



Research Paper

A Study on Comprehension of Warning Pictograms by Primary School Children

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Abstract

Accidents continue to be a threat to the lives of children. Hence, the discerning warning signs have become an important indicator of safety education. Children can easily understand the meaning of warning pictograms through clear design. As primary school children are prone to accident easily, this study targets on primary school children ages from 5 to 10 and their ability to recognize warning pictograms and color. This study used a questionnaire to determine children's understanding of warning pictograms and color. Interview method was conducted among the subjects to validate the degree of their perception. The results reveal that primary school children's understanding of warning pictograms is closely associated with their life experience and age. Most of the primary school children were able to recognize palm and triangle frame images, and "red" color as indicating warning. The differences among "palm", "cross", and "skull" images achieved statistical significance among three different age groups; 9 and 10-year-olds children opted "palm" as a prohibit sign, whereas 8-year-olds children recognized "cross" as the sign for prohibition.

Keywords: Primary School, Students, Warning, Pictograms, Color, Recognition

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I. Introduction

Children under 10 years old majorly die from accidents, inquisitive nature of children, negligence of parents and lack textual descriptions are often attributed as causes of accidents (Mayhorn and et al, 2018). In India, accidents are a constant threat to the lives of children (Chang LT, Tsai MC, 2011). Therefore, discerning warning signs are pivotal to educate the children on the road safety (McCarthy and et al, 1984) (Schieber and Vegega, 2002). Previous studies have shown that the understanding of warning labels by the common public is low (Wogalter and Laughery, 1996), (Davies S and et al 1998) and (Rother, 2012) particularly among accident-prone primary school children (Campbell, 2018).

The current literature exhibits that studies of warning signs primarily concentrate only on adults as their research subjects (Smith-Jackson, 2002) and the focus on children is very low (Wogalter, Conzola, Smith-Jackson, 2002). All present, instructions and warning signs on goods for children assess only the choices of adults and continue to ignore children's perception. In addition, warning pictograms should think through the diversity of the target audience, such as language impairments, literacy level, age, and culture, particularly for children who are in the process of learning the language (Laughery, 2018, Mayhorn, Wogalter, Bell, 2014).

In spite of Wogalter's suggestions that warning information is not the ideal method of preventing danger, such information is still valuable to users. To avoid danger and make instructions more clear visually, Wogalter suggested that there are two resolutions for using warning signs: (1) to inform users about possible danger effectively and (2) to decrease dangerous behaviors. Warning messages can serve as communication tool to inform the users of potential danger and help them prevent the danger. In addition, pictograms can intensify user awareness of possible threat, danger and accidents. Moreover, graphics and colors can be used in warning signs to deliver the most crucial message to the focus group to quickly overcome the hurdles of verbal communication.

Primary school children are in the stages of development and are immature in both physical and mental development also they lack experience and knowledge (Papalia, Olds, Feldman, 1990 and Vonèche, 2011). The mental agility and cognitive development of children of this age group is continuous and gradual. The first stage of development is enactive demonstration, in which children understand and explore the world through physical movement before they reach 3 years. The second phase is iconic representation, in which children learn through images and pictures. The final phase is symbolic representation; in which children use language, words, and symbols to gain knowledge (Bruner and Olson 1977). Cognitive and visual cues and abilities are the keys to picture recognition of primary school children (Barton, Sevcik, Ann Mary, 2018). The increased elasticity of a child's iris muscle leads to the gradual proliferation of light regulation by the pupils of the eyes. Visual development progressively stabilizes at the age of 5 to 6, and children at that age can also better perceive hue and contrast (Andrick and Tager-Flusberg, 1986).

