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Comparative Study of Effectiveness in Precautionary Information on Slip

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Abstract: With the prophase studying aiming at the slip behavior, this paper draws a conclusion that it is the best method to prevent slippery with the design of precautionary information. Furthermore, designing three methods of precautionary information in laboratory, it had caught through data of analysis and comparison of utilized coefficient of friction in people with slip experiment, respectively by the perspectives of graphic, text and voice. Then with the comparison of average value and standard deviation, we can draw the conclusion that it is the easiest precautionary notification to alert which is graphical feature, thereby, it confirmed that the precautionary notification method which is the most universal significance is to be resorted to visual graphic.

Key words: Psychology, precautionary, information notification, slip

INTRODUCTION

At present, slip injury caused by the different situations and reasons is major cause of accidents in the home environment and public places.

It has been shown in the recent research data that: In the United States the injury rate caused by the body slipping accidents accounted for 17% of the total number of industrial injury accidents and it accounted for 20% of the total number of family accidents, accounting for 18% of total public accidents. In the United States it is close to 300000 of accidents annually caused by slip behavior, the average death rate reaches to 1200~1600 persons (Redfern *et al*., 2001). Slip behavior has become a major risk factors threatening manual workers, the elderly and disabled people in today's society. Yan (2009), Wang, 92005) In the range of the United States, in the group of body injured whose average age is more than 75 years, the death caused by slip accidents has become the dominant factor (Bo, 2007) and in the 45-75 age group, slip is second factors leading to accidental death (Lockhart *et al*., 2005). In addition, according to the statistical data of the United States National Security Council, it shows that:: in 2001, 15400 Americans die from sliding down (Lockhart *et al*., 2005).

SLIP AND DYNAMIC BALANCE

In view of the above analysis data, in the academic field, we should make scientific investigation for the slip behavior in its forms, in order to design more humane precaution prompt information facilities. In the most common physical behavior, walking behavior should be used with maximum application rate in the one day's body dynamic, so we should choose this most illustrative physical behavior as our researching object and make investigation in slip causes.

Reason of slip state: First of all, it needs to be clear that, in terms of human walking, the gravity center of the human body is constantly changing. With the large difference of people's state in static standing balance, compared to the standing state, the stability mechanism in the process of human walking is very complex. Human body's walking is mainly divided into two aspects.

The first one is the normal walking. Because the normal walking has typical periodicity, the regular pattern in walking process is still relatively easy to be studied. Townsend and other scholars pointed out that, in walking of stable gait, it showed a linear function relationship between the contact location with ground of foot and

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displacement and velocity of the system center of mass. In 1998, Tucker and other scholars found that, in human body walking process, the peak velocity of center of gravity horizontal direction and the vertical direction had the phase shift, in other words, control of center of body gravity is not based on the principle of optimal conversion between kinetic energy and potential energy,

The second one is that balance should change when walking is affected by external influence. In conditions being met, this balance destruction will cause the actual occurrence of slip phenomenon. Because the tend of body's slip will produce two results: One is the self adjusting balance in slip process, so there is no real slip. The other is that the slip process balance is broken and the actual slip phenomenon appears.

Control of dynamic balance to slip behavior: People are affected by the external environment in the process of walking, so it will change regular pattern of walking balance at any time. In order to realize self-protection, the individual will react as some response accordingly to maintain his body balance. From this perspective, we can investigate the realization rate during people's preventing slip in the process of walking in direction of precaution. Of course, to prevent slipping cannot completely rely on the people's awareness, in the environment which is easy to slip and therefore we must use other protective measures in order to achieve the anticipation. If only from the perspective of slip, because this process is usually occurred in a very short time and people's thinking process in this event is different from the ordinary with adequate consideration of time, balance state will be affected by the speed of response to people and strength of slip inducement conditions etc.

It is called dynamic balance when people achieve balance of the body by self-adjusting in a slip phenomenon appeared in walking process. In public under the conditions of slip inducement, in order to achieve the dynamic balance of the human body in the maximum possibility, bring into play the balance mechanism of self-adjusting and reduce the probability of occurrence of slip essence, effective prompt is the strongest method of implementation.

COMPARATIVE EXPERIMENT OF THE VALIDITY IN SLIP PRECAUTION PROMPT

Many factors lead to slip, mainly including internal and external factors. Internal factors mainly refer to some situations of human body, including body's gait feature, the neuromuscular control, biomechanics, sensory abilities(for example: visual, proprioceptive, vestibular function) and the ability of information processing. The reaction force against human body which is produced by the ground is a key biomechanical factor to prevent slip in walking process. The external factors mainly refer to the objective environment without people themselves, including a sole characteristics (for example: Sole material, shading, the degree of abrasion, etc), surface characteristics (for example: roughness, pollution medium, compliance, etc), lighting conditions and pavement angle. The main cause of external factors leading to slip is frictional coefficient of contact surface between shoes and ground. If there is a lower friction characteristics, it will cause the body to lose traction and eventually lead to slip in the process of walking. For the healthy people, the reason leading to slip mostly is that they are not able to adapt to the external environment conditions.

