

# Research on Preschoolers' Comprehension of Safety Signs and Its Influencing Factors

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**Abstract:** As an integral part of children's safety education, safety signs hold significant importance for preschoolers' safety. This study aims to investigate the comprehension level of safety signs and its influencing factors among preschoolers and explore the role of background factors such as safety education in children's learning of safety signs. Sixty-seven preschoolers participated in the questionnaire investigation on 11 safety signs. The results were encoded by a binary method and subjected to descriptive analysis and multiple correspondence analysis. The results indicated that preschoolers can understand symbols, but there is a certain degree of arbitrariness. The existing thematic education fails to improve their understanding of safety signs. This study provides a theoretical basis for improving and optimizing child safety education.

**Keywords:** Preschoolers; Safety signs; Safety education

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## 1. Introduction

With the rapid development of society and the acceleration of urbanization, the safety of preschool children is increasingly receiving attention. During children's growth, they are inevitably exposed to various potential hazards, such as sharp objects, power sockets, heights, etc. Therefore, safety signs, as an integral part of children's safety education, have significant importance for the growth of preschool children.

Symbols, the main components of safety signs, are directly related to children's understanding and memory of safety signs<sup>[1]</sup>. Dewey believed that all signs were graphical except for the "P" representing parking spaces and the "H" representing hospitals. Meanwhile, due to children's ability to easily recognize and read symbols, it has been identified as a tool for starting to recognize text<sup>[2]</sup>. Therefore, for preschool children, it is crucial to deeply understand and effectively utilize the intuitiveness and comprehensibility of symbols, which not only helps to identify and understand safety information but also provides them with effective protection at critical moments.

Preschoolers are in a vital period of physical and mental development, where their cognitive, attention,

and comprehension abilities are rapidly developing. However, there are significant differences in the way preschoolers receive and process external information compared to adults. They can understand and use simple symbols to transmit and receive information, while they may still have difficulty understanding complex concepts and rules. Children’s understanding of traffic signs is far inferior to that of adults [3]. Waterson developed a set of safety sign design strategies for trains through classroom discussions with children [4]. In addition, there are differences in the recognition of symbols among different children [5]. Colorful signs are more effective for recognition among girls. Children’s color preferences quite differ from that shown in ISO-registered signs [6].

Therefore, this study aims to analyze the understanding of different safety sign symbols among preschool children, as well as the role of background factors such as safety education in children’s learning of safety signs. This study helps us gain a deeper understanding of how preschool children interpret safety signs, providing a scientific basis for designing safety signs that are more in line with children’s cognitive characteristics. The research results can be directly applied to children’s safety education, improving the pertinence and effectiveness of education.

## 2. Methods



### 2.1. Participants

Sixty-seven children were recruited as experimental participants. Considering their literacy, the questionnaire was filled out by the kindergarten teacher on behalf of the children. The kindergarten teacher provided no other assistance related to the questionnaire content except for helping to fill it out. Parents of the participating children received an explanation of the research objectives and guaranteed that the research results would be kept confidential and only accessible to the researchers. The participating children were not asked to provide their names or other identification information.










### 2.2. Questionnaires

The survey questionnaire includes 11 safety signs from GB 2894-2008, as shown in **Table 1**. These safety signs include three common types of signs for preschoolers: prohibition, warning, and reminder. The content of safety signs is related to accidents and emergency measures. After deleting the textual information, the safety signs were randomly arranged on the questionnaire, and the image format of the safety signs was the same as GB 2894-2008 and printed in full color. Each participant was required to describe the meanings indicated by 11 symbols. For each safety sign, the questionnaire included a question about whether they had been exposed to it before. The questionnaire also included a section that collects demographic information, including age, grade, gender, color blindness, or color weakness, as well as education on safety topics and safety signs.

**Table 1.** Symbols and results in questionnaires

Symbols	Safety signs	Accuracy	Proportion of those who have seen	Accuracy of those who have seen
	No entry	40.9%	53.0%	65.7%
	No stretching out of the window	15.2%	59.1%	15.4%

**Table 1 (Continued)**

Symbols	Safety signs	Accuracy	Proportion of those who have seen	Accuracy of those who have seen
	No tossing	28.8%	59.1%	30.8%
	Warning electricity	56.1%	81.8%	63.0%
	Warning hands pinching	48.5%	60.6%	65.0%
	Warning dogs	48.5%	59.1%	56.4%
	Warning wet floor	75.8%	78.8%	88.5%
	Exit	57.6%	78.8%	69.2%
	Haven	19.7%	47.0%	22.6%
	Emergency assembly point	24.2%	34.8%	30.4%
	First aid	53.0%	62.1%	73.2%

This questionnaire adopts an open-ended filling method and is graded based on the understanding of the meaning of symbols in the questionnaire. Except for completely correct meanings, understanding the appearance of correct images and actions or similar meanings is defined as partially correct. The partial correct answer for “no entry” is “no pedestrian passage.” However, a clear misunderstanding of the safety sign symbols and a significant deviation between the definition of the image or indication action and the correct meaning is an incorrect answer. For example, “no running” for “no entry” sign is an incorrect answer. Using a binary scoring program, the scores for correct and partially correct answers are defined as 1, while the scores for incorrect and missing answers are defined as 0.

