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ORIGINAL ARTICLE

Evaluation of the Perception of Workplace Safety Signs and Effective Factors

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ABSTRACT

Safety signs in the workplace are effective in the controlling of workplace hazards. Correct interpretation of signs is vital, preventing injury and saving lives. This study seeks to assess the perception of workplace safety signs and determine effective personal factors in comprehension. The current analytical-descriptive study was carried out in 2012 on 166 factory workers in 4 factories at the Khoramdasht and Bumehen industrial areas. Data was gathered using ISO 9186 and Demographic Information questionnaires. Stratified–random method was used for sampling and data were analyzed with Kendal statistical test using SPSS 16. General perception of safety signs was 69.22% with a standard deviation of 20.32%. Out of the 11 signs studied, the “eye protection must be worn” and “hand protection must be worn” signs had the highest effective perception and the “wear face shield” had the lowest. Results show a positive relationship between sign perception and factors such as age, experience and safety sign training ($p \leq 0.05$). However a meaningful relationship between sign perception and gender was not observed. Acceptable perception of signs was 72.72% based on ISO 3864 and only 9% based on ANSI Z5353. Results show overall safety sign perception within the studied samples was low and few signs actually reach the perception limits. The contribution of personal factors on sign perception can be reduced by educating the work force on workplace safety signs.

Keywords: *Safety Signs, Perception, Cognitive Ergonomics, ISO Standard*

INTRODUCTION

Cognitive ergonomics is the science of ergonomics with the aim of optimizing the adaptation of systems with human beings and human-machine interactions. This field focuses mainly on cognitive factors in human perception of motivation, information processing and action or behavior. Human beings are predictable creatures with specific abilities and limitations that factor in the designing of signs and play a role in increasing the effective function of systems [1]. Safety signs are a way of informing and alerting workers regarding possible safety hazards and risks which they may be exposed to in the workplace [2-3].

These signs offer are a more desirable interaction between human and the environment as they verily occupy little space and help to globalize productions [4]. The use of safety signs is the fourth common method of accident and injury prevention [5].

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Safety signs without supplementary text have advantages over safety signs that do, such as high visual effect for influential information transfer, concise informing and also language independence [6].

Signs and symbols are widely used for transferring meaning in various scenarios. In many cases they can be substituted for texts and/or supplementary texts (signs without supplementary text). They also have the advantage of being visible from great distances in comparison with signs (signs with supplementary text) [1]. Signs without supplementary text can also cause problems; for instance, they may not attract adequate attention to themselves [7]. It is also possible that these signs may convey a different or inverse meaning [8]. This is why is why signs are comprehended differently in various countries and regions [9-10], which may even cause injury or loss of life [11].

Although the National Safety Council (NSA) has listed misperception as being the third cause of accidents in the workplace it is still seen that in some cases attention is not paid and perception is presumed to be adequate [12]. It must be determined whether the signs have been comprehended correctly in different cultures [4].

Studies carried out on safety sign perception consider various factors as being influential in sign perception, these factors include training, job experience, work duration and time, type of safety signs, background color of safety signs and comprehension training [13-14]. The results of the study of Zamanian et al. in Iran showed a pre-existing level of sign comprehension among industrial workers, however there was a noticeable difference between perceptions of safety signs, because the perceived pattern of safety signs was different [15]. Article reviews indicate that very few studies have been carried out in the field of safety sign perception.

This research has therefore been conducted In Iran, considering the widespread use of various safety signs in industrial settings, to determine correct comprehension of safety signs and contributing factors with the aim of reducing accidents and injuries.

MATERIALS AND METHODS

The current analytical-descriptive study was done in 2012 within 4 factories in Tehran (in the industrial region of Khoramdasht–Bumehen). The participants in this study were 166 factory workers who were not colorblind. For colorblind testing the Aishi Hara test was used [15].

In order to quantify safety sign perception, the international standard organization (ISO 9186–1, 2007) questionnaire was used for data collection [16]. The reliability and validity of this questionnaire was previously determined by safety and ergonomics specialists at Shiraz University of Medical Science [15].

