchi and Cheema 2013; Gnambs et al. 2010; Ilie et al. 2008), the relationship between colours and the decision-making process was not explicitly addressed (Silic 2016). It seems that for the computer realm, researchers have mostly followed guidelines from other disciplines. Typically, the colour red, which is associated with hazard and danger, is used as a universal signal of warning. Consequently, it is assumed that red will trigger avoidance motivation (Maier et al. 2008) or increase the salience of financial losses when compared to gains (Kliger and Gilad 2012). Hence, it is expected that the colour red will lead to risk-averse behaviours. However, colour can carry different meanings and can have an important impact on people's affect, cognition, and behaviour (Elliot and Maier 2014). A study conducted by Guéguen (2012) found that women sitting at a bar were more frequently approached by men when they used red lipstick. Several other studies also found red to be positively associated with behaviours: patrons gave more tips to waitresses wearing red dresses (Guéguen and Jacob 2014) and web advertisements using the colour red received more clicks than advertisements in a blue colour (Sokolik et al. 2014). This suggests that red does not necessarily lead to a negative outcome but that, on the contrary, depending on the context, it can also provoke a positive outcome. Clearly, colours can have different implications in different contexts (Elliot and Maier 2007; Elliot and Maier 2014; Elliot et al. 2007).

In summary, we believe that the cognitive-affective model of communication, complemented by the theory of psychological reversals, provides an explanation as to how colour can affect the decision-making process whereby the colour application will affect the psychological arousal of the user. More precisely, when the user is confronted by the computer warning message (i.e. the communication medium), the user's psychological arousal will be influenced by the colour application, which will drive the user's behavioural intentions.

3 Hypothesis Development

Our study, uniquely, introduces the actual behaviour construct, which reports the user's actual security behaviour. Our research model is depicted below in Figure 2.

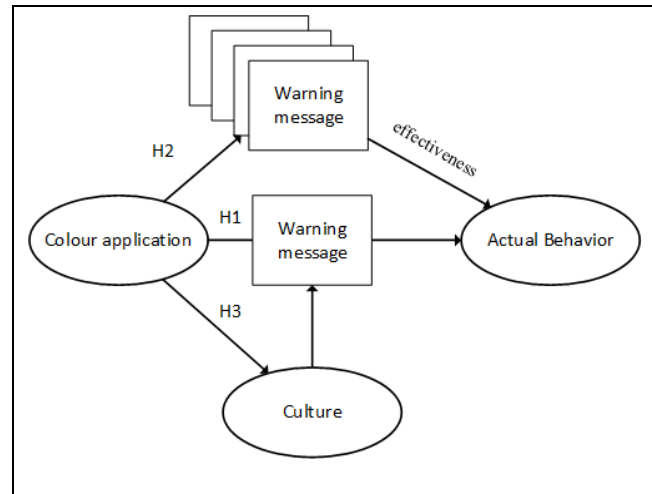


Figure 2. Research model

3.1 Colour and user decision making

The effects of colour on human preferences have received considerable attention from psychologists (Goldberg et al. 2002). Their relevance is not just related to aesthetics. In western cultures, for instance, red means “mistake” (e.g. teachers use red to correct mistakes), stop (e.g. red traffic lights) or danger (e.g. warning message). But it is also associated with love and sexuality (e.g. Amsterdam red light district). When it comes to gender separation, pink is usually attributed to girls and blue to boys (Chiu et al. 2006). White usually means immaculacy and black corresponds to tragic situations (e.g. death). Overall, different colour applications may have different impacts on the user's decision-making process. However, current research suggests that red is the colour that commonly represents danger, as it denotes risk and danger on warning labels, traffic signals, and many other systems used to inform about the threat (e.g. anti-virus software). However, as can be seen from previous studies, red can provide different levels of arousal. While we expect to find red to be the most efficient colour in transmitting risk in the computer warning message context, the lack of empirical findings related to colour and user decision making suggests that the relationship between colour application and the warning message needs to be better analysed. Consequently, it could be that other colours will have stronger secondary (i.e. second and all consecutive warning message displays) arousal effects on the user's attention. For instance, humans are so habituated to seeing the colour red in everyday life (e.g. traffic signs) that in the computer context the user may pay it less attention (i.e. not read the warning itself) and, consequently, may skip over and ignore the message. It could be interesting to see what would happen, for instance, if the computer warning message had a constantly changing background, with the objective of decreasing the user's habituation to seeing the colour red. On one hand, the user could be confused by this constant colour change, but on the other hand, the user might pay more attention as he/she would not become habituated to always seeing the red background. Overall, we argue that different colour applications will have high or low psychological arousal effects on the user. Hence, we hypothesise:

