

Safety signs were
defined as symbols
psychology essay



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Safety signs were defined as symbols or icons with certain warnings or safety instructions used in attracting peoples attention so as to reduce unnecessary injuries and accidents in industrial aspect and any potential danger areas. Nevertheless, recent researches and studies revealed that most of the safety signs are ineffective to be conveyed into safety message and most of the pictorials in related to safety are found poorly understood by the people. In addition, some past studies indicated that most of the safety signs do not meet the comprehension criteria of American National Stand Institute (ANSI Z535. 330) and Organization for International Standardization (ISO 3864). Hence, collecting user drawing ideas or concepts on safety sign referents before redesigning safety signs is necessary so as to increase the effectiveness of the safety signs and improve the sign comprehension of user. However, studies for gathering drawing ideas of the user on safety sign referents had never been explored.

Unlike the traditional methods of investigating the comprehension level and the reusability of safety signs, this study will explore the relationships amongst user factors, safety sign referent characteristics and user performance on safety sign redesign through a particular technique called stereotype production method (sign production method) for gathering user concepts during the process of safety signs design. All of the results in present study will provide useful and valuable suggestions or recommendations for further safety sign redesign use.

In present study, the impact of the user factors like age group, educational level, occupation, visual vividness imagery, object imagery preference and spatial imagery preference and also sign referent characteristics like context

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availability, familiarity, concreteness and ease of visualization on safety sign redesign were explored with construction workers through stereotype production method. Forty five Hong Kong Chinese construction workers were divided into two group, one group was asked to depict images for 12 safety sign referents (Set A) and to rate their perceived context availability, familiarity, concreteness and ease of visualization on these safety sign referents. The participants of second group were asked to depict images for 12 safety sign referents (Set B) and to rate their perceived context availability, familiarity, concreteness and ease of visualization on these safety sign referents. As a result, it was found that the age group, educational level, occupation, spatial imagery preference, object imagery preference and visual vividness imagery of the participants had no impact on the safety sign redesign. For the sign referent characteristics, familiarity, context availability, concreteness and ease of visualization were found to have negative effects on the number of drawing concepts for safety sign referents and have positive influence on the stereotype strength. Nevertheless, no significant effects on the level of difficulty to depicting the sign referents were found. Such results revealed if the sign referent were high context availability, concrete, easily to make participants visualize a images and also participants familiar with that sign referent, they would created lesser concepts for that sign referent and then more same kind of elements would be found in the drawings for that sign referent. The findings in this study thus could be used to recommend that designers should take four sign referent characteristics (familiarity, context availability, concreteness and ease of visualization) into consideration for designing or developing a greater set of more user-friendly safety signs.

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1. Introduction

1.1 Background

In recent years, the number of industrial accidents keeps on a rise especially construction industrial accidents. Occupational Safety and Health Statistics Bulletin (Issue No. 12; July, 2012) indicated that Hong Kong construction industrial has the highest accident rate among different industrial. To compare with year 2010, the case of construction industrial accidents increased from 2884 to 3112.

Laughery and Wogalter (2005) stated one of the purposes of the safety sign is to remind people that unaware of these hazards or dangers at most of the time. Thus, in order to reduce and prevent the case of industrial accidents, safety signs are the most important and essential things to remind and warn people aware of those hazards or dangers on their work. However, recent studies stated that there are some safety signs are ineffective to be conveyed into safety message (Duarte and Rebelo, 2005). Besides, most of the safety-related pictorials that are simply presented are found poorly understood by the people (Brelsford et al, 1994).

In order to increase the effectiveness of the safety signs, redesign safety sign is needed for reminding people effectively. Past studies investigated the ways for increasing warning noticeability on the labels of alcohol. The results showed that the icons, color and pictorials could greatly increase the warning noticeability (Young, 1991). Also, Green (1979, p. 77) the drawings of subjects could be counted as suggestive ideas and the collected data combined with user factors should be explored through a full qualitative

method so as to produce a greater set of icons. In addition, Wogalter, M. S. et al, (1992) found that pictorials served an important function for people like illiterate who poorly understood the warning commands. Thus, before redesigning the safety sign, people's ideas and concepts on the safety sign referents are the great suggestions for designers to redesign a new set of effective safety signs.

