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PICTOGRAMS ON PACKAGING: A COMPARISON OF OBJECTIVE AND SUBJECTIVE MEASURES OF THEIR NOTICEABILITY

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Abstract: *Safety pictograms convey information to consumers who should be warned and protected from consequences that may arise as a result of the misuse of a product. The noticeability of the safety pictograms on the packaging is a prerequisite for the effectiveness of this communication. There are few methods for measuring the noticeability of the pictograms. In general, they can be based on objective or subjective estimations. This paper investigates the association between the objective and the subjective methods (namely eye-tracking and subjective scores) in order to examine whether expensive eye-tracking procedures can be replaced with low-cost procedures, such as subjective evaluation. Since the packaging is common medium for transmission of safety information by the pictograms, stimuli used in the study are samples of packaging that differ according to shape, colour and transparency. The results of the investigation of these variables provides wider insight in possible moderators of noticeability and gives clearer directions for future research in the field of communication role of the packaging.*

Key words: pictogram, packaging, noticeability

1. INTRODUCTION

Safety messages on the packaging have a role in protecting the user from the possible consequences of the misuse of the product. These messages commonly have the form of pictograms. The pictograms are simplified pictures that represent some object, concept or activity, and their meaning is understandable for the most. Some of the reasons for the often usage of the pictograms are breaking the language barriers, improving the memorability and enhancing the noticeability of the safety message. Speaking of noticeability, some studies have shown that the safety warnings which contain the pictograms quickly catch the users' attention and increase its noticeability (Laughery et al., 1993; Young, 1991). The noticeability of safety message on the packaging is a prerequisite for the effectiveness of the warning information. In other words, if users do not detect the warning, we cannot expect that they will process it or comply with it.
Drawing on the previous research, it is apparent that the noticeability of safety messages has been measured in a variety of ways. In the most cases, it has been measured indirectly by means of other variables such as memory. For example, in their study of health warning labels on alcohol beverage containers, Kaskutas and Greenfield (1991) conducted a survey six months prior to and six months after the enactment of the warning label law. Their method was based on the number of the respondents who reported having seen the warning labels, which reflected whether the respondents noticed the warning message. Indirect methods like this one are generally simple for use and they do not require special equipment. On the other hand, they reveal data that do not present clear relationship between the noticeability and influencing variables, which leaves space for ambiguous interpretations. Hence it is more suitable to use methods that gather data more directly. In general, direct methods can be based on objective or subjective estimations. This study focuses on eye tracking technology as an objective technique and on subjective scoring as a subjective measure.
Eye tracking method provides the information on which parts of the visual display participants are looking at any given time (Poole and Ball, 2005). It is based on the recording the participants' eye movements. Eye movements occur by alternating between saccades and fixation. A fixation refers to the time spent looking at the particular area on display, while saccade refers to eye movements while shifting the focus from one area to the next (Calitz et al., 2009). The sequence of fixations and saccades forms a scanpath which reflects participant's observing strategy. The observing strategy presents the directions of visual attention and provides insights on how the participant structures the visual information (Schiessl et al., 2003). That is why eye tracking can be used for objective evaluation of the noticeability, visibility and distinctivity of visual signs in specific surrounding. It is also very useful in investigation of scanning patterns while searching for target information (see Laughery et al. (1993) for the example). Researchers have measured variety of variables in order to determine participants' visual attention to warning messages. The most common

measures were time to notice the information (Laughery et al., 1993) and time spent on viewing the information (Cowley, 2009).
Perception of visual stimuli relies on individual characteristics to a certain extent and these individual aspects can affect attention. In comparison with technical data gathered by eye tracking, subjective assessment provides data that give wider insides about personal impressions of end users. In most cases, self-reports reveal additional valuable information that is independent of eye tracking quantitative measures, such as opinion or supplemental explanations of individual responses. While conducting the subjective evaluation, researcher should be aware of its potential difficulties and try to reduce it by planning the adequate experimental procedures. In order to get representative results, the number of participants should be large, which makes the process time-consuming. Furthermore, observation should be carried out in controlled conditions that are uniformed for each participant. Even if these requirements are fulfilled, the interpretation of collected data should made with consideration of the effects of participants' individual differences, like psychophysical attributes, personal experience and subjective judgement of evaluation procedure. Hence it is advisable to use homogeneous group of observers. In general, having the benefits and limitations in mind, subjective visual assessment offers great opportunities for insights into different aspects of safety communication by information on packaging. The key is in thoughtful design of experimental design and its careful procedure.
While comparing subjective scoring and eye tracking, it is clear that both methods have some merits and disadvantages. The most important benefit of eye tracking is direct relationship between the processes of detecting the visual stimuli and the accompanying measured data, while its disadvantage is the cost of the eye tracking equipment. On the other side, subjective scoring is less expensive from the point of experimental apparatus. The aim of this study was to compare the results gathered by these two methods in order to get closer to answering the question whether expensive eye-tracking procedures can be replaced with low-cost procedures, such as subjective evaluation. Besides, this study investigated how packaging characteristics (particularly shape, colour and transparency) affect the noticeability of the pictograms applied on the packaging.

