# Trip-Hit Accidents and Safety: Human Error Psychology and Influence of the Subconscious Mind in Preventing and Causing Trip Hit Accidents

Yadunath R Varma and Jeyapaul R
Department of Production Engineering, NIT-Trichy,
Tiruchirappalli, Tamilnadu-620015

## ABSTRACT

Much of the trip-hit accidents in industry or home are of false or mis-cognitive causes. The victim was in a situation where the person failed to judge the position of the obstacle and his psychomotor system misunderstood the environment and thus caused the trip or hit. When a person does the same job repeatedly, the person's subconscious mind learns how to do it. Hypothesis was that during a repetitive activity when our sub conscious mind is taking control of it, we tend to make an error or accident in the activity if the activity environment changes because our sub conscious may fail to recognize the change in the work environment". A wire-loop activity game was designed for the purpose of experiment. The experiment is essentially a hand-eye coordination task wherein the subject has to traverse a loop along a central wire without touching it.. Several parameters were varied during the experimental run without the subject noticing it which tested the psychological, cognitive and other response factors of the subjects.The experimental results proved the hypothesis. It was observed that when the subject was carrying out the task with his subconscious mind and when the work environment (task) was altered, the subject made more number of errors. Also on comparison of gender, females tend to show greater working capacity with their subconscious mind than males.

**Key words:** Trip, hit accidents-human – subconscious

## INTRODUCTION

In a man-machine machine environment, errors or accidents may arise owing to the fault of either. This paper focuses on the human error aspects. Especially it focuses on the psychological aspects of human errors in carrying out a repetitive task. This paper tries to reason out why people with years of experience in carrying out a specific task make accidental errors. The paper uses the terms "conscious" and "subconscious" minds in their usual context. When we do an activity for the first or initial few trials, we use most of our "conscious" mind into it. But gradually our "subconscious" understands the task and takes over. For eg: while brushing teeth, we know how and do not need to consciously brush. But if all of a sudden, we get a job in an assembly line, we need to "learn" the new task. But gradually, we become "acclimatized" to the task and we do it routinely. This is because our subconscious mind helps in doing it.

## HYPOTHESIS

The experiment is designed to verify the proposed hypothesis that "during a repetitive activity when our sub conscious mind is taking control of it, we tend to make an error or accident in the activity if the activity environment changes because our sub conscious may fail to recognize the change in the work environment".

## METHODS

### Setup

A wire loop game was designed to verify the hypothesis. Wire loop game is a popular children's science toy wherein the objective is to traverse a small circular loop along a convoluted central wire without touching it. If the loop touches anywhere on the wire, an electrical circuit is made closed and a buzzer/bulb glows/rings and the participant fails.

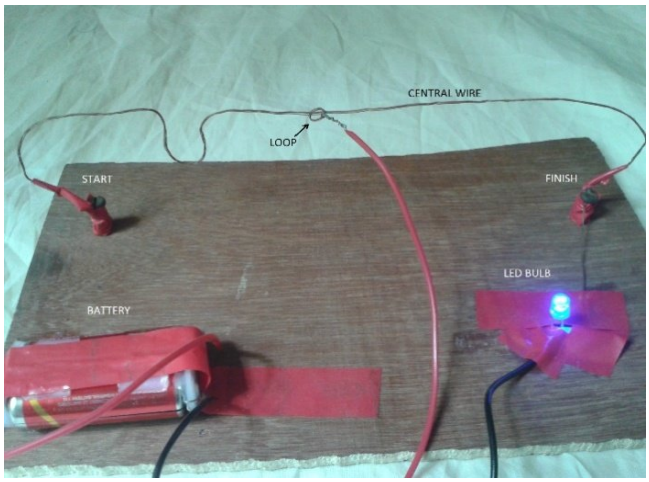


**Fig 1**: **Wire-loop game setup**

The central wire is made out of strands of wires twisted. The start and finish ends of the wire are selected as shown in figure. The central wire is convoluted in the shape as shown. The purpose of such a shape is to give the subject both a tough as well as easy experience in completing the track run. The 'U' shaped section poses a challenge whereas the straight portion provides an easy task. The circuit consist of two 1.5 volt dry cells giving a total voltage of 3 volts to power a blue LED bulb that shows a contact is made between the loop and wire.