Hypothesis 1: Different colour applications will have different levels of psychological arousal effects on the user's actual behaviour when confronted by the computer warning message

Furthermore, little is known about the effects of colour on repeated occurrences of the hazard. For instance, a study found that by removing the colour from cigarette packs and showing health warnings on 'plain' white packages, people were significantly more likely to recall specific health warnings on packs (Beede and Lawson 1992). According to the restrictive deterrence theory, individuals who intend to commit a crime or antisocial act can be dissuaded if sanctions and disincentives that are relevant to these acts are implemented (Straub and Welke 1998). In the computer warning message, it is expected that the user will be dissuaded from continuing his/her actions if he/she believes that the threat may harm the user. In other words, according to the restrictive deterrence theory, offenders (i.e. users) will limit the frequency and severity of their individual offending (Gibbs 1975; Jacobs 2010) as they will be influenced by the warning message content. Clearly, colour has an important role in this communication process as, for instance, it was found that certain colours, such as black and red, are the most effective among different warning types (Sunshine et al. 2009). Hence, we argue that different colour applications during the first and all successive (i.e. repeated) exposures to the users may have a higher or lower impact depending on the user's socio-demographic background. More precisely, it could be that red is the most effective colour for deterring users at the first appearance of the warning message, but it may not be very effective in all successive appearances (i.e. when the warning is displayed for the fifth time). On the other hand, it is possible that the colour blue does not have such a strong deterrent effect at its first appearance, but that all consecutive appearances could lead to higher levels of deterrence and, ultimately, to higher user compliance levels. Hence, we hypothesise:

Hypothesis 2: The effectiveness of the warning message on the user's decision-making process during the first and successive event occurrences will depend on the different colour applications

3.2 Colour and culture

Different cultures attribute different meanings to colour. In Japanese culture white is associated with death, while in western cultures death is associated with the colour black (Russo and Boor 1993). Studies dealing with colour across different cultural groups are quite rare. When using the internet, users expect the website to be localised (i.e. translated into their language), which implies that other aesthetic details should be considered such as currency, images, etc. This is due to the fact that web interface acceptance and preferences vary between cultures (Cyr et al. 2010; Russo and Boor 1993). Clearly, colour is an integral part of the visual design and as such it would be interesting to understand how, in different cultural setups, colour application impacts the user's decision-making process and, ultimately, the behavioural intention toward complying with the computer warning message. In their study across 8 countries (Madden et al. 2000)'s findings revealed that 1) brown and black have "sad" and "stale" meanings; 2) blue is seen as being "peaceful" and "calm"; and that 3) yellow and orange do not have any particular associations across different cultures. This confirms that colour will have different meanings in different cultural environments (Barber and Badre 1998). Hence, we expect that users from different cultures will behave differently in the presence of the computer warning message when the colour application is adapted to their cultural expectations. In other words, cultural groups will have expectations when it comes to the visual anaesthetics of the computer warning message, which includes the colour application (Barber and Badre 1998). Furthermore, we expect to see a higher degree of compliance with the warning message when the user pays more attention to the warning message content. This suggests that the user's actual behaviour will be more compliant as it will be impacted by the psychological and affective perceptions of what the computer warning message should look like. Hence, we hypothesise:

Hypothesis 3: Diverse cultural groups, when presented with the computer warning message, will be differently affected by the colour application

4 Research design

4.1 Participants

In order to test our research hypotheses, we plan to conduct a non-controlled online experiment involving participants from different cultures. After receiving the approval of the Institutional Review Board (IRB), we will use the deception method to measure users' actual behaviours. We plan to include students from at least three different countries (Japan, the US and Switzerland) as participants. In addition, we intend to get a different sample by using Amazon Mechanical Turk. All final participants will be chosen based on the different values (e.g. power distance or individualism) for their cultural dimensions as suggested by (Hofstede 1984).