2. METHODS

The noticeability of safety pictogram was investigated by two methods – one objective and another subjective. The measure of objective assessment was time to fist fixation on the pictogram, while the measure of subjective assessment was the score based on personal evaluation. The following sections describe the procedures, samples and equipment used in each of the methods.

2.1 Objective method

The objective method was based on eye tracking technology. The stimuli were presented on a Lenovo computer display (model LEN L1900pA) and viewed from a distance of 60 (+/–1) cm. The resolution of the computer screen was set to 1280 x 1024 pixels with a refresh rate of 60 Hz. Fixations and time to first fixation on the pictogram were recorded with Tobii Eye Tracker X60 with a sampling rate of 60 Hz and an accuracy of 0.5 degree. The presentation of the eye-tracking stimuli was created using the Tobii Studio 3.2.1. software.
30 observers participated in eye tracking testing. All of them were students at the University of Zagreb, Faculty of Graphic Arts, who voluntarily participated in the experiment. Their ages ranged from 21 to 24 years of age (M = 22.73, SD = 0.91). 63% of the participants were female and 37% were male. All of the participants had normal vision or corrected-to-normal vision.
Packaging samples were presented on screen in the form of three-dimensional models. Figure 1 shows the examples of the packaging samples. The samples were designed especially for the purpose of the study and they differed according to following packaging characteristics. The colour was varied at four levels (yellow, blue, red, multi-coloured), shape was varied at two levels (rounded, angular) and the transparency was also varied at two levels (transparent, nontransparent). Combination of all of these levels resulted with 16 samples.

Figure 1: The examples of the packaging samples

The eye tracking experiment was conducted on in a slightly dimmed room isolated from outside distractions. The room was located within the Faculty of Graphic Arts at the University of Zagreb. Each student individually participated in the experimental procedure. Before the measuring the fixations on the samples, the calibration was performed in order to relate an observer's gaze angle to locations at the display (Goldberg and Wichansky, 2002). After that, the participants were familiarized with the samples by seeing one example of the packaging that was excluded from the later analyses. They were asked to look at the presented sample in a way as they would do if they observed it in their realistic everyday environment. They were informed that presentation of the samples is time-limited. The presentation started by displaying the white symbol "x" in the middle of the black screen. Its purpose was to drive the participant's attention to a neutral starting position. After that one of the samples were shown. Its presentation time was 5 seconds. Then again the black screen with white "x" was displayed in order to compensate for fatigue effects and to prepare the participant for the next sample. Samples were displayed randomly to avoid ordering effect. After the experiment ended, subjects were thanked for their participation and debriefed.

2.2 Subjective method

Subjective method was based on subjective scoring during visual assessment. 30 observers participated in visual assessment. All of them were students at the University of Zagreb, Faculty of Graphic Arts, who voluntarily participated in the experiment. Their ages ranged from 22 to 24 years of age (M = 23.07, SD = 0.64). 53% of the participants were female and 47% were male. All of the participants had normal vision or corrected-to-normal vision.

Observers were asked to take the Ishihara Colour Vision Test before the experiment to ensure they did not have any colour defects. The experiment took place in the XRite Macbeth Judge II-S Light Booth located in a dark windowless room at the Faculty of Graphic Arts at the University of Zagreb. Macbeth D50 lighting source with 5230 K colour temperature was used for lighting the booth. Luminance level was 1227 lux. Overhead lighting was turned off. The observers viewed the samples at an angle of approximately 45° at a distance of around 30 cm. Before they started with the evaluation, participants were informed about the experimental procedure by using a sample that was not included in the later analysis. The observation time was unlimited. The participants' task was to evaluate the safety pictograms on the packaging by rating their noticeability on the basis of 7-point Likert scale ratings (7 = excellent, 1 = unacceptable).

