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A Pilot Study on Driving performance and Crash Characteristics under Simulated Indian Traffic Condition

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Introduction

Driving is a complex task requiring a vigilant mind and sound health. An alert mind always helps in proper decision making and faster reactions which in turn can help in reduction of road accidents. Major cause of accidents has been identified as improper driving behaviour. Hence it is important to understand and study the influence of driver behaviour on road traffic accidents. Heighted emotions such as stress, anger or upset are a form of distraction that can significantly impede drivers' ability to spot and respond to hazards. Research has found that drivers who suffer from work-related stress are more likely to speed and take other risks while driving and more like to be involved in serious crashes. All drivers are exposed to stressful driving situations from time to time, even if they do not generally suffer from stress in everyday life. Traffic jams, tailgating and inconsiderate behaviour from other drivers can cause stress. Some drivers react angrily to stressful driving situations: this is often referred to as 'road rage', and can be incredibly dangerous. Research has shown that angry drivers are more likely to take risks such as speeding, rapidly switching lanes, tailgating and jumping red lights. Driving aggressively can in turn increase your stress levels, becoming a vicious circle. Driving anger, impulsiveness, and instrumental and emotional aggressiveness have been proposed as the three predictors of aggressive driving behaviour [1]. Driving is a skill that requires constant and complex co-ordination of mind and body of the driver. It involves multi-task activities, i.e. operating heavy machinery at high speed, navigating across changing terrain, calculating speeds and distances and responding to all the other drivers and obstacle [2]. Driving is a serious responsibility and it demands and deserves full and undivided attention of the driver. However, there are many driver distractions which contribute to crashes and injuries. The level of safety of road system is influenced by all road users among which the driver plays a crucial role in road safety through scanning, processing and applying appropriate action patterns towards oncoming stimuli [2].The simulator driver's conditions will still be comparable at a higher, more aggregated, level, if this is sufficient or not varies depending on the type of experiment. For some experiments, equal conditions at the micro level are essential and stochastic simulation may not be suitable to use. In other experiments, comparable conditions at a higher level are sufficient [3].

Figure 1: Test Performance on the Driving Simulator at CSIR - CRRI

Objectives

The objective of this pilot study was to observe the driving performances of drivers under different terrains in simulated Indian Traffic Condition.

Performance Characteristics

During simulated driving condition different performance characteristics of each driver were identified. Some of the characteristics were acceleration, use of clutch, stalling error, lane selection characteristic, use of gear, use of park brake, engine on/ off characteristics, use of indicator, signal violations, overtaking from wrong side, over speeding, behaviour while merging at roundabouts, driving off road and finally crashes. The other errors considered for the analysis are all the errors mentioned above excluding crashes.

Methodology

In the present study 119 drivers were administered different driving tests at different simulated driving conditions and performance characteristics of these drivers were collected. Percentage of errors made by each driver under different driving terrain conditions, and the results of the drivers' performance were observed and analyzed accordingly.

Data Collection

The data collected for 119 drivers were segregated based on the different driving terrains. The performance characteristics for each driver were directly recorded in the simulator. The information provided includes the distance covered, duration, fuel economy and a detailed list of errors committed by the driver and the result of the driver performance based on the errors committed and marks for each error. The details for each driver were segregated according to the terrain classification, where repeated and failed data entries were removed.

Equipment Used

A driving simulator was used to study the driver's driving characteristics. **Driving simulator installed at CSIR-CRRI** is a versatile, indoor training system for light, medium and heavy vehicle drivers. The simulator simulated Indian driving conditions of city, hills etc. It enables instructor to control sessions, monitor and continuously assess the progress of trainees individually, selectively or collectively. The clutch, brake, accelerator, engine oil, temperature and various other readings are displayed on the Instructor Station. The system continuously records the faults committed by trainees. The instructor can inject faults and obstacles during the exercise to judge the reactions of trainees [4].