Past studies indicated that population stereotype production method (or called sign production method) is designed to collect the concepts and ideas of user systematically during the sign design process. This method is to ask a group of target individuals to create drawings so that to collect the best expression of the safety sign referents (Green, 1979; Howell and Fuchs, 1968). The population stereotype referred to the most frequent elements that produced for the safety sign referent drawings and then the population stereotype could be sent to designers or artists to render into an actual safety sign. In general, there are three measures in stereotype production method such as the number of drawing concepts, stereotype strength (measured by the scale of common responses to the total responses for a safety sign referent) and the level of difficulty in depicting a sign referent (measured by the ratio of failure responses to the total responses for a safety sign referent) so that to quantify a safety sign referent.

Since there were little research studies on the effect of referents characteristics and user factors on safety sign redesign through stereotype production method in general. Therefore, this study was designed to explore the influences of user factors and sign referent characteristics on safety sign redesign through stereotype production method.

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For the user factors, past studies found that there was a significant relationship between age and the performance in drawing a family picture (Cherney et al., 2006). As an expectation, age group would have a significant effect in the stereotype production. Other than age group, educational level also was a factor that would affect the stereotype production due to a study indicated that different educational levels result in differences in the drawings (Ainslie et al., 1993). Besides, Cherney et al., (2006) stated that the children's ability in drawing the elements that were related to spatial from their surroundings through the understanding of an object is placed in where. Thus, object and spatial imagery preferences would have positively influences on the stereotype production as an expectation. Also, past studies indicated that visualization served an important function in help with design aspect and it can help to decrease the level of difficulty in designing something (Dahl et al., 2001). Therefore, ease of visualization and visual vividness imagery that are in related to visualization aspect would be predicted to have effects in stereotype production. Ease of visualization is that how easy is it to construct a mental picture for sign referent. Vividness of visual imagery referred to present something in the mind as a way like image. Other than the ease of visualization, the familiarity (perceived frequency with which safety signs have been encountered before) and concreteness (used in measuring the safety signs like actual thing or not) would be predicted in relation to stereotype production due to McDougall et al., (1999) stated that familiarity and concreteness are important sign features for used in icon or sign design.

In general, there were no research studies explored the effects of colors, the user factors like context availability (the level of easy for people to think of places the sign referent is located) on safety sign design through stereotype production method with construction workers. This study was thus also designed to examine the colors and effectiveness on safety signs through stereotype production method with construction workers. In case, there are many designated trades in construction industrial. Hence, occupation is also a user factor that would be investigated in this study.

Based on the above studies and research, the effects of the user factors and referents characteristics on safety sign redesign was to be explored by using stereotype production method. All user concepts and ideas were to be collected through stereotype production method. The age group, educational level, occupation, spatial imagery preference, object imagery preference and vividness of visual imagery were the user factors that would be investigated in this study. The sign referent characteristics on safety sign redesign such as context availability, familiarity, ease of visualization and concreteness would also be examined in this study. The number of stereotyped drawings and the number of drawings that the participants could not be depicted pictorially and colors in depicting safety signs were used in measuring the performance of the participants. In this study, the level of difficulty in depicting sign referent, stereotyped drawings and the number of drawing concepts of each sign referent were the dependent measures for the safety sign referents.

Several hypotheses could be made to test in the study:

The safety sign drawings were expected to draw with different colors other than the black color.

The number of stereotyped drawings and the number of drawings that the participants could not be depicted pictorially were predicted to affect by the age group, educational level and occupation.

The number of stereotyped drawings and the number of drawings that the participants could not be depicted pictorially were predicted to affect by the vividness of visual imagery, object imagery preference and spatial imagery preference.

The context availability of safety sign referent was predicted correlated with the level of difficulty in describing sign referent, stereotype strength and the number of drawing concepts of each sign referent.