### 3. Results

#### 3.1. Participant demographic

Among the 67 collected questionnaires, one questionnaire was deemed invalid due to not filling in any content other than demographic information. The validity of the questionnaire is about 98%. The final sample consisted of 66 participants aged between 3 and 7 years old (mean = 5.11, standard deviation = 1.025). Among them, there were 31 males and 35 females, accounting for 47% and 53%, respectively. Three males (9.68%) and four females (11.43%) reported color vision defects such as color blindness or color weakness. The proportion of male participants with color vision defects is close to a 1950 survey in China (9.94%), while the proportion of female participants is much higher (1.42%)<sup>[7]</sup>.

In terms of educational level, 16.7% of participants are in junior grade, 63.6% are in middle grade, and 19.7% are in senior grade. The literacy levels of preschool children are divided into 0–50, 50–200, and over 200. The educational level of the participants in the experiment is shown in **Table 2**. In addition, two participants (3%) stated that they had not received safety-related education. Considering that all participants came from the same kindergarten, we speculate that these two participants may have mistakenly stated that they had not received safety education due to memory bias. This situation is not uncommon in investigations and may be due to a long time, vague memory, or confusion of educational experiences in different situations<sup>[8]</sup>. There were 49 participants (74.2%) who reported receiving education on safety signs.

**Table 2.** Number of participants in different classes and literacy levels

Class	0–50	50–200	> 200
Junior	7	3	1
Middle	22	17	3
Senior	5	4	4

#### 3.2. Descriptive analysis

In terms of the types of safety signs, the accuracy of prohibition symbols is generally low. Participants can guess the imagery of things in symbols, but there is a significant misunderstanding of the prohibited actions. The accuracy of warning sign symbols is good. The accuracy of “exit” and “first aid” in reminder symbols is relatively high, while the accuracy of “haven” and “emergency assembly point” is relatively low.

Among all the symbols tested, the accuracy of “warning wet floor” was significantly higher than other symbols (75.8%). The “exit” symbol ranked second (57.6%), demonstrating the rapid response ability of preschoolers in the face of emergencies. More than half of the correct answers were “warning electricity” (56.1%) and “first aid” (53.0%), indicating that preschoolers also have a high level of awareness of potential dangers and the handling of accidental injuries. It is worth noting that although the recognition accuracy of “warning electricity” is relatively high, there are still many participants who mistakenly interpret the image of the symbol as lightning. Given the significant differences in scene and response measures between electric shock and lightning, the answer of mistaking the symbol for lightning is deemed incorrect. In the test of “first aid,” most responses pointed to hospitals through the cross symbol. Given that hospitals also serve as first aid, the answer that includes hospitals is deemed correct.

The lowest accuracy rate is “no stretching out of the window” (15.2%). Although participants can recognize the window image in the symbol, they cannot fully understand the gesture of stretching out. Similarly, “no tossing” (28.8%) had a low accuracy rate, where participants focused more on the items in the sign and ignored the hands and dynamic lines representing throwing actions. Among the indicative signs, “haven” (19.7%)

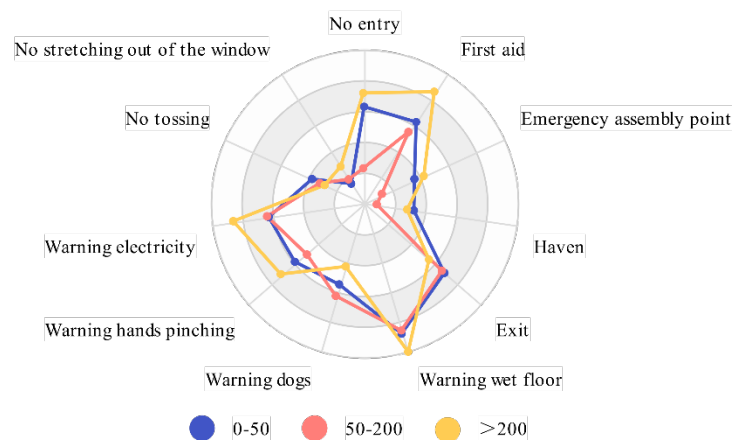


and “emergency assembly point” (24.2%) may be challenging for participants to understand their true meanings due to their rarity in daily life.

