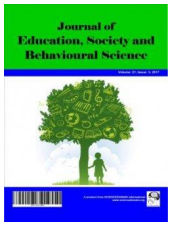

Journal of Education, Society and Behavioural Science

26(1): 1-9, 2018; Article no.JESBS.41503
ISSN: 2456-981X
(Past name: British Journal of Education, Society & Behavioural Science, Past ISSN: 2278-0998)

Traffic Communication as Determinant of Motorist Behaviour

Nana Kwame Nsiah-Achampong[1*], Naa Aku Mingle[1] and Isaac Kofi Yankson[1]

[1]CSIR - Building and Road Research Institute, P.O.Box UP40, KNUST, Kumasi, Ghana.

Authors' contributions

This work was carried out in collaboration between all authors. Author NKNA designed the study, wrote the research protocol and first draft of the manuscript. Authors NKNA and NAM managed the literature searches. In the field studies, authors NKNA and IKY supervised data collection while authors NKNA and NAM studied motorist behaviour and assigned psychological reasons thereof. All authors did independent data analysis first and then double-checked together to ensure convergence. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JESBS/2018/41503
Editor(s):
(1) Jyotsana Shukla, Assistant Professor, Amity Institute of Behavioral and Allied Sciences, Amity University, Uttar Pradesh, India.
(2) Alina Georgeta Mag, Professor, Department of Private Law and Educational Science, University of Sibiu, Romania.
Reviewers:
(1) Murat Darçin, Turkey.
(2) Hui Yang, Beijing University of Posts and Telecommunications, China.
(3) Akshat Pandey, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/25557

Original Research Article

Received 20th March 2018
Accepted 31st May 2018
Published 14th July 2018

ABSTRACT

Motorists are communicated to in the road traffic environment by graphics, the level of clarity of which elicits correlating responses. The study observed motorist behaviour at a selected location, Briscol Y-junction in Kumasi, Ghana, which is typical of a visibility phenomenon. Motorists related independently to a gantry at the junction. Concealed passive neural processes precipitating motorist behaviour hardly gained consideration by traffic authorities. Consequently, negative reinforcement (as occurs in operant conditioning) robbed the motorist reason for his actions. The subsequent driving behaviour of the motorist is affected by the adjudication of traffic laws which rigidly considers inhibitory schemata as an infringement of the law. The study makes an exposition on the passive cause of traffic conflicts traceable to poor traffic communication. The paper hypothesizes on whether driver behaviour arising out of poor graphic traffic communication (GTC) may have an impact on road safety. Using observation as a qualitative phenomenological research method, motorist

**Corresponding author: E-mail: n.nsiah@inorbit.com;*

behaviour at the junction was examined. The psychological theory of operant conditioning propounded by BF Skinner was applied as a yardstick of probing motorist behaviour at the Briscol Y-Junction. This was complemented by the Schema Theory of motorist actions. A strata of 320 motorists who drove past the red light exhibited different behaviours traceable to their visibility level of GTC supported by their previous knowledge of the traffic environment. It was found that traffic management is unmindful of the concealed psychological, biological and neural processes that occur in the motorist as the cause of traffic conflicts. It was recommended that to help maintain motorist composure in subsequent driving situations, traffic audit and management should first ensure that all traffic communication features are properly situated and oriented at all times.

Keywords: Motorist behaviour; gantry; traffic conflicts; sight distance; graphic traffic communication; operant conditioning; schemata.

1. INTRODUCTION

1.1 Background

1.1.1 Graphic traffic communication and law enforcement

In the management of traffic, traffic law enforcement has been lopsided towards offending motorists. However, some traffic offences are consequent of inappropriate placement of traffic communication signs which defy motorist visibility thereby eliciting primary traffic conflicts susceptible to crashes. Administering sanity in the road traffic environment in Ghana has evolved through stages of development resulting in improvements in road use and a significant reduction in fatalities. However, one area of road safety where motorists go through excessive traffic inconveniences is motorists' response to graphic traffic communication (GTC). GTC involves providing non-verbal information for the road user by means of traffic sign symbols such as road signs, with colour as an element for enhancement in communication. In Ghana, non-standard road signs can be found on the road. Many stakeholders in road safety claim they do safety auditing [1]; nonetheless, the existence of non-standard road signs shows otherwise.