The familiarity of safety sign referent was predicted in related to the level of difficulty in describing sign referent, stereotype strength and the number of drawing concepts of each sign referent.

The ease of safety sign referent visualization was predicted associated with the level of difficulty in describing sign referent, stereotype strength and the number of drawing concepts of each sign referent

The concreteness of safety sign referent was predicted to be correlated with the level of difficulty in describing sign referent, stereotype strength and the number of drawing concepts of each sign referent

1. 2 Aims

Since there were no studies and researches investigated the factors of construction workers' effects on safety sign redesign through stereotype production method in the past. The aims of this study was to explore the effect of the user factors and sign referents characteristics on safety sign redesign by using stereotype production method with Hong Kong construction workers so that:

To obtain a deep understanding of the impacts of user factors and safety sign referent on safety sign redesign for further design use

To help designers or artists in generating a greater set of user friendly safety sign

1. 3 Objectives

In order to achieve the aims, the objectives were shown below:

1. To design a study used to examined the impact of user factors and sign referents characteristics on safety sign redesign through stereotype production method
2. To design a safety sign questionnaire for collecting the ratings of subject on four sign referents characteristics
3. To conduct stereotype production method for gathering the number of subjective drawing concepts, the stereotype strength, the level of difficulty in depicting safety signs, the stereotyped drawings and the number of sign referents that could not be depicted pictorially.

4. To design a questionnaire for capturing the demographic information of subject.
5. To collect the subject perceived vividness of visual imagery using vividness of visual imagery questionnaire (VVIQ; Marks, 1973).
6. To collecting the subject perceived object imagery preference and spatial imagery preference using object and spatial imagery questionnaire (OSIQ; Blajenkova et al., 2006).
7. To review the findings, distinguish whether the consequence of study in complying with the reference literature or not.

2. Literature review

2. 1 Safety signs

Akerboom (1993) stated that the symbols for safety sign is mainly used to attract people's attention and make an improvement on warning comprehension for people who have poor reading and visualization skills. Laughery and Wogalter (2005) concluded that there are several purposes of the safety signs: to make people communicate more on safety issues with others in order to help them make better decisions in relation to the safety. Also, to convince people to have a safety concept in their mind so their behavior could help them to reduce or prevent accidents, injuries and disease. Moreover, to remind people who unaware of these hazards or dangers at most of the time but they may know these hazards or dangers that have been existed already.

2. 1. 1 Safety signs standards

According to the American National Standard Institute (Z535. 3, 2002), symbol signs on the criterion of 85% or above correct in a safety sign comprehension test must be met. For the Organization for International Standardization (3864-3, 2006), symbol signs on the criterion of 67% or above correct must be met in a sign comprehension test. However, one of the recent studies investigated the comprehensibility of registered safety officers and non-registered safety officers on 30 safety signs commonly used in Hong Kong industrial (Chan and Chan, 2011) and then the results showed that only four safety signs satisfied with the comprehension score on 85% or above that is within the criterion of ANSI Z535. 3. Also, only eleven safety signs satisfied with the comprehension score on 67% or above that is within the criterion of ISO 3864-3. In general, the comprehensibility of safety signs is essential for users who are poorly understood and read the words of the safety signs. Based on the above recent studies, it seems most of the existing safety signs in Hong Kong industrial are quite poorly and ineffective in conveying the safety message.

2. 1. 2 Colors on safety signs

Several studies indicated that the effects of color on sign design. One of the past studies reported that the colors on warning signs could attract people's attention (Adams and Edworthy, 1996). Also, P. Waterson et al., (2012) investigated the influence of using colors in the safety signs. The result showed that the color was an important element for conveying the messages that are related to safety such as all of age groups recognized red represents danger and green denoted something was safe.

2. 1. 3 Pictorials on safety signs

Kenneth (2006) mentioned that pictorials are presented on the sign in different forms such as representative drawings, abstract symbols and photographs so that to serve two main functions. Firstly, the pictorials can help in attracting people's attention. Secondly, they can convey the information of content effectively. Young and Wogalter, (1988) found that the pictorials could greatly improve users' memory on the consciousness of warning.