Findings of the Study

The collected data were segregated and studied for different parameters considering the most important error i.e., crashing. It was observed that for the drivers driving under any terrain the result was found to be above average if the number of crashes was zero for the given driver. It implies that the driving performance of the driver is directly proportional to the number of crashes he/she makes. Similar trend was observed for all other errors also. The other errors were found to be much lower for drivers with no crashes when compared to the driver who performed with crashes. These trends can be observed for each of the terrain area provided. The errors reverse gear and gear though sound belongs to the same error kind, was marked as two distinct errors as the chance of a reverse gear error is very less on a straight highway or city drive. Among the 119 drivers who undertook the driving test around 62 % drivers were found to have driven without any crashes. The statistics is represented in Fig 2.

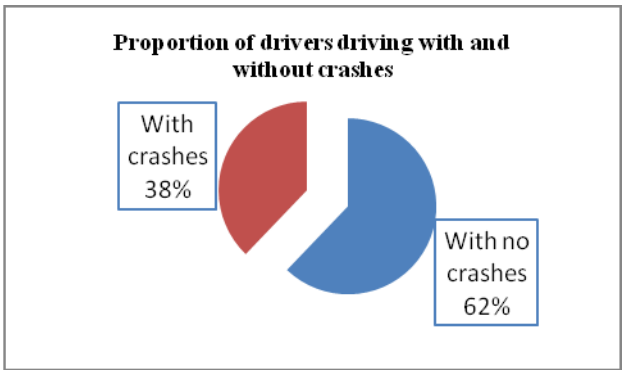

Fig 2: Proportion of drivers driving with and without crashes

Performance Characteristics

The total available data was analyzed and classified based on the number of crashes caused by the drivers tested under various terrain categories. The total number of other errors committed by the drivers disregarding crashing errors was found to be 5627. The data has been segregated as with crashes and without crashes. The proportions of other errors are as in Table 3. Graphically the other errors are represented in Figure 3.

Table 3: Proportion of all errors against number of crashes

NUMBER OF CRASHES	PERCENT ERRORS	TOTAL ERRORS
With no crashes	30.58	1721
With crashes	69.42	3906

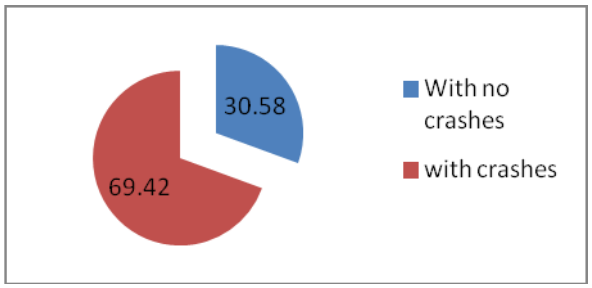

Fig 3: Proportion of Other Errors against varying Crash Frequencies

The data collected was segregated and tabulated according to the terrain on which the driver had driven. The data for different City Areas A, B, C & D were compiled together under one head, and the other terrain considered was highway. The total errors of all the drivers on a particular terrain were summed up and their proportion to the respective totals was considered as in Table 4 and represented in Figure 6. It can be observed that for drivers with zero crashes the proportion of other errors is also relatively low. This shows a direct relation between the driving performance and crash frequency. Drivers with lower values of crash frequency can be said to have a better result in the driving simulator test. Two driving terrains were isolated for analysis. They are City and Highway area.

Driving Terrain Classification

Table 4: Proportion of other errors against crash frequencies for City area

Crashes	Accelerator	Clutch	Lane Selection	Stalling	Park Brake	Reverse Gear	Engine Off	Signal	Indicator	Overtaking	Brake	Gear	Ignition
With No Crashes	25.4	34.9	25.5	32.8	28.7	0	25	39.4	31.9	5.8	40	61.6	42.1
With Crashes	74.6	65.1	74.5	67.2	71.3	100	75	60.6	68.1	94.2	60	38.4	57.9