There are standard specifications for road signs and markings though (Ministry of Roads and Highways) [2], there have been identifiable cases of road signs and markings in existence which go contrary to the standards as observed by Nsiah-Achampong [3]. These signs defy legibility distance and sign luminance requirements. Motorist visibility, response to the timely detection, and comprehension of signs are therefore compromised. These affect motorist behaviour ultimately and translate indirectly to other safety problems. Ross et al [4] decry the prevalence of obstacles to motorist visibility in developing countries.

The traffic environment hinges on physical structures like roads, road signs and vehicles; and intangibles like education and law enforcement. These two co-exist to ensure safety. Conversely, if they are not properly administered to ensure balance, safety is compromised. If, for instance, the content of road signs is not conformable to the road nature being depicted, it becomes incongruous for the law to prosecute any offending motorist. However, there have been situations in Ghana where motorists fall prey unduly to the law for responding to traffic communication giving discordant information. Similarly, a motorist may move unknowingly into a restriction without an advanced warning sign and yet still be culpable of the law [5]. Ross et al [6] indicate that if traffic systems are not as "self-enforcing" as possible, enforcement demands become too complicated for Traffic Law Enforcement Agents. It is rather challenging to escape the pattern if one wishes to understand from a psychological perspective the effects of enforcement on driver behaviour.

1.1.2 Traffic conflicts

The Immediate consequences of poor GTC belong to the category of traffic conflicts pre-crash events likely to lead to crashes ultimately when not properly dealt with. Traffic conflicts pre-crash events, according to OECD [7] are situations involving one or more vehicles where there is imminent danger of a collision if the vehicles' movement remained unchanged (OECD [8]). Most accidents are multi-array interwoven factors. The driving task is composed of actions ranging from the danger of collision to actual collision. Each action is referred to as a schema. In between the two (danger of collision and actual collision) are actions which precipitate

the possibility of a crash. Poor GTC is a prevalent potential for the precipitation of uncoordinated motorist actions that can translate into crashes.

1.1.3 Psychological factors

Mostly, the solidity of traffic engineering and the rigidity of traffic law enforcement overlook the fluidity and subjectivity associated with the concealed neural and psychological processes occurring in the motorist which translate outwardly into traffic conflicts, traffic law infringement or crashes. For instance, the bio-psychological bases of neuron action potential in the body explain what defines some actions in the body of the motorist as a biological being. Cherry and Gans [9] explain how neurons transmit signals by means of the action potential in humans. Neuron action potential is referred to as a quick fluctuation in the electrical membrane potential (voltage variance across the plasma membrane) of the neuron (Fig. 1) consequent of the stimulus causing depolarization of cell membrane. An action potential is created when the electrical membrane potential turns out to be more positive and surpasses the threshold potential. The neurons, at this stage, are in the excitable stage (forming excitatory schema). When the electrical membrane potential turns into negative and is not able to generate an action potential, neurons are in the inhibitory state. All motorist action stems from schemata that are either positive (excitatory) or negative (inhibitory).

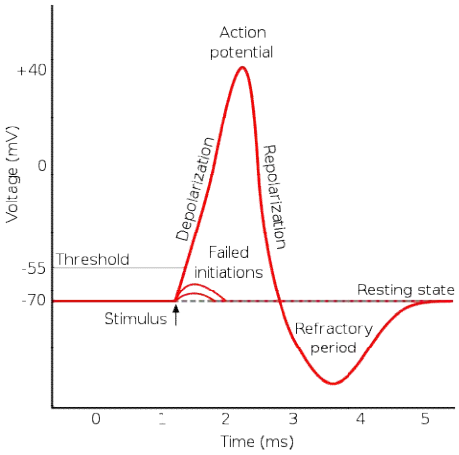

Fig. 1. Action potential
Source: Purves D. (1970)

Motorists belong to the human species (biological beings). All humans are prewired with genetic inheritance with automatic responses called respondents. Respondents are acts that are triggered by events immediately preceding them (Davidoff [10]), and dictating a certain behaviour. Research indicates that driver behaviour, expectations and alertness may change, depending on the area and operating conditions (Transportation Research Institute, [11]). Studies on driver behaviour research making explicit use of behaviour analysis paradigm are mostly not relatively published as studies in other areas of road safety (Cassiabue [12]).