2. 2 User factors

2. 2. 1 Age group

Drawings would be affected by age. Hancock et al., (1999) concluded that the older the people, the lower the abilities of perceptual and cognitive. Also, past studies indicated that the aging of people would cause shorter term of memory capacity (Salthouse, 1990; Light and LaVoie, 1993). In addition, Burkitt et al., (2011) found that the elements or features were drawn by children would be affected by the age. Thus, the number of stereotyped drawings and the number of sign referents that could not be depicted would be expected to be affected by age.

2. 2. 2 Educational level

For the education level, several past studies showed that it would be affected the performance on drawings. Different elements would be drawn due to the differences in educational level (Cherney et al., 2006; Lourenco et al., 2008). In addition, past study indicated that different educational levels result in differences in the drawing test (Ainslie et al., 1993). Thus, as an

expectation, educational level would have influences on the number of stereotyped drawings and the number of sign referents that could not be depicted.

2. 2. 3 Object imagery preference and Spatial imagery preference

Past researcher stated that object imagery preference may be identified with the preference for producing realistic, detailed and concrete images or pictures of an object (Blajenkova et al., 2006). He also stated that spatial imagery preference was defined as the preference for using imagery to show complex spatial transformation and to illustrate a picture or image so that to indicate the relationship between spatial and the objects. Cherney et al., (2006) found that the children's ability in drawing the elements that were related to spatial from their surroundings through the understanding of an object is placed in where.

2. 2. 4 Visual vividness imagery

Vividness of visual imagery referred to representation in people's brain and mind that are presented in some ways such as picture (Thomas, 2008). Past studies indicated that visualization served an important function in help with design and it can help to decrease the level of difficulty in designing something (Dahl et al., 2001).

2. 3 Safety Sign referents characteristics

2. 3. 1 Context availability

Context availability can be defined as how easy is it for people to think of the context for sign referent. High context availability referred to the situation

that people could easily associate or imagine a sign referent with a certain context or circumstance in which the referent would appear. Otherwise, the sign referent was classified as low context availability (Altarriba et al., 1999). Also, past researchers stated that the ratings on context availability were used in asking children to rate on a particular attribute like the level of easier in thinking a sentence for certain word. They also indicated that if the children found that it was easy to put a word in a sentence, perceived knowledge in related to that word would be easy to regain (Paula J et al., 1996).

2. 3. 2 Familiarity

Familiarity referred to the perceived frequency with which safety signs have been encountered or seen. Ben-Bassat and Shinar (2006) showed that the familiarity could greatly improve the comprehension of the symbol signs. Past study found that most of the people preferred to draw familiar elements than the unfamiliar elements in happy drawings (Burkitt, E. et al., 2013). Also, Green, (1981) showed that automobile users found difficulty in depicting symbols for some unfamiliar function used in the panels.

2. 3. 3 Ease of visualization

Ease of visualization was defined the level of easy to formulate a mental picture or image of sign referent (Ng et al., 2012). Past studies found that the easier for people to visualize the referent, the lower level of difficulty in drawing their pictures or pictorials. (Dahl et al., 2001; Ng et al., 2012)

2. 3. 3 Concreteness

The concrete referents defined as referents indicated something realistic material and denoted some actual thing. In contrast, the referents contained something that considered other than object or material was defined as an abstract referents (Altarriba et al., 1999). Concrete sign design is more easily comprehend than the sign with vague design (Wolff and Wogalter, 1993; Passini et al., 2008).

2. 4 The method of data analysis

2. 4. 1 Population stereotype production method (Sign production method)

In order to gather the participants' ideas and concepts of the safety sign referents, population stereotype production method (or called sign production method) would be used in this study. This method is to ask a group of target individuals to create drawings that included the best expression of the sign referent. The population stereotype referred to the most frequent elements that found on sign referent drawings (Green, 1979; Howell and Fuchs, 1968).