Design of the packaging was identical to the design of the samples presented in the previous eye tracking experiment, except in this case the packaging samples were printed and folded in their final shape, so the participants could touch them and view them from all sides like they do in everyday life. Packaging dimensions were 60 x 60 x 100 mm. Nontransparent packaging was made of cardboard, while transparent packaging was made of plastic material with attached foil with print.

3. RESULTS

To test whether the packaging manipulations would affect the noticeability of safety pictogram, three separate tests were conducted with packaging shape, packaging transparency, and packaging colour as independent variables and time to fixate the pictogram as dependent variable. The Kolmogorov–Smirnov test of normality revealed that the assumption of normality was violated in all cases (all $p < 0.001$), and therefore nonparametric methods of statistical analysis were used.

The median and 1st and 3rd quartiles in parenthesis are reported in the results. Mann-Whitney U tests showed that angular packaging took significantly longer to detect the pictogram than rounded packaging

(Mann-Whitney U = 18873.5, $p < 0.001$). This result is corroborated by Figure 2 that represents the scanpaths of the two participants for angular and rounded samples. The median time to detection of the pictogram on the angular packaging was 2.41 (2.01 – 2.64) and in the case of rounded packaging it was 2.12 (1.25 – 2.31). Transparent packaging also took more time to notice the pictogram, Mdn = 2.31 (1.98, 2.52) than non-transparent packaging, Mdn = 2.29 (1.84 – 2.45), but the Mann-Whitney U test did not reveal a significant difference between these two conditions (Mann-Whitney U = 27123.5, $p = 0.269$). The median times to first fixation on the pictogram on the yellow, blue, red and multicoloured packaging were 2.24 (1.89 – 2.58), 2.36 (1.91 – 2.51), 2.18 (1.87 – 2.36), 2.31 (1.63 – 2.41), respectively, with no significant difference according to the Kruskal-Wallis test ($\chi^2(63) = 7.25$, $p = 0.06$).
Spearman correlation analyse was performed to evaluate the association between objective and subjective measures, particularly between the time to first fixation on the pictogram and subjective scores of its noticeability (Figure 3). Spearman correlation coefficient was -0.72, indicating that longer times to detection of the pictograms are correlated with lower subjective scores, and this relationship was significant ($p = 0.002$).

Figure 2: Scanpaths of two participants that reflect fixation order before fixating the pictogram

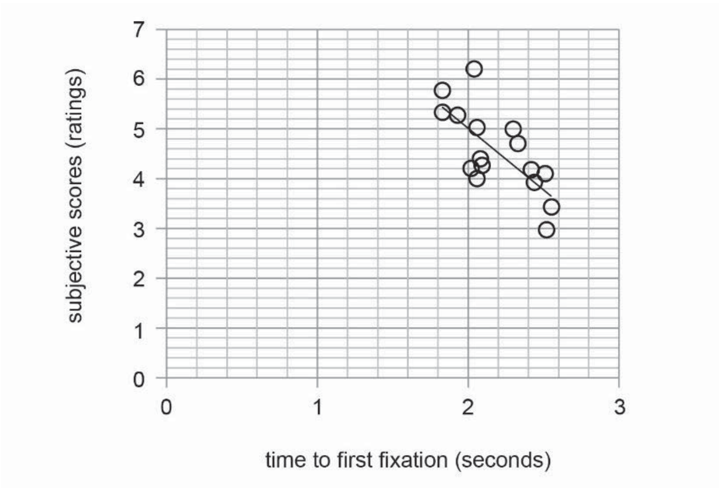

Figure 3. Graph shows correlation between objective and subjective measures

4. DISCUSSION

4.1 Packaging variables

The results showed that packaging can affect the noticeability of the pictogram. Among all the packaging characteristics included in our study, the angular shape was the significant factor that lengthened time to pictogram detection. This is in line with previous study (Kovačević et al., 2013) which showed that the safety pictograms on the samples of the cylindrical commercial packaging were evaluated as superior in comparison to angular ones. In that study, the noticeability of pictograms was measured only by subjective