1.1.4 Sight distance

Jin et al [13] found that generally if the sight of motorists is restricted, they mostly follow the lead car. Ross et al [14] state that the general driving environment influence motorists preparedness to take particular actions and manoeuvres. If some or all of the surrounding features and messages confuse or mislead the motorist, false expectations will occur which can lead to hazardous situations and accidents.

By means of the driver's conditioning history of learned associations among discriminative stimuli, responses and consequences to explain motorist actions are not without serious problems. This strict behavioural approach is vulnerable to the somewhat improbable requirement that drivers learn through a prolonged conditioning process on how to respond safely to what is virtually an infinite number of road and traffic scenarios.

1.2 The Setting: Bristol Y-Junction

The location chosen for the study is the Briscol Y-junction in Kumasi, Ghana. By description, the traffic light gantry at Briscol Y-junction is the F-type (Fig. 2). The horizontal gantry extension at the top bears two traffic signal heads (A) which direct traffic moving ahead (straight). On the vertical leg is another traffic signal head (B) directing traffic turning to the left. The length of the traffic head (B) is 3.11 feet, placed on a height of 11.2 feet from ground level. Both traffic signal heads (A) and (B) are above eye level. However, the angle of elevation of sight of motorists to traffic light (B) is compromised by reason of obstruction to visibility. As the motorist moves forward the angle of elevation of sight drops to the level of the vehicle before (Fig 3a & 3c). Thus, the vehicle ahead falls in the line of vision of motorists, causing obstruction. Vehicles are of different heights. If the height of the

vehicle before is higher, the magnitude of obstruction is worse (Fig 3b). Ross, et al [15] show that while higher vehicles (such as buses and trucks) have visibility advantage, their heights affect the sight distance of other smaller vehicles (Fig. 3b).

By contrast, the traffic lights (A) directing motorists ahead are clearly above eye level (Fig 2). Motorists turning left largely relied on the movement of vehicles ahead of them, whereas vehicles moving ahead relied on self-judgement according to the dictation of the traffic lights. Thus, motorist behaviour of vehicles turning to the left was partially influenced by vehicles ahead of them.

The case at Briscol Y-junction (Fig. 4) is synonymous with sight distance. Sight distance is a span of the road surface which a motorist sees with an acceptable level of clarity (Constructor, [16]). Maze and Plazak [17] further break down sight distance to intersection sight distance, describing it as the unhindered view of an intersection, including traffic control devices, and ample lengths along the intersecting highway to allow the motorist anticipate and avoid a potential collision.

A study by Santos-Berbel [18] on sight distance on roads where a software application was used to set values for the height of target obstacle and height of driver's eye emphasizes, even more, the algorithmic accuracy and significance of sight distance in road construction. Ministerio de Fomento [19] also makes reference to values for sight distance required for motorists' eye height as per the Spanish geometric design guidelines. Transportation Research Institute [20] indicates that adequate stopping sight distance must be provided on the street so that the motorist with the standard eye height may see an object of 150 mm (0.5) feet with sufficient time to stop safely. These underscore the relevance of motorist visibility for the important purpose of picking and transmitting information from the eye to the brain. At the Briscol junction, the traffic light is located at a convenient height of 11.2 feet though, occluding vehicles render visibility difficult.

The study observes motorist reaction to GTC at Briscol intersection. In trying to understand motorist behaviour, psychological theories are implicitly applied to movements and reflexes to explain why motorist behave the way they do. The study makes an exposition on the passive cause of traffic conflicts traceable to poor traffic communication. The paper hypothesizes on whether driver behaviour arising out of poor GTC may have an impact on road safety.