2. 4. 2 Test of normality

For assessing the normality of the data, Shapiro-Wilk's test and Kolmogorov-Smirnov test are commonly used. Shapiro-Wilk's test is to be chosen to use in this study. Shapiro-Wilk's test is used to detect the null hypothesis in which the samples that come from a normal distribution.

2. 4. 3 Correlation

According to Norusis (2012), correlation is used to study and determine the relationship between two groups of data. In this study, the bivariate correlations procedure was used to calculate the correlation coefficients (The Pearson correlation coefficient and the spearman correlation coefficient) and test the hypothesis so that to assess how strongly two variables are correlated linearly. Pearson correlation coefficient is calculated in measuring the linear relationship between two variables. The range of coefficient is from -1 (strongly negative correlation) to +1 (strongly positive correlation). If the value of correlation coefficient is a positive number, one variable will be directly proportional to other variable. If the value of correlation coefficient is a negative number, one variable will be varies inversely as other variable. In general, spearman correlation coefficient is used to measure through replacing data with the ranking.

2. 4. 4 Analysis of variance (ANOVA)

Analysis of variance (ANOVA) is used to test the hypothesis that is in relation to two or more means of multi groups of data. Then, through assessing linear combinations of the means, different pairs of means are different from other significantly could be identified.

2. 4. 5 Kruskal-Wallis Test

Kruskal-Wallis is one kind of nonparametric tests. Norusis (2012) stated that it is a one-way analysis of variance in order to test hypotheses about three or more independent groups. It can be used for pooling all of the data, ranking

the data from smallest to largest and finding the average rank for each group of data.

3. Methodology

In general, safety signs are used to convey warnings and safety messages in all places and locations especially working places so that to attract people's attention and then to reduce the number of accidents happened. Taking safety signs as a study, a group of construction workers in different construction sites was asked to participate in a safety sign redesign study through the stereotype production method. In present study, the construction workers were invited to draw different safety signs that are commonly found and seen in all locations especially working places. After that, the participants were asked to rate their context availability, familiarity, ease of visualization and concreteness in regard to the safety sign referents.

The number of stereotyped drawings and the number of safety sign referents that could not be described pictorially were used to assess the performance of each participant. However, the number of drawing concepts or ideas of each sign referents, stereotype strength and the level of difficulty in depicting a sign referents were measured independently in the study.

3. 1 Participants

Forty-five (23 were asked to finished Set A designed safety sign questionnaire and 22 were asked to finished Set B designed safety sign questionnaire) Hong Kong Chinese construction workers were invited to participate in this study. All participants are males. The age of the participants ranged from 18 to 59 years old. All participants participated in

this study have never been working in any design related aspects. Before starting the study, a set of verbal instructions was given to each participant. Participants need to complete a personal information questionnaire, one set of designed safety sign questionnaire, Visual Vividness Imagery Questionnaire (VVIQ; Marks, 1973) and Object-Spatial Imagery Questionnaire (OSIQ; Blajenkova et al., 2006) for about an hour independently that were told during the verbal instructions.

3. 2 Safety sign referents

Twenty-four commonly used Hong Kong industrial safety signs were used in this study. The comprehension score of these industrial safety signs was less than 75% in a previous understanding industrial safety sign study (Chan and Chan, 2011). Twenty-four safety sign referents used in this study were shown in Table 1. They are divided into two separate sets of designed safety sign questionnaire and drawing task evenly (Set A and Set B). Each participant was required to complete one set of designed safety sign questionnaire and drawing task for 12 safety sign referents only (Set A: A1-A12; Set B: B1-B12, shown in Table 3. 1).

3. 3 Questionnaires and Instruments

3. 3. 1 Personal information questionnaire

The personal information questionnaire was used to collect the basic information of the participants. It consisted of seven items that is regard to demographic questions on gender, age, education level, place participants have or have not been lived other than Hong Kong, occupation (designated trades), vocational status, working experience (year).

