



Difference in Visuospatial Abilities between Regular Four Wheeler Drivers and Non Drivers

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Abstract

The study aim to investigate visuospatial ability of Drivers to find influence of Driving on Visuospatial ability. The experimental Study was conducted using computerised test of Mental Rotation among population of size 70 in Bengaluru, India. The study included regular Four Wheeler Drivers and Non Drivers and results were compared then. The data was analysed using IBM SPSS. The findings depicts that there is no significant difference between regular Four Wheeler drivers and Non Drivers. Moreover, further research could be done on response accuracy and reaction time.

Keywords: *Visuospatial Ability, Drivers, Non Drivers.*

Introduction

The moving object called ‘vehicle powered by gas engine’ was an amazing vision to public when the automobile was introduced on the road for the first time in 1886. Technology and need has kick-started new developments and dynamics in automobiles since then. After one century, the age of driverless vehicle has commenced along with development of technology and sophistication in vehicle. Despite the dynamic change in automobile, driving has been a leisure and entertaining activity for many. Today No luxury car advertisement would approach the customers without advertising its drive utility other than its comfort features. They know the person buying an automobile probably enjoy the driving part. Moreover, different driving adventures such as off road ride, drag race, street race, race on track and car stunts are all interesting aspects about driving. It would be thought provoking to assess human motivation behind driving behaviour. Numerous research has been done on various aspects of driving and driving behaviour. Knowing the human cognitive abilities that enables driving could be as interesting as vehicle itself. For instance, knowing to drive a car technically would not make a perfect driver and practice makes them perfect. Apart from overt technical aspects, there are covert cognitive process which we acquire in driving that makes a perfect driver. Among the cognitive abilities behind driving, intelligence in spatial visualisation is important to understand these sophisticated driving skills. Exploration of differences in spatial intelligence between four wheel drivers and non drivers could help us understand the role of spatial intelligence behind driving.

The cognitive abilities used for driving include attention, working memory, motor coordination, visuospatial processing speed and executive functioning. For instance, remembering the roads and places require visual perception and memory, working memory is engaged when this information from Long term memory is processed in Short Term Memory, visuo-spatial processing speed for quick responses, Visual Motor coordination is required for stability and above all, the ability of driver to gradually adapt to new roads, increasing traffic and sophisticated driving environment. Usually the term visuospatial abilities and visuospatial intelligence is used interchangeably. Visuospatial intelligence is the capacity to perceive visual world accurately and perform modifications (Cary, R., 2004). Visuospatial ability is a component of visual perception which enable visual orientation or processing of objects. While visual ability everyone may possess, visual intelligence is the capacity which we gradually develop as we adapt to environment. There has been research on driving style and driving behaviour. It includes the way people choose to drive. From past research on cognitive domains on driving, the broad scope of research on that domain was understood. This study is an attempt to understand the chance of such development which improves the visuospatial intelligence of a driver. Through mental rotation ability test, we attempt understand the visuo-spatial. Spearman's intelligence in context of driving is the ability of an individual to adjust to an increasingly complex traffic and driving requirements. The idea of intelligence was expanded from single g factor to nine types of intelligence including spatial intelligence. Howard Gardner use 'spatial intelligence' for intelligence that helps us to visualise information and synthesize data into visual metric and images (Ciccareli & White, 2015). Spatial ability comes under broad scope of intelligence.

Driving four wheeler require more spatial ability than two wheelers considering vehicle size which becomes challenging at least while overtaking another vehicle, parking and calculating speed. As size increase, the role of visuo-spatial ability increase. Hence the studies on driving four wheelers and spatial abilities have possibilities in reducing human error in driving. Existing research are limited on this field and no studies was found comparing difference in visio-spatial abilities for driver and non drivers or size of vehicle, etc. Hence more research could be done on the topic to assess how spatial abilities including spatial intelligence are used in accident.

Review of Literature

Spatial abilities are cognitive processes that enable us to encode and process spatial information. There has been lack of consensus on definition of spatial ability and the term has been used widely to describe attention, localisation in two- dimensional plane, shape identification, discrimination of shapes and depth perception. Term spatial ability was in use to cover a range of skills in reference to ability with space and objects. Researches over the years have contributed to deep understanding of the term that culminated in evolution of new terminologies such as "space perception" for elementary processing stage and "spatial thought" for spatial function above perception operation.

Researches have given insights about various aspects of spatial ability. Mitolo et al. (2015) identified three distinct categories of spatial test- spatial perception, spatial visualisation and mental rotation. Halpern (2000) distinguishes and define subdomains: Spatial perception is the ability to assess spatial relation, mental rotation is the ability to rotate and see objects in different perspective, spatial visualisation is the cognitive ability to move around an environment and orient ourselves appropriately It can be understood that spatial ability is a broad term with many subdivision still under study. And further reviews give us insights that driving requires these aspects of spatial ability.