This questionnaire consist of four parts: A: Instruction sheet, B: Demographic information sheet (age, gender, occupational background, work experience and training), C: Example sheet and D: safety sign test sheet.

Eleven safety signs under use in all four of the sites were evaluated including seven mandatory signs, two safety condition signs, one warning sign and one sign for fire hazards.

All signs were 8×8 cm in dimension, color printed and were attached to standard size A_4 sheets of paper. Questionnaires were randomly distributed among workers whom were then asked to answer "*what they thought each symbol means?"* and *"what would they do in response to each symbol?"* The answers were analyzed in 5 groups (*A: Correct, B: Wrong, C: Wrong and inverse, D: I don't know, E: Without answer*). The total number of workers who chose "A" as their answer was set as the scale of perception for that sign. For assessment, the results were compared with thresholds suggested in the ANSI Z5353 and ISO 3846 standards [17-18].

Under the international standard organization requirements, at least 50 samples have to be examined for the assessment of a safety sign's perception rate. The story-random sampling method was used for sampling and the Kendal statistical test was used for data analysis. Graphs were drawn using SPSS (ver.16) and Microsoft Excel.

RESULTS

Samples were that of 166 workers consisting of 86.1% males and 13.9% females aged 15 to 55 of whom 42.8% were aged 15–35. Of these, 53.6% were aged 31–50 and 3.6% were aged over 50. In addition 45.8% were high-school drop outs, 37.3% diploma graduated and 16.9% were BS or BA graduates. 60.8% of these workers had previous safety sign training and 98.2% of the samples were dayshift workers. Work experience of samples was between 1 to 30 years with 58.4% having 1-10 years experience. Demographic data of workers participating in the study are presented in Table 1.

Results showed a general perception rate of 69.22% with a standard deviation of 20.32%. Highest perception belongs to the "*eye protection must be worn*" sign with 85.5% and "*hand protection must be worn"* sign with 84.3% perception. The *"head protection must be worn"* sign had the lowest perception (correct perception and inverse behavior) with only 5.4% valid perception. Highest misperception belonged to the *"wear face shield"* and *"first aid"* signs with 56.6% and 36.7% perception respectively.

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Table 1. Demographic Data Of Respondents (N=166)

Personal Factors	Data	Frequency	%
Age (yr)	15-30	71	42.8
	31-50	89	53.6
	51-55	6	3.6
Gender	Female	23	13.9
	Male	143	86.1
Education	Under Diploma	76	45.5
	Diploma	62	37.3
	BS/BA	28	16.9
Experience (yr)	<1	10	6
	1-10	97	64.5
	>10	59	29.5
Safety Signs Training	Trained	101	60.8
	Untrained	65	39.2

Table 2. The relationship between perception and personal factors by Kendal statistical test

Personal Factors	Perception	α
Age	*P*=0.02	0.45
Literacy	*P*=0.003	0.78
Gender	*P*=0.3	0.2
Experience	*P*=0.004	0.68
Training	*P*=0.01	0.54
Work shift	*P*=0.04	0.34

The results of this study indicate that there is a meaningful positive correlation between the rate of perception and Personal Factors such as age, training, work experience and safety sign training ($p \leq 0.05$) (Fig 1). In addition a weak correlative relationship was observed between perception and different work shifts. A meaningful relationship between gender and correct perception was not observed. The significant coefficient (α) for each test and the perception rate for each sign has been shown in Table 2 and 3, respectively. Fig 2 also graphically compares perception rate of different safety signs.