3. 3. 2 Visual Vividness Imagery Questionnaire

In order to examine the visual vividness imagery of participants, the Visual Vividness Imagery Questionnaire (VVIQ; Marks, 1973) was used in this study. The questionnaire contained 16 items that were examined with the participants' eyes open first and then with their eyes closed on a five-point scale. The ratings ranged from "no image" to "extremely clear and realistic image". The examples items are "The contours of the landscape." and "The sun is rising above the horizon into a hazy sky."

3. 3. 3 Object-Spatial Imagery Questionnaire

For assessing the spatial and object imagery preference of the participants, the Object-Spatial Imagery Questionnaire (OSIQ; Blajenkova et al., 2006) was used in this study. The questionnaire consists of 30 items that was related to spatial imagery and object imagery. The items of spatial imagery and the items of object imagery mingled together in the questionnaire. The ratings ranged from one "totally disagree" to five "totally agree". There are 15 items (4, 7, 8, 10, 12, 15, 16, 17, 19, 21, 22, 25, 26, 28, 30 in OSIQ) that are used in examining the object imagery preference of participants such as "My visual images are in my head all the time. They are just right there." and "When I hear a radio announcer or a DJ I've never actually seen, I usually find myself picturing what he or she might look like". The remaining 15 items that are used in examining the spatial imagery preference of participants such as "I have excellent abilities in technical graphics" and "In high school, I had less difficulty with geometry than with art".

3. 3. 4 Samsung GALAXY TAB 2 7. 0

The production of the drawings of 24 safety sign referents were developed by the tablet personal computer called Samsung GALAXY TAB 2 7. 0. For each of the safety sign referents, a touch screen (7 inches) and an application program called “ Scribble!” on Tablet PC were provided in which participants were asked to draw the corresponding image for each sign referent. Also, different colors could be chosen to use in their drawings were provided by the Tablet PC application program (Scribble!).

3. 3. 5 Designed safety sign questionnaires

In order to collect the participants’ perceived context availability, familiarity, ease of visualization and concreteness in relation to safety sign referent, four 0-100 point scales for rating different sign referent characteristics were provided on the designed safety sign questionnaires.

In order to read easily and communicate effectively with the participants, the personal information questionnaire, VVIQ, OSIQ and the designed safety sign questionnaires were printed in black and written in Traditional Chinese.

3. 4 Procedure

Firstly, the participants were asked to complete the drawing tasks and the designed safety sign questionnaire. Then, they need to complete the questionnaire that is in regard to personal information. After that, they were asked to fill in the OSIQ and VVIQ. For each participant, the entire study took about one hour.

A total of twenty-four safety signs were used in this study, they are divided into two sets of designed safety sign questionnaire and drawing task evenly (Set A and Set B). Each participant was required to complete one set of designed safety sign questionnaire and drawing task for the 12 safety sign referents only (Set A: A1-A12 or Set B: B1-B12, shown in Table 3. 1).

First at all, the participants were asked to draw the first image that came to their mind as soon as possible in the tablet personal computer for each of the 12 safety sign referents. Before starting the drawing task, they were asked to draw each image as large as possible on the touch screen of tablet personal computer, to keep their drawings simply, to avoid using words, letters and numerals in their drawings, to describe their design concepts and ideas verbally while drawing each safety sign referent, different colors could be used for their drawings and explain the reason on choosing particular colors. After that, the participants need to rate the context availability, familiarity, ease of visualization and concreteness for each of the safety sign referents on 0-100 point scale in the designed safety sign questionnaire, in which 0 point denote the sign referents are very low context availability, very unfamiliar, very difficult to visualize or very abstract, however, 100 point denote the sign referents are very high context availability, very familiar, very easy to visualize or very concrete.

Then, the participants were asked to complete the personal information questionnaire that consisted of seven demographic questions on their gender, age, education level, place they have been lived other than Hong Kong (if any), occupation (designated trades), vocational status, working experience (year).

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For the VVIQ (Marks, 1973), it contained 16 items that is related to the vividness and visual imagery. For each item, participants need to rate the vividness of the mental image with their eyes open