### Procedure

Fifty healthy subjects (25 males and 25 females) participated in the study. The subject was asked to sit in a comfortable posture and was told to make the run on the count of three given by the experimenter. One motion from the start to stop is defined as a run. They were asked

to complete a run as fast as possible. This is to make them more target oriented. During a run, the subjects had to adhere to the following; the loop movement must be continuous (one fluid motion) without stopping in between. Ten runs were conducted per subject. The time taken and no: of errors (bulb glows) from start to finish was noted down. After the 10$^{th}$ run was over, the subjects were asked to close their eyes and recollect the path they traversed in the previous 10 runs while counting down from thirty to zero. In this span, the experimenter makes a slight modification to the wire path without the subject knowing it. The two limbs of the U section were slightly displaced in opposite directions and the wire in its straight section was untwisted so that one of the strands stands out separately without the subject recognizing it easily. Now the subject was asked to repeat the run but this time, he/she has to answer some questions put forward by the experimenter simultaneously. The nature of the questions were both logical (eg: 3*3 + sin90) and memory based (eg: (a+b)*(a-b) ). The time taken for the run as well as the no: of errors were recorded. Similarly, the experiment was repeated for all the 25 subjects.

**Fig 2: Normal and altered U section (top view)**

**Fig 3: Normal and altered straight section (top view)**

**OBSERVATION**

Rows: Serial no of subjects 1 to 50. 1-25 for males and 26-50 for females
Columns: Run no 1 to 11

Data recorded: (time taken for run, no: of errors)