Design of experiment: In order to study the issue validity of slip prompt with a step further, the author of this study has finished a series of relative experiments. As indicated above, the most feasible method to prevent slip in urban environment should come down to: In the place where people would appear slip possibly, through effective prompt and giving full play to individual precaution adjustment mechanism, we can achieve a certain degree of security. The visual prompt and the voice prompt are the most common ways. Based on this conclusion, in experiment, we chose several prompt informations respectively which resort to visual and auditory reaction as the experimental objects, so then we carried out comparative analysis of precaution validity. As Table 1 shows.

During the experiment, we used three forms including graphical prompt, text prompt and actual lingual voice prompt. Contrasting color combinations chose in graphic information was used as current popular combination of black figure in yellow ground. If used properly, these three kinds of prompt will get favorable expectation and experiment was set up in a quiet interior space as its external environment in order to discuss on validity comparison of three kinds of prompt in a relatively ideal environment. Therefore, through this experiment, we can find a more effective method of identification in body walking process in a certain degree.

Experimental subject: The experimental group was selected in the 23-26 years old healthy people, including 50 men and 50 women. The experimental space was designated in the interior environment. Every one of the subjects was followed by three kinds of preventing slip information experiment. The graph, text and voice in experiments are shown in Table 2.

Table1: Experiment method comparison of precaution prompt informations

Prompt method	Graph	Text	Lingual voice (Chinese)
Prompt information	Diagram of a black slip figure in yellow ground	Chinese characters caution: The road ahead is easy to slide	Chinese mandarin caution: The road ahead is easy to slide

Table 2: A detailed description of precaution prompt information

Method of information	Graph	Text	Lingual voice (Chinese)
Specific description of information features	490mm X 297mm paper printing picture size: 280×280 mm square Black: R32 G27 B23 yellow:R254 G245 B2	490×297 mm paper printing black text in white paper bold-face	Male voice prompt
Distance to the ground	Distance between the paper center and the ground surface is about 1.5 m	Distance between the paper center and the ground surface is about 1.5 m	

Three kinds of prompt were all operated in the environments which lead to slip easily within a range of four meters. At the same time in order to ensure the authenticity of the experiments, the random prompts were arranged in the process and this means that some experiments had not prompt while the prompts of the graph, text and voice were random disorderly.

Experimental method: In order to protect the safety of subjects and prevent to real appearance of slip accident in their walking process, we had been using protection device during the experimental process, so there was no real sense of the occurrence of falling. Protection device can support experimental subjects when slip appears and it also can adjust transmission speed as human walking speed. Then it can guarantee there is not gait disturbance to people and no impact in authenticity of experimental data. (Protection device comprises two parts including supporting device and transmission device and the transmission device comprises a transmission structure, power source, a travel limit block and a safety belt.) The theoretical source of this experiment came from data collection of the traditional friction coefficient and comparative study of their final calculations between the average value and standard deviation. Because the judgment standard of meeting critical state of slip should be based on whether the actual coefficient of friction is greater than the available coefficient of friction or not, then, we should adopt the principle mainly collected by data of actual coefficient of friction as the theoretical basis for the experiment, concluding the optimal information type of precaution prompt in the case of final comparison. The following contents will specifically interpret the theoretical source of friction coefficient.

Friction coefficient: The coefficient of friction is mainly divided into three categories, including Available Coefficient of Friction (ACOF), Required Coefficient of Friction (RCOF)and Utilized Coefficient of Friction (UCOF), so they form a basic condition to describe the probability forecast of human walking slip.

- **Required coefficient of friction (RCOF):** Minimum friction which is needed to support us between sole and ground surface when people walk on dry ground normally
- **Available coefficient of friction (ACOF):** Transitional friction which is produced between sole and ground surface in the process of walking
- **Utilized coefficient of friction (UCOF):** The friction which is produced by body in different conditions during walking

The definitions of the three friction coefficient:

- **Required coefficient of friction (RCOF):** Maximum ratio of horizontal force and vertical force decomposed in contact force between sole and ground surface when people walk on dry ground normally:

$$RCOF = \frac{F_{Tr}}{F_{Nr}} = \frac{\sqrt{F_{Xr}^2 + F_{Yr}^2}}{F_{Zr}} \quad (1)$$

- **Available coefficient of friction (ACOF):** The ratio of horizontal force and vertical force between sole and ground surface, also known as the transitional coefficient of friction:

$$ACOF = \frac{F_{Ha}}{F_{Va}} \quad (2)$$

RCOF completely depends on the gait feature of human body and it does not have any relations with ground conditions. When RCOF is more than ACOF, then slip appears; when RCOF is less than ACOF, then slip dose not appear. As shown from Eq. 1, RCOF shows the human gait feature on, the ground reaction force. At present, scholars from various countries also generally adopt RCOF as a judgment standard of slip risk.