Research done on patients with certain cognitive impairment is another way of testing such functions and abilities. People with cognitive impairment cannot engage in driving compared to normal functioning individual. The lesion in brain region or neural damage can limit people in using spatial ability. A study was conducted by Mark Tant and colleagues (Tant et al., 2002) on people with visual impairment to understand role of visual performance and cognitive functioning in driving. The study was done on 28 patients with complete or

incomplete Homonymous hemianopia. Homonymous hemianopia (HH) is a visual impairment by which half of the visual field becomes blind. The study had these tests included- a practical drive test with associated questionnaire on driving behaviour by filled by driving examiner and a battery of test to assess visual functioning and another questionnaire for visual impairment. The driving task found serious inabilities such as lack of stability especially in complex situation, unsteadiness, decreased speed and too wide turns. The study found that visual performance in driving was related with visuo-spatial test performance: with relevance to speed, accuracy and lateralisation. This study shows the role of cognitive function behind driving task.

A study was done by Tinella et al.(2020) to find relationship between cognitive functioning and spatial ability among drivers. The study was conducted on 83 drivers in Italy using computerised driving tasks. The study using computerised test found that spatial mental skills are related to fitness to drive.

A study was found on correlation of executive functioning and Visio-spatial processing Speed using web based assessment. Although research on visuospatial intelligence is scarce, this study was done on 'Functional Relevance of Visuospatial Processing Speed (VIPS) across Lifespan' (Aul et al. 2023). The aim was to assess visuospatial processing speed across lifespan to understand cognitive ability changes. The study includes two experiments with time constraints. One of the two experiment included web based VIPS task for performance assessment and neuropsychological assessments for visual and cognitive functioning. The result showed significant correlation of VIPS task performance and cognitive domains- attention, executive functioning and working memory. In driving, the quick decisions taken by a driver regarding parking space assessment enough for size of vehicle, size of road, while overtaking assessing the length of other vehicle at the same time deciding to overtake or not- these situations are exercise of visuospatial processing speed. This study also shows validity and relevance of computer web based assessment in assessing visuospatial ability, especially visuospatial processing speed.

A study was done on Non Verbal intelligence using Mental rotation shapes. The exploratory study by Karnik, S.& Sahasrabudhe, N. (2020) was done using Raven's Coloured Progressive Matrices on a school population of size 56 in Konkan, India. The study used mental rotation images in manual form to assess non verbal intelligence. The data analysis found no significant difference on Non verbal intelligence between boys and girls.

Another study was done to assess Mental Rotation Ability for test construction among school students in India. The study done by Datta, S., & Roy,D. D. (2016) using Vandenberg & Kuse Mental Rotation Test and a redrawn version to compare both test among population of size 147 school students. This shows the use of objects and shapes in assessing mental rotation ability and visuospatial reasoning.

Driving four wheeler has to use spatial abilities more than two wheelers considering situations where driver must know size and space of car required while parking in simple sense and length of the four wheeler with reference to speed travelling while overtaking in complex situations.. As size increase, the role of visuospatial ability increase. Hence the studies on driving four wheelers and spatial abilities have possibilities in reducing human error. Existing research are limited on this field and no studies was found about difference in visuospatial abilities need and size of vehicle, hence more research could be done on the topic to assess how spatial abilities including spatial intelligence are used in accident.

Throughout the existing studies we understood the significant role of visual spatial abilities in driving exploring its various aspects and how it is used in driving. While our driver assessment test or test for driving license does not consider the role of visual assessment other than vision of eye. There is more consideration needed for visual abilities and understanding spatial abilities in driving tests and understanding visual intelligence.

Method

The study aim to investigate the visuospatial ability of Four Wheel Drivers compared to Non drivers. Understanding the differences in Visuospatial ability performance is critical to understand impact of driving in Visuospatial ability.

Research Design

This study is an Experimental study to analyse and compare Visuospatial ability of both Drivers and Non Drivers. The study did not include manipulation or intervening in driving of participants. The Quantitative research approach with experimental research design was used since the study compare regular four wheel drivers and non drivers and performance in computerised Mental Rotation test.

Objectives of the Study

The objectives of the study were to understand spatial ability using Mental Rotation test among regular four wheel drivers and non drivers.

Research Question

- How Visuospatial ability differs between regular four wheeler drivers and non drivers?
- How Mental Rotation ability differ between regular four wheeler drivers and non drivers?

Hypothesis

- H01 : Regular Four wheel drivers will have faster reaction time in Mental rotation test than Non Drivers.

Operational Definition

Regular Four Wheel Drivers: An individual who has frequently driven a four wheeler vehicle on Road at least for 6 months.

Non Drivers: An individual who do not drive a four wheeler vehicle.

Variables

Dependent variable: Visuospatial Ability (Reaction Time)

Independent Variable: Participant Type (Regular Four Wheeler Drivers and Non Drivers)

Population

Regular four wheeler drivers were the population for the research. Experimental study research require at least 30 regular four wheeler drivers and 30 non drivers. The population size is 70 with 31 non drivers and 39 regular four wheeler drivers. The study was conducted in Bengaluru, Karnataka.

Sampling

Purposive sampling was used in the research. Participants were of any gender of age less than 30. Since cognitive ability and test performance can be differed depending on age, young population were only considered for the study.