**Table 1**: Time and error recordings from experiment

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 60,15 | 40,13 | 39,8 | 32,10 | 23,11 | 33,13 | 40,11 | 38,8 | 41,15 | 52,10 | 58,41 |
| **2** | 47,6 | 46,3 | 51,7 | 38,6 | 45,7 | 46,10 | 41,5 | 40,10 | 57,6 | 56,3 | 48,14 |
| **3** | 26,16 | 25,13 | 23,19 | 25,13 | 35,13 | 26,14 | 25,15 | 25,14 | 24,9 | 28,10 | 48,25 |
| **4** | 36,18 | 26,11 | 23,4 | 31,10 | 26,8 | 23,11 | 25,9 | 27,7 | 23,5 | 25,7 | 29,15 |
| **5** | 10,6 | 10,8 | 9,10 | 10,1 | 6,10 | 6,10 | 10,6 | 7,12 | 8,9 | 10,10 | 40,11 |
| **6** | 50,27 | 49,32 | 39,16 | 35,37 | 31,19 | 36,19 | 34,14 | 33,21 | 39,7 | 42,13 | 48,23 |
| **7** | 39,18 | 46,20 | 40,13 | 37,13 | 45,18 | 38,14 | 55,16 | 51,36 | 60,25 | 45,11 | 62,28 |
| **8** | 34,24 | 25,24 | 20,16 | 12,11 | 16,12 | 14,18 | 17,26 | 13,25 | 20,33 | 18,24 | 36,33 |
| **9** | 37,22 | 35,7 | 28,13 | 31,8 | 24,27 | 47,10 | 44,12 | 43,15 | 53,10 | 56,8 | 30,15 |
| **10** | 33,17 | 23,15 | 34,17 | 24,12 | 34,9 | 27,8 | 31,9 | 28,10 | 22,13 | 28,13 | 67,16 |
| **11** | 63,21 | 57,29 | 41,31 | 38,29 | 62,22 | 50,35 | 32,26 | 33,31 | 35,17 | 28,25 | 73,35 |
| **12** | 72,15 | 44,9 | 43,9 | 48,12 | 54,8 | 37,13 | 49,7 | 39,15 | 39,9 | 37,7 | 38,10 |
| **13** | 49,13 | 35,17 | 37,21 | 23,19 | 42,23 | 34,16 | 44,18 | 39,9 | 33,20 | 40,17 | 49,23 |
| **14** | 16,20 | 25,22 | 26,23 | 35,5 | 51,26 | 53,18 | 54,10 | 47,15 | 53,9 | 42,12 | 67,10 |
| **15** | 43,16 | 36,23 | 36,20 | 35,24 | 34,30 | 40,31 | 30,27 | 29,25 | 25,25 | 27,25 | 29,41 |
| **16** | 60,16 | 52,20 | 53,18 | 60,10 | 74,10 | 72,10 | 64,10 | 46,9 | 50,14 | 81,13 | 90,22 |
| **17** | 8,16 | 10,16 | 8,15 | 7,15 | 9,20 | 9,22 | 10,24 | 13,19 | 10,20 | 13,20 | 15,26 |
| **18** | 54,34 | 45,41 | 39,37 | 38,38 | 29,42 | 24,45 | 38,43 | 31,42 | 34,18 | 34,30 | 35,35 |
| **19** | 42,18 | 37,16 | 28,17 | 17,18 | 29,20 | 50,21 | 49,13 | 31,14 | 27,13 | 20,14 | 76,23 |
| **20** | 24,18 | 11,14 | 14,20 | 11,10 | 10,12 | 11,13 | 13,23 | 13,13 | 11,12 | 11,9 | 21,17 |
| **21** | 33,30 | 28,32 | 32,18 | 32,25 | 35,17 | 34,37 | 34,38 | 29,37 | 36,43 | 36,42 | 46,18 |
| **22** | 17,21 | 13,33 | 22,17 | 14,30 | 18,29 | 16,23 | 13,27 | 8,32 | 16,26 | 17,30 | 13,28 |
| **23** | 51,22 | 70,14 | 53,16 | 69,9 | 79,2 | 63,9 | 75,5 | 57,13 | 87,12 | 82,0 | 136,21 |
| **24** | 52,14 | 47,18 | 52,25 | 43,26 | 37,22 | 25,20 | 28,29 | 25,30 | 39,26 | 30,24 | 64,32 |
| **25** | 29,15 | 31,11 | 27,14 | 30,26 | 25,17 | 30,13 | 29,19 | 26,16 | 28,7 | 25,10 | 30,18 |