4.2 Measures and procedures

Our objective is to use the experiment method to explore and measure the progression (i.e. defines user's persistence to continue despite the warning message), frequency, and duration (i.e. time) of user behaviour when confronted with the warning banner message through different colour applications. Users will be provided with a web link, which will lead them to a website, where they will be asked to complete a task. The task will consist of choosing the product image they prefer. After clicking on the task 'start' button, they will be presented with the warning banner message (Figure 3). The warning message is based on the latest Google Chrome web browser malware warning, which we modified slightly (instead of using the word 'malware' we used the word 'safe' for simplicity and comprehension reasons). The background colours will be randomly displayed (the random function is used in the web application to control the display), and could be *red*, *blue*, *green*, *black*, *yellow* or *white* (the final colours choice will be theoretically driven). In addition, we will incorporate other variables (e.g. self-efficacy) that could have impact on users' decision making process.

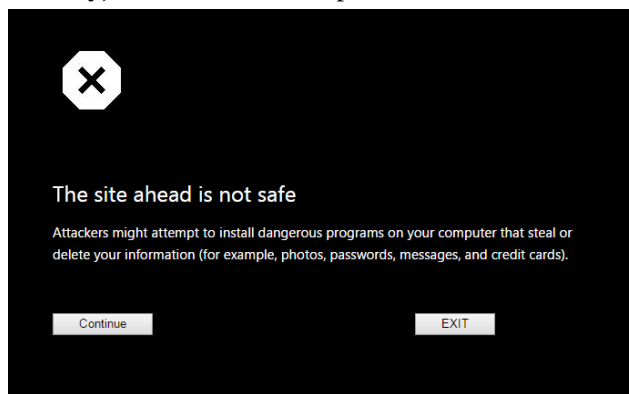


Figure 3. Warning message displayed (adapted from Google Chrome version 46)

When users click on 'Continue' or 'EXIT', the binary decision will be registered on a remote SQL server (1 for continue and 0 for Exit) together with several other data such as: browser version, time spent deciding (time is measured in milliseconds and corresponds to the time from when the user clicked on the start button until the user clicks on continue or exit). Also, in order to measure the first and successive event occurrences we will display warnings to users at least three times. Finally, users will be taken to an online survey where they will be asked to provide several pieces of information including demographic data, and also to provide their perceptions on various constructs.

4.3 Method for analysis

To analyse the effects we plan to use the Kaplan-Meier Survival Curve, which is an estimator used to estimate survival time from lifetime data. The Kaplan-Meier method is a nonparametric method used to estimate the probability of survival past given time points (i.e. it calculates a survival distribution) (Kaplan and Meier 1958). Time to event represents an event course duration which has a beginning and an end for each user. In this type of analysis, every participant is characterised by three variables: 1) the duration, 2) the status at the end of the event (exit or continue) and 3) the colour application.

Furthermore, to test the effect of the warning message on the duration (repeated use) we will use Cox's proportional-hazard regression model which allows for investigations of the relationships between the survival of the event and independent measures of interest (Box-Steffensmeier and Jones 2004). The variables that we will use will be: 1) the duration, 2) the status at the end of the event (exit or continue) and 3) the colour application.

Also, we will employ variance-based structural equation modelling (SEM) techniques (Chin 1998; Chin et al. 2003) to test our hypotheses.

5 Discussion and conclusion

The objective of this research in progress is to understand how colour affects the user's decision-making process in the warning banner message context. So far, little research has examined this complex psychological and cognitive process wherein the psychology of colour can play an important role in the relationship between the warning message and the user's binary decision-making process. Moreover, the effects of the user's repeated exposure to a certain type of warning message (with the same colour application) have not been adequately researched. This is an important area to further understand as not only would it provide new insights into the user's behavioural intentions, but it could also have important implications for user interface designers. By revealing new factors that influence the user's attention, we could advance our understanding of the psychological process that precedes the decision itself. Colour seems to play an important role in this communication process occurring between the communication medium (i.e. the warning message) and the receiver (i.e. the user). We believe that further research will reveal interesting findings whereby some colours could have a greater secondary effect during the successive event occurrences (e.g. a warning with a black background colour may have a higher impact on the user's attention during the fifth or sixth occurrence, while the colour red could have the opposite effect – in the fifth occurrence red could be simply ignored). Furthermore, so far, the colour-cultural aspect has been widely under-researched. With our research, we aim at investigating the cultural component, which should provide good insights into the influence that culture exercises on the psychological reversal processes that occur in different colour applications.

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