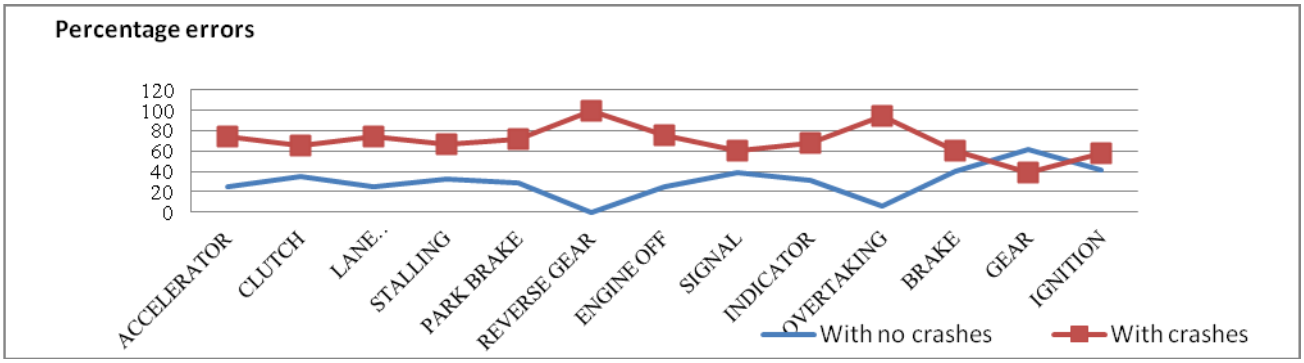

Fig 4: Proportion of other errors against crash frequencies for City area

The data reveals that 74.6 % crash prone drivers did accelerator related errors as against the 25.4 % of safe drivers. The drivers with crashes did more clutch related errors (65.1 %) as against the 34.9 % of safe drivers. It can also be observed that lane selection error and stalling errors for drivers with crash history are respectively 74.5 % and 67.2 %, which is much higher than 25.5 % and 32.8 % corresponding values for drivers with no crash history. Drivers who drove with crashes tended to have a

higher proportion of error of not engaging the park brake i.e. 71.3 % as against the 28.7 % for drivers with no crashes. In case of reverse gear error it was observed that 100 % of drivers with crash history tend to have erroneous driving as against the safe drivers. Also 75 % crash prone drivers marked engine off error as against the 25 % of safe drivers. The signal error was observed for as high as 60.6 % of drivers with no crashes as when compared to 39.4 % of no crash drivers. The drivers with crashes did more indicator errors, 68.1 %, as against the 31.9 % of safe drivers. Overtaking error was found to be higher, 94.2 %, for drivers with crash history as when compared to the 5.8 % for drivers with no crash history. Similar trend can be observed in case of brake error, i.e., 60 % of drivers with crash history were erroneous as against the 40 % of no crash drivers. Furthermore 57.9 % of crash prone drivers had ignition errors as when considered to the much lower proportion of 42.1 % for drivers with no crash history. A similar trend can be observed for the drivers driving on highway terrain. More performance characteristics like off road errors, speed breaker error and right/left turn errors are reported for highway terrain and the data compiled was tabulated as in Table 5. The proportion of these errors can clearly be understood from Figure 5 showing the proportion of all performance parameters against the crash frequencies.

Table 5: Proportion of other errors against crash frequencies for Highway drive

Crashes	Accelerator	Clutch	Lane Selection	Stalling	Reverse Gear	Park Brake	Engine Off	Over speed	Off Road	Speed Breaker	Signal	Right/Left Turn	Indicator	Overtaking	Brake	No Entry	Gear	Ignition
With No Crashes	27.5	44.6	44.9	27.4	66.7	24.7	66.7	0	27.8	10.9	0	42.9	9	40.7	6.8	85.7	43.8	37.2
With Crashes	72.5	55.4	55.1	72.6	33.3	75.3	33.3	100	72.2	89.1	100	57.1	91	59.3	93.2	14.3	56.2	62.8