Children start to understand the graphic representation from the age of three (Myers and Liben, 2012) For instance, a study by Piaget investigated 3-year-old children and found that children can associate the features of a banana to that of a telephone receiver (Piaget, 1962). Similarly, children can understand graphics to know warning, danger, and harm. Mayhorn et al (2018). investigated the usage of danger signs at home for children aged 5 to 8 and found that the learning through graphics can elevate their understanding of warning messages. Furthermore, warning graphics can be used in cleaning products, toxic substances, and health care to prompt children about the dangers and can be used to depict the usage of the product. Many studies have found that warning graphics are helpful to children in helping them identify danger (Loring and Wiklund, 1988) (Kelley, Gaidis, Reingen 1989), (Hellier, Wright, Edworthy, 2000) helping them understand warning messages (Wogalter, Sojourner, Brelsford, 1997), assisting them in finding the associated harm (Bzostek, Wogalter, 1999) reminding them to pay attention to warnings, and increasing the understating of safety guidelines through graphics. These studies show that children have low levels of discernibility for warning pictograms. It is clear that there are myriads of problems regarding primary school children's perception and understanding of warning pictograms. Thus, this study investigated 5- to 10-year-old primary school children and aimed to identify how they perceive and understand warning pictograms (signs, frames, and colors). The purposes of this research are as follows. 1) to understand Primary school children's cognition of warning pictograms (signs, frame, and color); 2) to analyze the variation in degree of cognition of warning pictograms across age groups and to further investigate the subjects' understanding of pictograms; and 3) to provide insight for designers and educators who develop warning pictograms for products and teaching aids.

II. Methods

2.1 Experimental design

The research process included three stages. The first stage involved the choosing and preparation of pictograms, which included discussing the results of the pretests with professionals, modifying the survey, and choosing three items each for five pictograms (sign, frame, and color) (see Figure 1). To determine the children's perception of warning pictograms, they were asked to choose the pictograms that best depicted the danger sign. The second stage was the survey that used questionnaire to investigated primary school children's recognition of warning pictograms. Finally, one-on-one interviews were conducted with the subjects to determine their interpretation of "warning pictograms".

2.2 Subjects

Primary school children were the subjects of this study and the subjects were selected through convenience sampling method. The subjects were selected from two primary schools located in Salem district of Tamilnadu state, and a formal approval on research was sought. The children's parents provided written agreement and were given all the required information related to the study. Interviews were conducted with the subjects to verify the extent of their perception. Children, who showed difficulties in communication or interpersonal relationship, were excluded from the tests. After analyzing the learning backgrounds and parental consent, children were filtered. There were 90 respondents in total, including 30 students each from 5-6 year-old children group, 7- 8year-old children group, and 9-10 year-old children group. These students included 53 boys and 37 girls (see Table 1). This study chose primary school children as the research subjects because children grow the ability to use symbolic representation around the age of five. In a previous study, Mayhorn et al. (1976) investigated 3- to 6-year-old children's understanding of warning symbols and inferred that primary school

Table1 : Class and number of subjects

Age	Age	Male	Female	Total
5 to 6-year-old children	5 years and 8 months ~ 6 years 7 months	16	14	30
7to 8-year-old children	7 years 8 months ~ 8 years 7 months	17	13	30
9 to 10-year-old children	9 years 8 months ~ 10 years and 8 months	20	10	30
Total	Average of 5 to 10 years old	53	37	90
















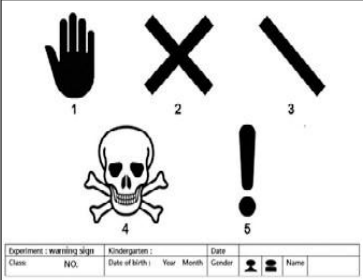
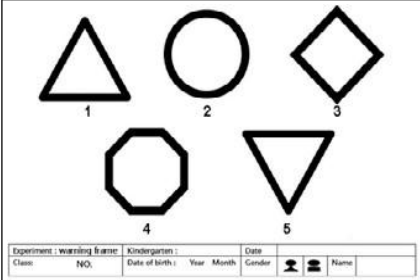
1.Warning Sign				
				
A1: Palm	A2: Cross	A3: Oblique Line	A4: Skull	A5: Exclamation Point
2.Warning Frame				
				
B1: Triangle Frame	B2: Circular Frame	B3: Diamond Frame	B4: Octagonal Frame	B5: Inverted Triangle Frame
3.Warning Color				
				