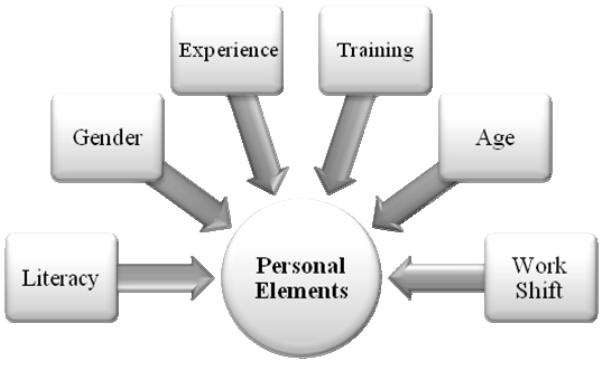

Fig 1. Investigated Personal Factors

DISCUSSIONS

Results show the average rate of correct perception of samples as being 69.33% with a standard deviation of 20.33%. Minimum perception was related to the *"head protection must be worn"* sign with 20.5% and the "*first aid"* sign with 56.6% perception. Maximum misperception (wrong Answer) also belonged to these signs and was calculated at 77.1% and 33.7% respectively.

The Loung Lio et al. study carried out on the perception of safety signs in China and Germany shows average sign perception to be 32.2% in China with a standard deviation of 30.3% and 42.7% in Germany with a standard deviation of 36.3% [6]. Anier et al. concluded average perception to be 67.54% with a standard deviation of 23.47% [3]. CHAN et al. in their study found the average perception of U.S workers to be 63.08% with a standard deviation of 28.47%; they also found average perception in Hong Kong and Korea to

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Table 3. Answers to 11 safety signs by 166 samples (percent)

No	Sign	Perception						Act for sign			
		Meaning	True	Wrong	False & opposite	Don't Know	No answer	True	Wrong	Don't know	No answer
1		First aid	56.6	33.7	0	9.7	0	44	36.7	19.3	0
2		Emergency exit	63.3	30.1	3	3.6	0	80.1	14.5	5.4	0
3		Hearing protection must be worn	83.1	16.3	0	0.6	0	88	9.6	2.4	0
4		Head protection must be worn	58.4	28.3	5.4	7.9	0	85.5	13.9	0.6	0
5		Wear face shield	20.5	77.1	0	2.4	0	39.2	56.6	4.2	0
6		Hand protection must be worn	84.3	15.1	0	0.6	0	85.5	11.4	3.1	0
7		Foot protection must be worn	82.5	14.5	0	3	0	80.1	14.5	5.4	0
8		Eye protection must be worn	85.5	13.3	0	1.2	0	88	8.4	3.6	0
9		Respiratory protection must be worn	81.3	16.3	0.6	1.8	0	86.7	7.3	6	0
10		Caution, risk of electric shock	72.3	27.7	0	0	0	81.9	15.1	3	0
11		Fire Equipment	83.7	14.5	0	1.8	0	82	12	6	0
Mean			70.13	26.08	0.81	3.1	0	76.45	5.36	18.1	0
Standard Deviation (SD)			19.75	1.76	1.76	2.9	0	17.5	4.9	14.9	0

be 20.47% and 27.94% respectively [13]. Zamanian et al. concluded that the average correct perception of safety signs in Iran to be 70.94% with a standard deviation of 27.38% [15]. Mean and standard deviation values for each Study are shown in Table 4.

The measure of standard deviation in the current study and studies elsewhere indicate a difference in sign perception and also perception style in each type of sign [15]. Other studies showed the perception of safety

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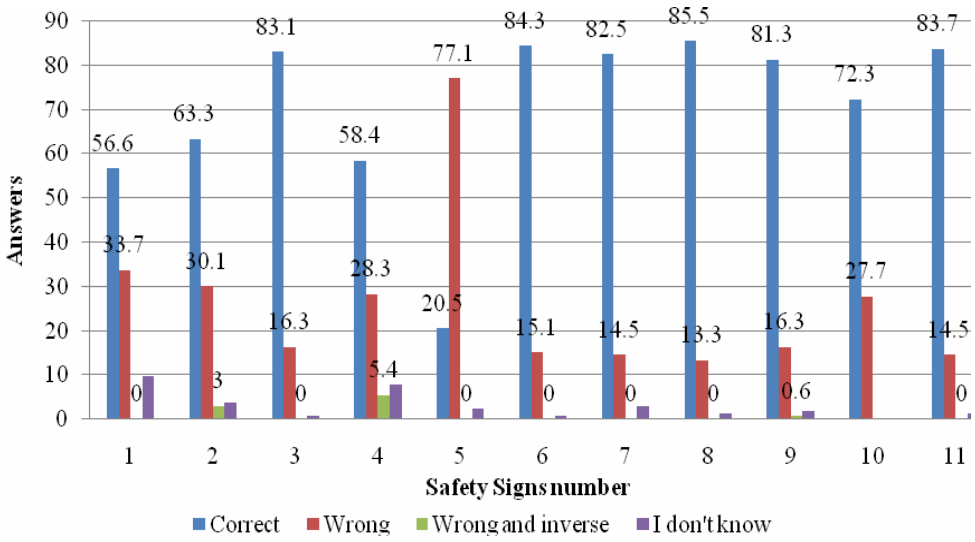