- **Inclusion Criteria-** Regular Four wheeler Drivers who preferably hold Driving license and used to drive any Four Wheeler Vehicle regularly for 6 months.
- **Exclusion Criteria-** People who hold driving license but do not engage in driving for past 1 year or is not a regular driver.

Sampling Tools

- **Mental Rotation Test in CogLab 2.0**

The test was done using computer based Mental Rotation test in,CogLab 2.0 software. The test has validity and reliability and has been used in academic settings. Mental Rotation test assess response time taken in 70 correct trials out of all the trials. Incorrect responses were repeated. The test shows 2 shapes rotated in different angles, one towards left and another towards right side. The participant can assign any keys in the beginning of the test and the task is to respond if the two shapes are same shapes rotated in different angles or different shapes. Only 70 correct trials will be considered and the response time in milliseconds is given in results for each trial.

- **IBM SPSS Statistical Analysis Tool**

The results of Mental Rotation test were analysed by statistical analysis software, IBM SPSS.

Result and Discussion

The Mental Rotation Test results are given in Table 1 and Table 2. Reaction time for each participant was given as two tables in the result, when both shapes in question were same and when both shapes were different. Accordingly, two analyses for both same shape and different shape were done separately using IBM SPSS Software. Independent sample Test was used since participants were above 30 each for both categories. The reaction time taken was dependent variable and Driver or Non Driver was categorical independent variable.

Table 1.

Independent Sample Test on Reaction Time for Same Shapes based on Drivers and Non Drivers with Sample size N, Mean, SD, t value and Significance Value.

	Four Wheeler Driver			Non Driver			T	Sig Value
	N	M	SD	N	M	SD		
Reaction Time	39	2238.4	1079.8	31	2485.6	1154.2	-0.923	0.582

*Significance Value >0.05.

The result obtained showed that data was not normally distributed with Significance value 0.582 and 0.421 (p value > 0.05). Majority of the data lied on Upper limit of frequency distribution table. Since sample size was above 30 for each category, Independent Sample Test was conducted to compare Reaction time of each category separately

In Table 1, the Mean Reaction Time obtained is 2238.4 for drivers and 2485.6 for Non drivers for the test when correct responses for questions were ‘Same shapes’. The statistical analysis for Table 1 found 0.582 Significance Value. Significance value above 0.05 means the data has no significant difference between both the categories. Hence, Equal Variance Assumed was considered to know ‘t value’ which is obtained -0.923. ‘t Value’ is the difference between ratio of two sample sets. Here, T value below 1.96 indicates the data is not significant or there is no significant difference between Four Wheeler drivers and Non drivers regarding Reaction Time taken for Same shapes in Mental Rotation Test.

Table 2

Independent Sample Test on Reaction Time for Different Shapes based on Drivers and Non Drivers with Sample size N, Mean, SD, t value and Significance Value.

	Four Wheeler Driver			Non Driver			t	Sig Value
	N	M	SD	N	M	SD		
Reaction Time	39	2139.5	1244.6	31	2451.9	1338.2	-1.009	0.421

* Significance Value >0.05

In Table 2, the Mean Reaction Time obtained is 2139.5 for Four Wheeler Driver and 2451.9 for Non drivers in the test when correct responses for questions were ‘Different Shape’. The statistical analysis for Table 2 found 0.421 Significance Value. Significance value above 0.05 means the data has no significant difference between both the categories. Since Sig. Value is above 0.05, ‘Equal Variance Assumed’ was considered to know ‘t value’ which is obtained -1.009. Here, t value is below 1.96 that indicates the data is not significant or there is no significant difference between Four Wheeler drivers and Non drivers regarding reaction time for different shapes in Mental Rotation Test.

While no significant difference between Four Wheeler drivers and Non Drivers was found, the reason could be lack of practice of the participants in this computerised test. While collecting data, some participants were performing quickly without analyses of shapes while some took time in analysing shapes and responding, despite reminder to be fast in response. Since the test did not consider overall trials, the percentage of correct responses was not included in Result. It was observed that along with Speed of reaction time, accuracy of reaction could have been included for better analyses.

Summary and Conclusion

The study found no significant difference between Reaction time of Regular Four Wheeler drivers and Non drivers in Mental Rotation test. The experimental Study was done on population of size 70 in Bengaluru, India. The hypothesis that Four Wheel Drivers will respond faster than Non drivers was rejected. However a study which would consider both correct and wrong responses for accuracy of response along with reaction time could have scope in the future.

Limitation of the Study

The study found few limitations during Data collection and Analyses. One major limitation would be considering only reaction time without accuracy of response. This may find a participant who respond quickly but with many wrong response as with better spatial ability than another who takes time but less wrong responses. Another limitation was Data collection among non taxi drivers. A future research among taxi or bus drivers might have better results. However, time and resource constraint was a hurdle to conduct data collection among bus or taxi drivers.

Further Scope of Research

Research further could be done on visuospatial accuracy where correct and wrong responses are considered in assessing reaction time. More research on spatial aspects of driving in terms of Size of vehicle is another scope of research. Integrating multiple tasks to assess visuospatial ability could also enable to compare different result to gain more insights.

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