C1: Orange	C2: Red	C3: Green	C4: Blue	C5: Black

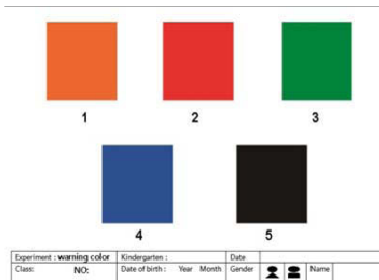
Figure1 : Survey Sample



1. Warning Sign



2.Warning Frame



3.Warning Color

Figure2 : Survey Questionnaire Sample

2.3 Materials

Sample selection: Based on the results of the pretest and the existing literature, the researcher selected samples from four categories of warning pictograms and warning frames, namely, ISO and ANSI, including traffic signs, symbols of dangerous chemicals, and signs of dangerous working places. The samples were selected from signs that showed hazard, prohibition, and warning (Dreyfuss, 1984). For this study, pictograms for the survey were altered based on the results of the pretests and expert suggestions. In total, there were five warning pictograms of each of the three types (sign, frame, and color).

Pictogram design process: In total five pictograms were used (Figure 1-1). As per the pretest, results the primary school children identified cross and palm pictograms as the warning signs (Mei-Chun and et al, 2011). Moreover, previous studies used three common types of warning signs: an oblique line, an exclamation point, and a skull.

The warning frames that were used in the survey were the commonly used on warning signs, which includes five pictograms: triangle frame, circular frame, diamond frame, octagonal frame, and inverted triangle frame (Figure 1-2). In the color usage (Braun and et al,1995) and (Kline and et al, 1993) opined from their survey findings that colors red, orange, green, blue, and black best expressed warning. Therefore, this survey used the Munsell Color System and selected the hues Red 2.5YR, Orange 7.5R, Green 5G, Blue 2.5PB, and Black N1.5 (see Figure 1- 3).

Modified pictograms: The scale of the graphic was drawn as per the norms of warning signs. Every pictogram was printed in a 70×70 mm black and white block and drawn on a G8K (210 x 297 mm) paper. All pictograms

were designed using Adobe Illustrator CS and were properly printed with high resolutions. Because children have a short attention span, the number of pictogram samples used was minimal. Surveys that need respondents to choose one answer out of five options have been found to be especially suitable for children. Samples from the questionnaire are shown in Figure 2.

The warning pictogram survey included three features: instruction, basic information, and a questionnaire form. The instruction primarily contained information for students related to the task for completing surveys. Instructions were also given orally, asking students to choose warning pictograms from five signs. Basic information collected includes personal background information, such as gender, age, and class. The researcher aided the children in providing this information prior to the test. Three types of questionnaire forms were used: warning sign, warning frame, and warning color. The subjects were asked to complete all the survey at the same time, which required them to choose one answer from five options.

2.4 Procedure

After the researcher explained the concepts of warning and danger, groups of children were asked to complete the survey once they fully understood the topic. The survey had the following title: "Please choose warning pictograms from five pictograms (sign, frame, and color)". The subjects completed their answer sheets around ten minutes in the classroom. The time spent on the surveys was monitored carefully. The purpose of the survey was clearly defined: when a respondent expressed ambiguity about a question, the researcher explained it to him or her again. The classroom was lit by natural and fluorescent light. The researcher observed the survey process, which was also recorded by digital video. After all surveys were completed and returned, they were properly organized, documented, coded, and analyzed.

2.5 Data analysis

The raw data derived from the survey were coded and analyzed using SPSS. Different classes of respondents were compared using various statistical methods, including descriptive statistics, ANOVA (one-way analysis of variance), LSD (Post hoc Test), and multiple comparison, to explain primary school children's differential recognition of warning pictograms.

III. Results

3.1 Recognition across age groups

As shown in Table 2-A1~A5, the descriptive statistics reveal the recognition of warning pictograms across classes. In terms of the percentage of children who chose "palm", 9-10 year-old children had the highest percentage (100.0%), whereas 7-8 year-old children had the second highest percentage (90.0%) and 5-6 year-old children had the lowest percentage (50.0%). However, with respect to the recognition of "cross" and the percentage of children who chose this pictogram, 5-6 year-old children had the highest percentage (50.0%), and 7-8 year-old children had the second highest percentage (6.7%); in contrast, none of the 9-10 year-old children chose this option (0.0%). Overall, 7 to 10-year-old school children had better recognition of "palm" (73.3%), and the lowest recognition level was shown for "exclamation point" (0.0%). Through this survey it was evident that children were unable to correctly identify the "oblique line", "skull", and "exclamation point" forms.