Fig 2. Perception of safety signs

signs among various countries to be different as a result of cultural factors [4]. Other factors such as mode of presentation, graphical symbols [19] and the different style of thought in various populations [13] can cause variances in sign perception.

As it is shown in Table 5, according to ISO 3864 and ANSI Z5353 the minimum average valid perception of a sign must be 67% and 85% respectively across the board [17-18]. Results showed that 63.63% of signs had acceptable perception rates for ISO 3864 and only 9% for ANSI Z5353. In the Zamanian at al. study these values were calculated at 60% and 50% respectively [15].

The Loung Lio study showed minimum acceptable perception rates based on ANSIZ5353 and ISO 3864 were 50% and 78% in Germany and 25% and 18.75% in China respectively [6].

Acceptable perception rates of signs were 75% based on ISO 3864 and 30% based on ANSI Z5353 standards [3]. Only 23.80% of signs reach acceptable perception rate limits according to ISO 3864 [4].

General perception among drivers was measured at 40% and furthermore, only 17% of all signs received admissible perception based on the ANSI Z5353 standard [20]. In the U.S at least 50% of signs reach acceptable limits based on ISO 3864 while in Hong Kong and Korea this is only 8.33% [13].

In the current study, the relationship between personal factors and the perception of safety signs has also been studied. The results showed that there is a significant relationship, a positive correlation between sign training and correct perception of signs ($p \leq 0.05$), this was concurred by other studies [12, 20].

The study at hand shows that training can improve perception rates of safety signs as it is apparent that training raises awareness of hazards and safety risks [20-21].

A meaningful positive correlation exists between perception and age ($p \leq 0.02$), and also between perception and work experience ($p \leq 0.05$). Studies suggest familiarity with various signs is a contributing factor on perception [1, 22]. What is meant by familiarity is the level of exposure to various signs throughout a worker's career [1, 23-24], this frequency of encounters enables better learning and recollection of

Table 4. Perception of safety signs in different studies

Study (Ref. No)	Samples	Average (%)	SD (%)
[6]	China	32.20	30.30
	Germany	42.70	36.30
[3]	Hong Kong, China	67.54	23.47
[13]	American	63.08	28.47
	Hong Kong	20.47	-
	Korea	27.94	-
[15]	Iran	70.94	27.38

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previously encountered safety signs thus we can conclude that age and work experience improves familiarity with signs and therefore sign perception and is an effective measure in compensating weak sign perception [6, 10].

This study also concluded that a meaningful positive correlation exists between perception and training, as has been concluded by Hashemi Almahadi et al. [25]. The reason for this can be attributed to the effect of training on thinking style and worker attitude. A reason for the differences in perception of safety signs are an individual's thinking style [13].

Results of this study did not show a significant relationship between gender and perception of signs; however a meaningful but weak correlation was seen between work shifts and sign perception which may be the result of the small statistical population of work-shift workers.

CONCLUSION

Overall results show 63.63% of safety signs fall within acceptable thresholds of the ISO 3684 standard and only 9% fall within the ANSI Z5353 standard's thresholds. Age and work experience were found to be effective factors in sign perception. Safety sign training was also found to be influential in increasing sign perception and training solutions were accordingly proposed.

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