| **26** | 31,9 | 31,10 | 31,13 | 34,17 | 47,24 | 53,19 | 46,19 | 42,19 | 47,19 | 43,16 | 61,15 |
| **27** | 31,19 | 30,20 | 34,18 | 28,24 | 29,20 | 24,19 | 28,17 | 31,16 | 27,19 | 28,19 | 57,6 |
| **28** | 27,24 | 28,18 | 39,17 | 39,20 | 52,17 | 34,19 | 41,12 | 29,19 | 36,21 | 36,16 | 35,14 |
| **29** | 35,15 | 39,21 | 27,12 | 30,14 | 38,17 | 30,17 | 34,16 | 33,20 | 33,18 | 53,20 | 82,33 |
| **30** | 27,21 | 31,16 | 34,16 | 34,10 | 33,9 | 32,7 | 37,12 | 40,7 | 39,7 | 50,1 | 48,11 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **31** | 21,15 | 20,24 | 17,19 | 14,16 | 20,17 | 23,21 | 29,17 | 25,15 | 37,13 | 35,15 | 33,9 |
| **32** | 100,2 | 62,13 | 70,12 | 40,18 | 81,0 | 66,7 | 78,2 | 74,0 | 74,2 | 48,13 | 80,9 |
| **33** | 27,34 | 24,20 | 37,30 | 31,26 | 20,22 | 18,21 | 30,37 | 23,21 | 25,26 | 33,32 | 15,19 |
| **34** | 42,33 | 36,28 | 41,9 | 35,15 | 45,41 | 64,4 | 78,5 | 69,6 | 69,10 | 81,9 | 115,20 |
| **35** | 5,16 | 7,10 | 6,20 | 10,15 | 7,20 | 9,21 | 11,23 | 8,26 | 7,24 | 5,18 | 13,17 |
| **36** | 39,3 | 28,5 | 23,5 | 26,3 | 23,6 | 22,9 | 20,16 | 41,8 | 42,9 | 50,5 | 53,18 |
| **37** | 42,19 | 32,20 | 33,16 | 25,11 | 26,18 | 28,12 | 30,13 | 37,20 | 38,18 | 33,19 | 53,29 |
| **38** | 16,27 | 28,7 | 25,18 | 29,12 | 27,12 | 33,18 | 28,18 | 39,22 | 30,4 | 37,3 | 57,21 |
| **39** | 57,15 | 38,20 | 42,32 | 44,5 | 46,10 | 47,11 | 37,18 | 43,3 | 42,8 | 52,10 | 89,11 |
| **40** | 25,14 | 26,6 | 25,16 | 25,3 | 23,8 | 25,8 | 33,12 | 26,5 | 25,1 | 30,11 | 39,17 |
| **41** | 38,26 | 35,15 | 43,19 | 27,28 | 39,23 | 42,24 | 42,19 | 41,19 | 47,13 | 45,21 | 45,16 |
| **42** | 27,25 | 38,12 | 35,15 | 43,6 | 40,2 | 37,3 | 37,8 | 31,16 | 36,12 | 34,6 | 40,20 |
| **43** | 45,20 | 32,12 | 28,12 | 33,16 | 29,23 | 39,9 | 38,11 | 47,14 | 39,14 | 55,5 | 46,18 |
| **44** | 40,29 | 35,19 | 32,18 | 32,13 | 28,15 | 28,17 | 39,19 | 36,20 | 36,16 | 35,28 | 41,33 |
| **45** | 65,17 | 53,16 | 38,25 | 38,10 | 23,21 | 42,6 | 46,3 | 42,7 | 42,10 | 53,16 | 91,18 |
| **46** | 35,7 | 31,10 | 26,16 | 28,14 | 36,14 | 36,3 | 33,11 | 33,8 | 43,4 | 46,4 | 60,28 |
| **47** | 38,19 | 34,16 | 36,11 | 39,14 | 36,3 | 34,8 | 35,9 | 35,5 | 34,3 | 40,5 | 45,22 |
| **48** | 54,55 | 44,31 | 49,47 | 50,41 | 43,37 | 49,44 | 50,44 | 59,36 | 37,36 | 37,33 | 49,36 |
| **49** | 44,21 | 45,10 | 39,17 | 39,10 | 37,17 | 42,23 | 44,20 | 47,24 | 44,25 | 48,23 | 91,30 |
| **50** | 34,19 | 41,14 | 43,12 | 37,8 | 51,21 | 44,17 | 42,17 | 43,13 | 42,10 | 44,6 | 52,17 |