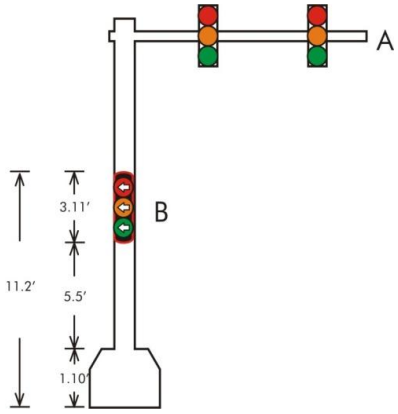

Fig. 2. Gantry bearing traffic signal heads at Briscol Y-Junction, Kumasi

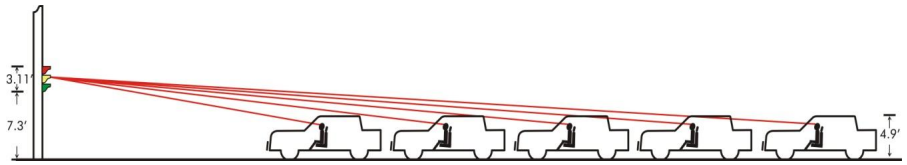

Fig. 3 (a). Relationship between the traffic light and motorists' angle of gaze (involving same height vehicles) at Briscol Y-Junction, Kumasi

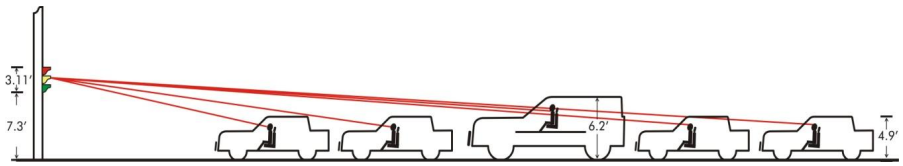

Fig. 3 (b). Relationship between the traffic light and motorists' angle of gaze (involving irregular height vehicles) at Briscol Y-Junction, Kumasi

Fig. 3(c). Photographic illustration of obstructed motorist view at Briscol Y-Junction, Kumasi

2. METHODOLOGY

The study is a qualitative phenomenological research that seeks to examine the difficulty and inconveniences confronting motorists in traffic consequent of poor GTC, and its impact on road safety and traffic regulations.

Motorists were observed in traffic. The theory of operant conditioning propounded by Edward Thorndike and Burrhus Frederic Skinner (Davdoff, [21]) was applied to motorist behaviour at the Briscol junction to ascertain a scientific inquiry into the behavioural processes of the motorist. Operants are actions (or voluntary responses) which animals initiate. Just as the autonomic nervous system mediates respondents, the somatic nervous system, which exerts control over the movement of skeletal muscles, mediates operants. Operants appear spontaneous and entirely under the animal's control. This was complemented by the Schema Theory of motorist actions.

Apart from observable corresponding processes of neural action, this method avoided the subjective imagination of what might be going on in the driver's mind and restricted itself to describing systematic relationships among observable events.

The study was carried out in the morning peak hour traffic of between 0700 hours and 1100 hours, at a frequency of two times in a week for a period of four months (July to October 2015), making a total 32 days of observation. Traffic was slow and dense. Motorists who jumped red light were stopped by Traffic Law Enforcement Agents (TLEAs) located at 'A' and directed to park at 'B' (Fig 4). They (defaulting motorists) were interviewed by Field Assistants (FAs). However, TLEAs were not regular on duty. On days that TLEAs were not on duty, FAs were positioned at locations 'C' and 'D' (Fig 4). FA at location 'D' noted and counted a number of vehicles which went past the red light to the left