assessment without supplementing the objective measures. Despite this shortcoming, the results showed clear congruity with the results in this study. Adequacy of rounded shapes of packaging and containers was also indicated in Schenieder's investigation of children's attraction toward the containers of harmful substances (Schneider, 1977). His results showed that rounded packaging have tendency to improve children's safety when it comes to controlling accidental childhood poisoning by packaging design. However, there are notable differences in methodology, such as packaging sample selection or experimental procedure, so the comparison between the results revealed by this study and those reported in mentioned researches should be made with caution.
The transparency of packaging material and packaging colour did not affect the noticeability of pictogram. The lack of the colour effect is somehow intelligible, mainly because the power of the colour mostly comes to the fore when it is combined with some other colour, creating the contrast between the packaging colour and the colour of the pictogram. For example, while investigating the noticeability of computer icons, Huang (2008) found the effect of colour on visual search time at the basis of five different figure/background colour combinations. It seems that our study did not cover enough colour combinations that could explain how colour would drive users' attention to pictogram in different colour context.
In the investigation of transparency effect, our study showed that pictogram was detected slightly easier on the non-transparent packaging. This could be explained by clearer visibility of the elements printed on the packaging surface that is opaque. Nontranslucent packaging material does not expose potentially visually disturbing parts of the product. However, it should be noted that transparency effect was not statistically significant. This was surprising, mainly because some previous studies have shown that visibility through the packaging material can affect the perception of the packaging (Vilnai-Yavetz and Koren, 2013).

4.2 Comparison of objective and subjective method

Users' subjective evaluation was in accordance with visual response recorded by eye-tracking technology, indicating a strong correlation between objective and subjective measures. In other words, quickly fixated pictograms were rated as more noticeable. The strength of this relationship is relatively surprising given that subjective scoring was based on individual attitude and personal preferences that may greatly vary across the group of users. The reason for the consistency of these results probably lays in the homogeneity of the group of the participants. Besides that, it is possible that strong differentiation between examined samples enabled clear and undisputable self-reporting outcomes within pictogram evaluation, which homogenized the results.
Although our study showed the concurrence of subjective measures, we cannot expect that this will always be the case. In practice, it is hard to control over many other influencing variables that are highly dependent on the individual subject (Manhartsberger and Zellhofer, 2005). Even if this difficulty is reduced by careful experimental design, researcher should have in mind that, like any self-report measures, subjective scoring may not be accurate reflection of true users' impressions (Martin and Hanington, 2012). That is why the objective measurements are more effective tool in testing the visual stimuli and should be used when possible. Eye tracking as the most common objective method of investigating human visual responses gives technical information on exactly which parts of packaging participants are fixating, and provides viewing patterns during visual search. Besides, it provides accurate time calculations such as fixation duration or time to detection of particular visual element. In our study, these directly gathered objective measures has been shown as effective in analysing the influence of packaging manipulations. Still, in some other circumstances, the eye tracking technology could be too expensive (costly equipment) or inappropriate for use (unrealistic experimental environment). The researcher should be aware of these limitations before planning the experimental procedure.
The subjective scoring method also has been shown as effective in our study. Despite its strong correlation with eye tracking measures, we cannot say that it is always reasonable to use it as a replacement for eye tracking. It is true that subjective scoring does not require expensive equipment, but it is time-consuming and involves a large number of participants. In many cases these difficulties can override the benefits of this method.

5. CONCLUSIONS

Two main findings were revealed by our study. First, among packaging shape, colour and transparency, only the shape affected the noticeability of safety pictogram. This result suggests that, in early stage of packaging design, designer should take into account that pictogram could be less noticeable on angular

packaging. In line with that, the pictogram on angular packaging should be designed as prominent visual unit that stands out among other graphical elements. This is especially important if the product is unsafe and ignoring the safety pictogram can lead to harmful consequences. Another finding is that subjective responses can strongly support objective eye tracking measures, so both methods can be used in testing the best design solutions and deciding about the direction a design should go. However, the benefits and weaknesses of each method should be taken into consideration when choosing an appropriate experimental procedure.
There are several limitations to this study. First, in both experiments only young participants were included. Since the visual acuity and attention processes change over time, it is plausible that older participants respond differently on packaging samples. Furthermore, the number of the levels of the experimental factors was quite small. Future research should examine more levels of packaging characteristics, including more pictogram/packaging colour combinations. Besides that, future studies should use other methods based on feedback from potential users and examine the relationship between these responses and eye tracking data.

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