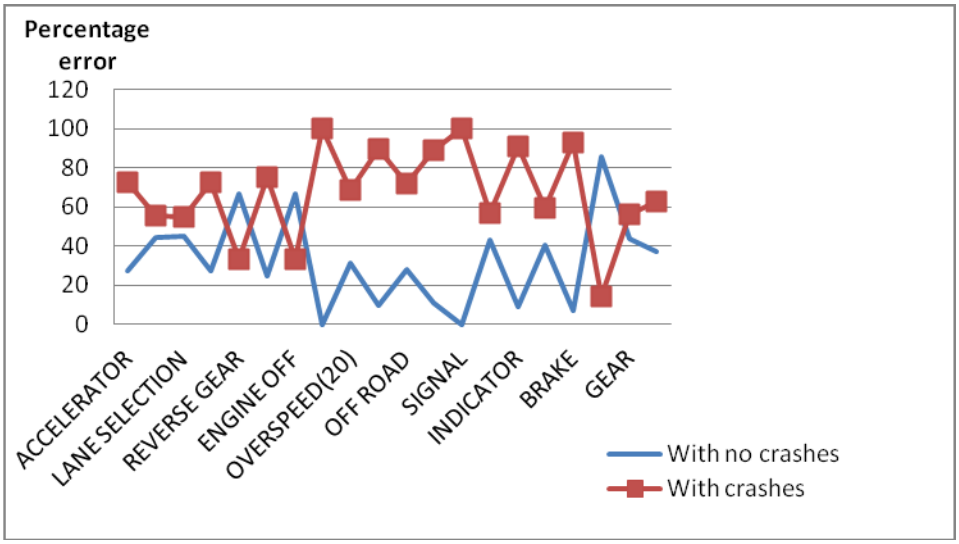

Fig 5: Proportion of other errors against crash frequencies for Highway drive

The data reveals that 72.5 % crash prone drivers did accelerator related errors as against the 27.5 % of safe drivers. The drivers with crashes did more clutch related errors (55.4 %) as against the 44.6 % of safe drivers. It can also be observed that lane selection error and stalling errors for drivers with crash history are respectively 55.1 % and 72.6 %, which is much higher than 44.9 % and 27.4 % corresponding values for drivers with no crash history. Drivers who drove with crashes tended to have a higher proportion of error of not engaging the park brake i.e. 75.3 % as against the 24.5 % for drivers with no crashes. In case of over speed and signal errors it was observed that 100 % of drivers with crash history tend to have ride over designated speed limits and violated the road signals. Also 72.8 % crash prone drivers drove off road as against the 27.5 % of safe drivers. The drivers with crashes did more indicator errors, 91 %, as against the 9 % of safe drivers. Further it was observed that 89.1 % crash drivers were erroneous when met with speed breakers and 57.1 % during right or left turn against the corresponding proportions of 10.9 % and 42.9 % for drivers with no crash history. Overtaking error was found to be higher, 59.3 %, for drivers with crash history as when compared to the 40.7 % for drivers with no crash history. Similar trend can be observed in case of brake error, i.e., 93.2 % of drivers with crash history were erroneous as against the 6.8 % of no crash drivers. Furthermore 56.2 % and 62.8 % of crash prone drivers had gear and ignition errors as when considered to the much lower scores of 43.8 % and 37.2% for drivers with no crash history.

Conclusions

This study concludes that the number of crashes is directly proportional to the performance of drivers irrespective of the driving terrain. Drivers with no crash history showed a considerably reduced amount of other driving errors when compared to drivers with crash frequencies. This shows a substantially reliable conclusion that driver performance can be validated by considering his/her crash history. Thus the results of the present study highlight that driver performance can be screened objectively using a driving simulator. Drivers with crash history thus indicate poor driving performance and are more prone to accidents.

Future Scope of the Study

Due to the limitation of time other driving characteristics (different environmental conditions and under different traffic volume) could not be measured. Same drivers can drive under real world conditions and results can be compared.

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