## 4. Discussion

### 4.1. Literacy

The increase in literacy often accompanies the improvement of children’s cognitive abilities, including attention, memory, comprehension, and reasoning skills. Although there is no research directly related to the topic of identifying safety signs for preschoolers, there are some studies that are typically related to children’s identification of signs and symbols. Previous studies have shown that symbol recognition is important for the development of literacy skills and can serve as a tool for learning to read [9]. Some children rely on gestures to learn reading, and seeing pictures of text descriptions next to the literacy itself can help preschool children develop their reading and writing skills. The improvement of these abilities enables children to more accurately identify and understand complex safety signs. The relationship between the accuracy of understanding safety sign symbols calculated through multiple correspondence analysis and the literacy level of preschool children is shown in **Figure 1**. The accuracy increases from the center point to the edge. From the figure, preschoolers with a literacy level of 50–200 have a lower accuracy rate of reminder signs, while the accuracy rates of other markers are close to those of preschoolers with a literacy level of 0–50. Preschool children with a literacy level over 200 have the highest accuracy on most symbols.



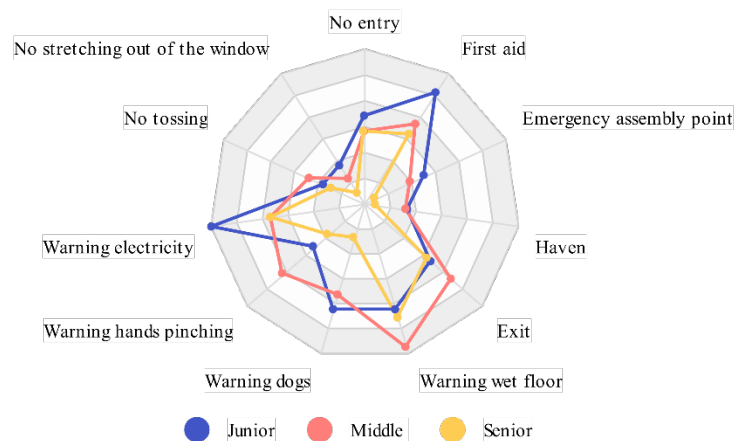
**Figure 1.** Accuracy of participants at different literacy levels

This phenomenon may indicate that for preschool children with literacy levels between 0–50 and 50–200, their basic visual recognition abilities are similar. Therefore, they scored similarly when identifying safety signs. These signs usually have distinct symbols and colors that are easy for children to recognize visually. With the increase in literacy, children not only have stronger reading skills but also higher comprehension skills. This enables them to better understand the meaning behind the symbols when faced with complex indicative signs. Therefore, preschoolers with a literacy level over 200 score higher in recognizing these signs.

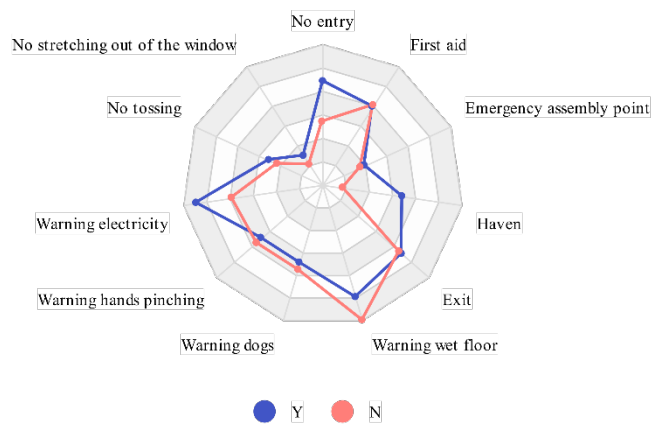
### 4.2. Grade and safety education

In previous studies, the educational level and thematic education of participants are positively correlated with the accuracy of safety sign recognition [10]. The relationship between the accuracy of understanding symbols in

this survey and grade level and whether they have received safety sign education is shown in **Figures 2 and 3**. However, neither showed any impact on safety signs in this study. Firstly, differences in sample size may lead to certain biases. In this experiment, more children in the middle grade may have weakened the influence of grade and safety education on the accuracy of safety sign recognition. Secondly, although the survey showed that some participants reported receiving safety sign education, the quality and effectiveness of the education may vary due to various factors. If the content of safety education is not detailed or engaging enough, and the process lacks interaction and hands-on practice, participants may struggle to accurately identify and understand safety signs, even after receiving the education. Finally, it is possible that the three grades received the same teaching methods and content for safety sign education. This may result in children’s ability to recognize safety signs not significantly improving with age or learning experience.