**Table 2**: Time and Error distribution

| **Run (Males)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average time (s)** | 39.4 | 34.6 | 32.6 | 31.0 | 34.9 | 33.7 | 35.3 | 30.8 | 34.8 | 35.3 | 49.4 |
| **Average Errors** | 18.3 | 18.4 | 16.9 | 16.6 | 17.3 | 18.1 | 17.6 | 19.1 | 14.9 | 15.4 | 23.2 |
| | | | | | | | | | | | |
| **Run (Females)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| **Average time (s)** | 37.8 | 33.9 | 31.6 | 32.4 | 35.1 | 36.0 | 38.6 | 38.9 | 38.8 | 41.9 | 57.7 |
| **Average Errors** | 20.1 | 15.7 | 17.8 | 14.7 | 16.6 | 14.6 | 15.9 | 14.7 | 13.6 | 14.1 | 19.6 |

**Table 3:** Time and error comparison

| | Time for males (s) | Errors for males | Time for females (s) | Errors for females |
|---|---|---|---|---|
| **Mean of first 10 runs** | 34.2 | 17.3 | 36.5 | 15.8 |
| **Difference from 11th run** | 15.2 | 5.8 | 21.2 | 3.7 |

## RESULTS

The experiment was successfully conducted on 25 males and 25 female subjects. Tabulation 1 gives the on-spot experimental observation for the time and no of error recorded. Tabulation 2 is derived from tabulation 1. It shows the time and error values averaged across both sexes for the different runs. Upon analyzing the variation of no. of errors, we can see a general decreasing trend from run 1 to run 10 for both males and females. This is because the subject gets acclimatized to the task and develops his/her own way and style in overcoming the obstacles. However, even in the general decreasing trend, there are values in which the no. of errors has risen. This can be explained using the fact that the subjects reported being "overconfident" and was trying to minimize the time taken. However, upon reaching the 9th and 10th runs, the subjects where more motivated in reducing the no: of errors and thus invested more attention onto the task. The average time taken remained quite stable in the range for both sexes in their category.However, when comparing the runs 1-10 with run 11, we find a large variation. For males, the average no of errors for 10 runs was 17.3 which rose to 23.2 in the 11th run and for the females, it rose to 19.6 from 15.8. For males, the average time for 10 runs was 34.2 seconds which rose to 49.4 seconds in the 11th run and for the females, it rose to 57.7 seconds from 36.5 seconds.

## DISCUSSION AND CONCLUSION

The initial hypothesis is thus verified. During the 11th run, when the subjects were answering questions simultaneously while completing the run, their mind was under multitasking. 46 subjects reported that majority of their conscious processing went towards searching towards the answers for the questions. Thus, their subconscious was involved mechanically performing the run. So during the 11th run, when the subject was using sub conscious to complete the run, no: of errors increased because it couldn't sense the alterations made in the central wire. In our daily life, we all use our sub conscious mind in doing a repetitive activity. For instance, when we enter a dark room in our house, we know "where" the light switch is. Our hand automatically moves towards the switch even if we are "consciously" engaged in a call over phone. By previous repetition, our sub conscious mind registered the location of the switch which made us reach it. Similarly is the case when we or more importantly, "aged" people walk in their house. They rely more on the sub-conscious mind which has already registered

the "task and direction" in moving from one location to the other. Even if a chair is slightly displaced from its original position, the person tends to hit the chair or even trip somewhere in the obstacle. Also we can observe from tabulation 2 that males are more prone to errors and accidents whilst using their sub conscious than females. Simultaneously we can see that males tend to complete an activity faster than the females.

## STATEMENT OF RELEVANCE

The study aims at finding out the why our subconscious mind when involved in an activity creates an error or mistake during the activity. Once we know this, we can design our work environment accordingly so that chances of such errors are reduced, thereby improving occupational safety as well as productivity.

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### REFERENCES

1. Linguo Gong (2012). The effect of testing errors on a repetitive testing process. European Journal of Operational Research 220 (2012) 115–124
2. MarianneDoos, Tomas Backstrom, CarinSundstrom-Frisk (2004). Human actions and errors in risk handling—an empirically grounded discussion of cognitiveaction-regulation levels. Safety Science 42 (2004) 185–204
3. Tom Kontogiannis (1999). User strategies in recovering from errors in man &machine systems. Safety Science 32 (1999) 49±68
4. R. Lardner_ and R. Scaife (2006). Helping Engineers to Analyse and influence the human factors in accidents at work. Process Safety and Environmental Protection, 84(B3): 179–183
5. International association of oil and gas producers (2010).Human Factors in QRA. Risk assessment data directory.
6. Department of energy. Chapter2: Reducing errors. Human Performance Handbook.
7. Federal Railroad Administration (2009). Confidential Close Call Reporting System (C3RS). Peer Review Team.Human Performance Handbook
8. P. L. Clemens (2008). Human Factors and Operator Errors. 2nd edition, Jacobs Sverdrup
9. Charlie Munger (1995). "Psychology of Human Misjudgement". (speech at Harvard University)
10. Stone, Sand & Gravel Review (2009)."Multitasking Causes Accidents". RIP & Share Safety Handout.
11. R S Bridger (2004). Introduction to Ergonomics. Wiley & Sons.