- **Utilized coefficient of friction(UCOF):** According to RCOF's definition, the existing condition of RCOF must be dry ground and if considering with pollution medium of ground, we need another friction to replace RCOF. Therefore, we define UCOF as the maximum ratio of horizontal force and vertical force decomposed in contact force between sole and ground surface when people walk in different conditions. The formula is as follows:

$$UCOF = \frac{F_{Tu}}{F_{Nu}} = \frac{\sqrt{F_{Xr}^2 + F_{Yr}^2}}{F_{Zr}} \quad (3)$$

The traditional judgment condition of walking slip is that: When RCOF>ACOF, slip appears; when RCOF<ACOF, slip does not appear. Next, we will verify the judgment conditions of slip accurately or not and the relationship between RCOF, UCOF and ACOF, by means of experiment designed above.

Friction which affects appearance of slip: Slips of usual definition are all based on the the comparing results of two frictions. One is static friction which means that when people walk normally, there is no force of friction with the ground. The other is dynamic friction which means that when the friction between soles and ground surface is more than the static friction in people's walking, it will lead to slip. However, it is difficult to appear this kind of ideal state in practice. Body slip will be affected with materials of ground and sole, slip medium, pace and many other aspects. The result under the same conditions is only scientific. This means that we can get the actual slip data by comparing the relationship between ACOF and UCOF. That is to say, when the UCOF>ACOF, slip will be sustained and body will be falling. Therefore, as mentioned above, during the experimental design, we mainly chose subjects between the ages of 23-26 who wear shoes with the same material soles in the same medium, comparing the affection with no slip medium and the same slip medium in an unified test on the marble slab. In this study, an instrument for measurement of transitional coefficient of friction was adopted. In addition to be noted, some experiments used soapy water as a medium on marble slab while some without any medium. They are disordered random.

Table 3:Comparison of UCOF data finally obtained in experiment

Method of information	Graph	Text	Lingual voice (Chinese)
data interval of UCOF	0.0233-0.4246	0.2954--0.754	0.2955--1.1198
Average value UCOF	0.2278	0.5526	0.7189
Standard deviation UCOF	0.1605	0.1802	0.3095

Experimental results: Based on experiments with 50 healthy men and 50 healthy women between the ages of 23-26, substituting data which was measured every time into formula 3, we had the calculation results shown in Table 3. (in standard of right foot data, being accurate to four decimal places).

The subjects used soles with Synthetic Rubber (SBR) material in tests. The ACOF on the marble slab with soap water was 0.302. According to the comparison of the data, we found that most of the data of prompt which was in a black figure in yellow ground, were consistent with "ACOF>UCOF". That was to say: After the prompt of yellow and black combination, slip rate was very low while in the other two kinds of prompt, the data of "ACOF>UCOF" was far less than results of prompt in yellow and black combination. It proves that the yellow and black combination is easiest to alert.

CONCLUSION

In real life, it is inevitable to people in some slipped environment. And it can greatly reduce the occurrence of slip if there are some effective prompt. It utilizes precautional to make people alert before the slip accident, thereby strengthening self regulation In time of danger. At present, for slip environment, visual and audio prompt are the most common schemes. In order to compare the most effective kind of prompt, we have adopted three kinds of prompt methods which were text and graphics in black figure with a yellow background and a 30 year old male voice. People's responses to sounds will be affected by their habits and their responses to unfamiliar sound will be delayed, meanwhile, the voice prompts are also more vulnerable to outside interference. From the perspective of color, the mode of Light background with dark graphics is a best communication effect. And, in general, the acceptance or sensitivity of the text is lower than graphical perception. So from this perspective, the mode of yellow background with black figure is the most consistent with a prompt solutions to the visual perception theory in concentrated prompt schemes and it is the best prompt theoretically.

Through the experiments, in the same conditions, we measured UCOF on the marble slab with soap water and compared them with ACOF. When UCOF>ACOF, we found that the subjects had slipped. Through the experiment, we found graphics prompt had best effect with the lowest probability during prompt process. Therefore, we can judge that graphical prompt is the best mode.

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