With regard to the warning frame (Table 2-B1~B5), 5-6 year-old children primarily chose "triangle frame" (50.0%) and "circular frame" (36.7%); 7-8 year-old children largely chose "triangle frame" (80.0%), and 9-10 year-old children primarily chose "triangle frame" (43.3%) and "circular frame" (23.3%). All children generally had a high recognition rate for the "triangle frame" (57.8%) and a low recognition rate for the "inverted triangle frame" (3.3%). 5-6 year old children exhibited a more concentrated recognition pictogram, whereas 7-8 year-old and 9-10 year-old children showed a dispersed recognition pictogram. With regard to the warning color (Table 2-C1~C5), 5-6 year-old children primarily chose "red" (66.7%) and "orange" (16.7%); 7-8 year-old children chose "red" (66.7%) and "orange" (16.7%); and 9-10 year-old children chose "red" (50.0%), "blue" (20.0%), and "orange" (16.7%). In general, all children had a high recognition rate for "red" (61.1%) and low recognition rates for "black" (4.4%) as warning color.

3.2 Recognition differences across age groups

Table 3 (A1, A2, A4) demonstrates that primary school children's recognition of "palm" ($p=.000^{**}$), and "cross" ($p=.000^{**}$) showed very significant differences.

Table 2: Descriptive Statistics of Warning pictograms, number of people (percentage)




























Subjects	Pictograms	Name	5-6 year-old children N=30	7-8 year-old children N=30	9-10 year-old children N=30	Percentage of all N=30
A1		Palm	27 (90.0%)	30 (100.0%)	9 (30.0%)	66 (73.3%)
A2		Cross	2 (6.7%)	0 (0.0%)	15 (50.0%)	17 (18.9%)
A3		Oblique Line	1 (3.3%)	0 (0.0%)	2 (6.7%)	3 (3.3%)
A4		Skull	0 (0.0%)	0 (0.0%)	4 (13.3%)	4 (4.4%)
A5		Exclamation Point	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
B1		Triangle Frame	15 (50.0%)	24 (80.0%)	13 (43.3%)	52 (57.8%)
B2		Circular Frame	11 (36.7%)	2 (6.7%)	7 (23.3%)	20 (22.2%)
B3		Diamond Frame	3 (10.0%)	2 (6.7%)	5 (16.7%)	10 (11.1%)
B4		Octagonal Frame	1 (3.3%)	1 (3.3%)	3 (10.0%)	5 (5.6%)
B5		Inverted Triangle Frame	0 (0.0%)	1 (3.3%)	2 (6.7%)	3 (3.3%)
C1		Orange	5 (16.7%)	5 (16.7%)	5 (16.7%)	15 (16.7%)
C2		Red	20 (66.7%)	20 (66.7%)	15 (50.0%)	55 (61.1%)
C3		Green	2 (6.7%)	3 (10.0%)	0 (0.0%)	5 (5.6%)
C4		Blue	3 (10.0%)	2 (6.7%)	6 (20.0%)	11 (12.2%)
C5		Black	0 (0.0%)	0 (0.0%)	4 (13.3%)	4 (4.4%)

Table 3: ANOVA test of Warning pictograms

Factor: GROUP		Sum of Squares	df	Mean Square	F	Sig.
A1.Palm 	Between Groups	8.600	2	4.300	41.567	.000 * *
	Within Groups	9.000	87	.103		
	Total	17.600	89			
A2.Cross 	Between Groups	4.422	2	2.211	20.537	.000 * *
	Within Groups	9.367	87	.108		
	Total	13.789	89			
A4.Skull 	Between Groups	0.356	2	.178	4.462	.014 *
	Within Groups	3.467	87	.040		
	Total	3.822	89			
B1.Triangle Frame 	Between Groups	2.289	2	1.144	5.063	.008 * *
	Within Groups	19.667	87	.226		
	Total	21.956	89			
B2.Circular Frame 	Between Groups	1.356	2	.678	4.153	.019 *
	Within Groups	14.200	87	.163		
	Total	15.556	89			
C5.Black 	Between Groups	.356	2	.178	4.462	.014 *
	Within Groups	3.467	87	.040		
	Total	3.822	89			