**Figure 2.** Accuracy of participants in different grades



**Figure 3.** Accuracy of participants with or without safety sign education

### 4.3. Limitations

In previous studies, the educational level and thematic education of participants are positively correlated with the accuracy of safety sign recognition. However, neither showed any impact on safety signs in this survey.

Firstly, differences in sample size may lead to certain biases. In this experiment, more children in the middle grade may have weakened the influence of grade and safety education on the accuracy of safety sign recognition. Therefore, when evaluating the effectiveness of grade and safety education, future research should consider using a more balanced sample distribution, or at least adjusting for the impact of sample differences through statistical methods.

Secondly, although the survey showed that some participants reported receiving safety sign education, the quality and effectiveness of the education may vary due to various factors. If safety education focuses solely on theoretical explanations and lacks engaging, real-world case studies, it may fail to capture children's interest. Without stimulating and practical learning methods, children may struggle to quickly and accurately recognize and apply safety signs in everyday situations. Therefore, improving the quality and effectiveness of safety education requires educators to constantly explore and practice more scientific and efficient teaching models.

Finally, it is possible that these three grades received the same teaching methods and content for safety sign education. This may result in children's ability to recognize safety signs not significantly improving with age or learning experience. Therefore, personalized safety education according to grade differences should be offered to ensure that every child can achieve maximum growth in their most suitable learning environment. In addition, as the grade increases, children's safety awareness and self-protection ability should also be correspondingly improved, which requires educators to constantly adjust teaching strategies and difficulty levels in the teaching process to meet children's growing learning needs.

## **5. Conclusion**

This study delves into the differences in accuracy among preschoolers in recognizing and understanding different safety sign symbols. After data analysis, it was observed that children can recognize most of the imagery in the symbols, but there is a significant degree of randomness. Children with a literacy level over 200 demonstrated higher accuracy in understanding safety sign symbols. This discovery emphasizes the crucial role of early literacy education in promoting the development of children's safety awareness. However, at the same time, the study also revealed a surprising phenomenon: the increase in grades and specialized education on safety signs did not significantly improve children's understanding of safety signs. This result may indicate that the current safety sign education strategy has limitations and requires in-depth reflection and improvement from multiple perspectives.

Based on the above findings, it is recommended to take a series of measures to enhance preschool children's understanding of safety signs. It is necessary to conduct in-depth research on the design principles of safety signs to optimize their visual expression and reduce the difficulty of children's understanding. More targeted and interesting safety education content should be designed to stimulate children's interest in learning and enhance their participation. In addition, cooperation between families and schools should be strengthened to jointly create a safe, healthy, and educationally meaningful learning environment for children.

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## References

- [1] Laughery KR, Wogalter MS, 2014, A Three-Stage Model Summarizes Product Warning and Environmental Sign Research. *Safety Science*, (61): 3–10.
- [2] Neumann MM, Hood M, Ford RM, 2013, Using Environmental Print to Enhance Emergent Literacy and Print Motivation. *Reading and Writing*, (26): 771–793.
- [3] Xiong Z, Hong CS, 2020, Comparative Study of the Understanding of Safety between Adults and Children—Taking Traffic Signs in a Multidisciplinary Context as an Example. *The Korean Society of Science & Art*, 38(5): 369–380.
- [4] Waterson P, Pilcher C, Evans S, et al., 2012, Developing Safety Signs for Children on Board Trains. *Applied Ergonomics*, 43(1): 254–265.
- [5] Siu KWM, Lam MS, Wong YL, 2015, Gender Differences in Children’s Use of Colors in Designing Safety Signs. *Procedia Manufacturing*, (3): 4650–4657.
- [6] Siu KWM, Lam MS, Wong YL, 2017, Children’s Choice: Color Associations in Children’s Safety Sign Design. *Applied Ergonomics*, (59): 56–64.
- [7] Chan E, Mao W S, 1950, Colour-Blindness among the Chinese. *British Journal of Ophthalmology*, 34(12): 744–745.
- [8] Giles RM, Tunks KW, 2010, Children Write Their World: Environmental Print as a Teaching Tool. *Dimensions of Early Childhood*, 38(3): 23–29.
- [9] Chen J, Wang R Q, Lin Z, et al., 2018, Measuring the Cognitive Loads of Construction Safety Sign Designs During Selective and Sustained Attention. *Safety Science*, (105): 9–21.
- [10] Lesch MF, 2003, Comprehension and Memory for Warning Symbols: Age-Related Differences and Impact of Training. *Journal of Safety Research*, 34(5): 495–505.

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