Note: (*Significant Difference), $p < .05$; (**Very Significant Difference) $p < .01$

Table 4: LSD Multiple comparisons of Warning pictograms

Subjects	A1 : Palm 			A2 : Cross 			A4 : Skull 		
Age	5-6 year-old	7-8 year-old	9-10 year-old	5-6 year-old	7-8 year-old	9-10 year-old	5-6 year-old	7-8 year-old	9-10 year-old
5-6 year-old children	—	—	—	—	—	—	—	—	—
7-8 year-old children	.232	—	—	.433	—	—	1.000	—	—
9-10 year-old children	** .000 *	** .000 *	—	** .000 *	** .000 *	—	.011 *	.011 *	—
Subjects	B1 : Triangle Frame 			B2 : Circular Frame 			C5 : Black 		
Age	5-6 year-old	7-8 year-old	9-10 year-old	5-6 year-old	7-8 year-old	9-10 year-old	5-6 year-old	7-8 year-old	9-10 year-old
5-6 year-old children	—	—	—	—	—	—	—	—	—
7-8 year-old children	.005 *	—	—	.005 *	—	—	1.000	—	—
9-10 year-old children	.205	.011	—	.205	.114	—	.011 *	.011 *	—

Note: 1. (*Significant Difference), $p < .05$; (**Very Significant Difference) $p < .01$. 2. A1: 7-8-year-old children > 5-6-year-old children > 9-10-year-old children; A2: 9-10-year-old children > 5-6-year-old children > 7-8-year-old children; A4: 9-10-year-old children > 5-6-year-old children, 7-8-year-old children; B1: 7-8-year-old children > 9-10-year-old children > 5-6-year-old children; B2: 5-6-year-old children > 9-10-year-old children > 7-8-year-old children; C5: 9-10-year-old children > 5-6-year-old children, 7-8-year-old children

Their recognition of “skull” ($p=.014$) exhibited significant differences. After the data were found to be statistically different using a one-way ANOVA, the data were further analyzed using LSD to ensure that the differences across classes would be clearly shown. As shown in Table 4 (A1, A2, A4) with respect to recognition of “palm”, there are statistically significant differences between 5-6 and 7-8 year-old children ($p=.001$) and between 7-8 and 5-6 year-old children ($p=.001$). More than 90% of the 5-6 year-old children (90.0%) and 7-8 year-old children (100.0%) indicated that “palm” expresses warning messages clearly. However, only 30% of the 9-10 year-old children believed that “palm” expresses warning messages clearly.

In terms of the recognition of “cross”, there are statistically significant differences between 7-8- and 5-6-year-old children ($p=.000$) and between 7-8 and 5-6 year-old children ($p=.000$). 9-10 old children (50.0%) had the highest recognition of warning pictograms, compared with 7-8 year-old children (6.7%) and 5-6 year-old children (0.0%) with lower recognition. Most 9-10- year-old children indicated that “cross” signs most clearly express messages of warning and that “palm”.

Signs exhibit warning messages only moderately well. With respect to “skull”, there are statistically significant differences between 9-10 and 7-8 year-old children ($p=.011$) and between 9-10- and 5-6 year-old children ($p=.011$). 5-6 and 7-8 year-old children (0.0%) never chose this pictogram, compared with 13.3% of the 9-10 year-old respondents who believed that this pictogram expressed a warning message.

Regarding the warning frame, Table 3 (B1, B2) shows a statistically very significant difference between classes in the categories of “triangle frame” ($p=.008$). Their recognition of “circular frame” ($p=.019$) exhibited significant differences. The data were analyzed using LSD tests. Differences across ages are further illustrated in Table

As Table 4 (B1, B2) shows, there is a statistically very significant difference between 5-6 year-old children and 7-8 year-old children in the “triangle frame” and “circular frame” ($p=.005$). There is a statistically significant difference between 7-8 year-old children and 9-10 year-old children in the “triangle frame” and “circular frame” ($p=.011$). 7-8 year-old children generally believed that “triangle frame” (80.0%) was capable of fully expressing warning messages. Compared with the 7-8 year old children, only fewer 9-10 year-old (43.3%) and 5-6 year-old (50.0%) respondents thought that the triangle frame could express the warning messages adequately. A higher percentage of 5-6 -year-old children (36.7%) and 9-10 year-old children (23.3%) indicated that circular frame adequately revealed warning.

As shown in Table 3-C5, there is a statistically significant difference among the classes in the category of “black” ($p=.014$). The data were analyzed using LSD tests. Differences across all children are further illustrated in Table 4. As Table 4-C5 shows, there is a statistically significant difference between 9-10 -year-old children

and 5-6 and 7-8 year old children in the recognition of “black” ($p=.011$). Only the 9-10 year-old children indicated that “black” (13.3%) could express a warning message; 5-6 (0.0%) and 7-8-year-old children (0.0%) had lower recognition.

IV. Discussion

According to the statistical analysis, among all warning pictograms, the primary school children’s answers indicate that “palm” expressed warning most clearly and that “exclamation point” was the weakest expression of warning. With respect to age, 5-6 year-old children and 7-8 year-old children thought that “palm” expressed warning most strongly, whereas 9-10 year-old children thought that “cross” expressed warning most strongly and that “palm” expressed warning only moderately. In fact, children’s understanding of graphic symbols is the basis of perception, cognition, and action (Einarsdottir, Dockett and Perry, 2009). Results from previous research on schoolchildren cartographic design indicated that 8 year- old children use “hand” to express stop (Goria, and Papadopoulou, 2012). Children’s cognition of symbols ranges from concrete to abstract (Carlson, 2005). The results from the current study show that children can use their experiences to prompt notions through pictograms. For instance, a 10 year-old child described *“would use hands and crosses to express “don’t” or “warning”*”. Furthermore, the interview results show that most children have a deep imprint of previous life experience, such as their parents’ disciplinary styles, and thus are generally deeply familiar with “palm” as a reminder.

Regarding the features of the pictograms, “palm” had clear contours, and its meaning was easy to exude. Older children strongly acknowledged with “cross”, whereas younger children showed weaker recognition of this sign. From the result of interviews, it was known that kindergarten teachers plan to give some assignments to the 7-8 and 9-10-year-old children to help them understand the meaning of “cross”. The findings also show that younger children could not understand the warning messages of “oblique line”, “skull”, and “exclamation point”.

Especially in some of children expressed, they also could not understand the “oblique line” of the “prohibition sign”. In addition, through the interviewed results, a 5-6 year-old child described *“could not identify the “skull” as a warning and rather associated it with a ghost or a monster”*. They also tended to associate “exclamation point” with objects, rods, and bats.

With respect to warning frame, the children in this study showed strong preference of the “triangle frame” warning, moderate recognition of the “circular frame” warning signs. According to the theory proposed by Piaget, schoolchildren explore shapes according to their environmental understanding (Tolar and et al, 2012) and , which occurs much earlier than language learning phase (Piaget and Inhelder, 1967). At approximately 1 to 3 years old, children are able to recognize visual graphics and distinguish lines from a grey plane. Del Grande (1990) stated that the information classification capabilities of schoolchildren devise from their intuitive judgment. Children tend to use the shapes with which they are familiar for association. Based on previous studies, it is clear that schoolchildren are already able to identify shapes.

From interviews, it was inferred that the teachers seldom teach children about the relationship between these signs and danger. Moreover, the findings show that schoolchildren are most familiar with the triangle, circle, and diamond shapes. Because these frames are relatively easy to identify, the children were able to translate the visible cues easily. For example, a five-year-old child described, *“Triangle frame has a sharp edge and rather touched it with a feeling of pain”*. A seven-year-old child described *“triangle frame with warning mean, because she had seen the traffic signs with triangle frame in the roads”*. Some 9-10 old children had seen non-smoking signs; therefore, they thought circular frame also has a “warning” message. Primary school children often link danger signs with forms with which they have come across already (Namy, 2012). In the same vein, children are less likely to recognize complicated and unfamiliar forms, such as “octagon” and “inverted triangle”. In the psychology of form, tension represents movements. For example, high temperatures, red color, expansion, and impact force represent acute angles. In accordance with the principles of warning signs, triangle shapes are conducive to showing warning messages. However, children wrongly perceived the “inverted triangle” as a triangle because their teachers had not taught them the difference between the two and because they seldom observe this shape in their daily lives. Because round shapes are easy to recognize, some researcher have suggested that “frame” could stress pictograms and thus make children more aware of these warning signs (Elliot, 2011). Moreover, because rhombuses and octagons are rarely seen in children’s daily lives, they have difficulties in recognizing them. From the above information, we can deduce that education, life experiences, and environmental signs are the main attributes influencing the perception of warning concepts.

In the investigation of warning color, the schoolchildren in this study primarily recognized red as a warning color and did not recognize green or black as a warning color. According to Piaget’s theory (Zentner, 2001) the color recognition of schoolchildren belongs to the experiential phase. Their understanding of colors originates from their life experiences. From interview, it was understood that, the children described red as

bleeding, pain, and fire, all of which represent discomfort and danger. In color psychology, the meanings of red include attack, invasion, failure, and mistakes. With respect to warning colors, red also represents danger, lethal danger, and prohibition. For instance, in investigating the colors of warning signs, Kline et al. and Braun et al. (1993) found that red and orange represented the highest level of danger in messages. As a warning color, black represents death and terror (Boyatzis and Varghese, 1994). The interviews in this study showed that the children's impressions of black originated from night and death, both of which reflect fear and mystery. However, the children's cognition of this color was low, and most of them perceived red as an easily recognizable warning color.

V. Conclusions

The results of this study of 5 to 10-year-old children's recognition of warning pictograms suggest that children had stronger recognition of "Palm" among all warning pictograms, stronger recognition of "Triangle Frame" among all warning frames, and stronger recognition of the color "Red" among all warning colors. The palm, cross, skull, circular frame, and black types all achieved statistical significance. The findings of the recognition of warning pictograms across age groups show that older children demonstrate better recognition of symbols, given that 9-10-year-old children primarily chose the "cross" warning pictogram. In contrast, 5-6- and 7-8-year-old children opted to choose "Palm"; hence, through this investigation it was found that children were more likely to associate physical movements with warning messages. Thus, warning pictograms should be more in agreement with children's lives, and objects should be concrete to ensure that they will not conflict with children's cognitive development or cause confusion with other symbols.

Furthermore, the results suggest that 5-10-year-old children viewed the "triangle frame" as depicting the strongest warning message. There were statistically significant differences among different age groups in their recognition of "triangle frame" and "circular frame" messages. Younger children tended to recognize that "triangle frame" depicted a stronger warning. Whereas, older children thought that the "circular frame" sign indicate a stronger warning. Thus, through the results of survey, we know age, education, and experience are factors that influence children's recognition of frames. Most 5- to 10-year-old children correctly recognized triangle, square, and diamond because their teachers had taught these shapes in class. In addition, they are also familiar by association with the objects.

Based on the results, this study proposes several suggestions for warning pictogram design: (1) warning pictograms must fulfill the visual cues of "meaning" which, children should be able to associate this knowledge, and the pictograms should effectively help children identify danger; (2) warning pictograms should use simple and popular visual images to warn children against unwanted harm. "Popular objects" should be as simple as possible; they should be easy to remember and to recognize while sufficiently transmitting the necessary information.

In view of the above findings, primary school children's understanding of warning pictograms is closely associated with their life experience and age. When designing warning pictograms, designers should reflect children's cognitive development and their familiarity with such signs. To enable children's recognition of pictograms, the contour of pictograms should be specious to ensure that the intended warning message will be conveyed to them successfully.

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