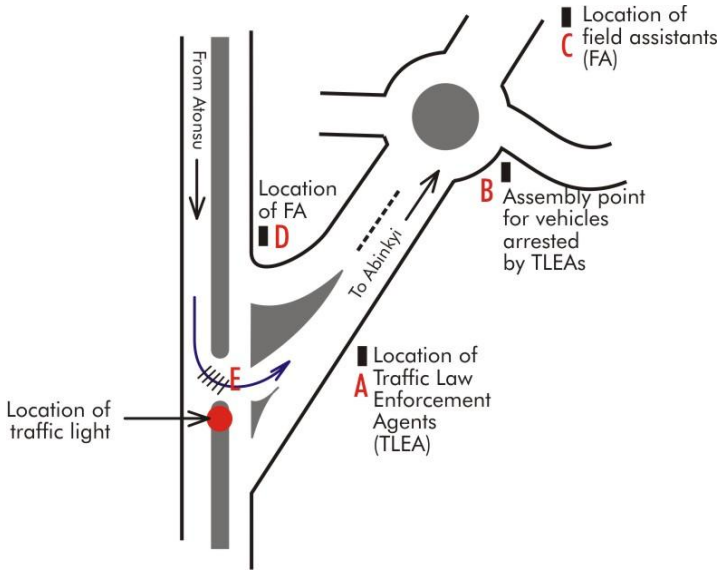

Fig. 4. Diagrammatic representation of Briscol Y-Junction, Kumasi (not to scale)

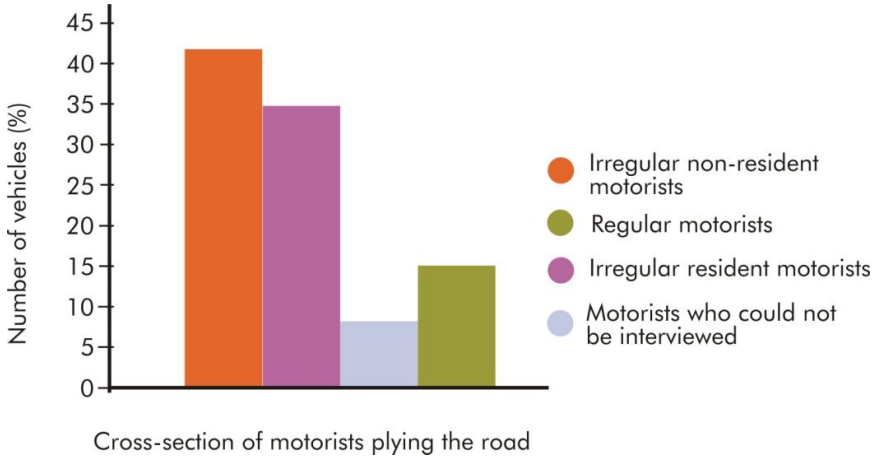

Fig. 5. Vehicle categories which drove past a red light

turn (Fig 4). He informed FA at location 'C' by telephone signal. FA at location 'C' then tracked and stopped such vehicles for interview. Not all such vehicles responded to stopping (for interview). The presence of TLEAs made it easier for counting. A total of 320 vehicles were recorded as having driven past the red light during the study period.

2.1 Psychological Bases of Motorist Behaviour

Three hundred and twenty motorists drove past the red light. All these motorists had one thing in common. Interviewed, the respondents claimed their view of the traffic light was hindered. Their movement was elicited by movement of the vehicle immediately preceding them (operant), involuntarily by reflex.

In this reflex arc, muscles move involuntarily without input from the brain. Cherry and Gans [22], explain that one does not 'think' under these circumstances and go on to state examples of reflex arcs as jerking your hand back after accidentally touching a hot pan or an involuntary knee wobble when a doctor taps on your knee. This is what Purves [23] refers to as inhibitory state when the electrical membrane potential turns into negative and is unable to generate an action potential (Fig. 1).

Observably, in some cases 'offending' vehicles showed a quick slow-down and moved again in what was seen as motorist's split-second decision-taking following sudden perception of traffic red light coming into focus. At this stage, the jerky movement of stopping the vehicle in the marked perimeter (E) was a manifestation of efferent (motor) neurons carrying information from the brain through the spinal cord to muscle fibres throughout the motorist's body.

All motorists who drove past the red light had three things in common:

(a) They did not see the red light
(b) Their movement was elicited by movement of the vehicle before them
(c) It was too late to stop and remain stopped by the time the red light came into focus

However, these applied in varying degrees to the different categories of motorists. The regular motorists had previous knowledge of the situation and therefore performed better with the least error score of 15%. Previous knowledge of a traffic situation by motorists elicits a cognitive process leading to the conscious exercise of control over the traffic situation. This regulating power is referred to as stimulus control (Davidoff [24]). Stimulus control is a situation in which behaviour is triggered by the presence or absence of some stimulus. In operant conditioning, antecedent stimuli are those which occur before the behaviour. Once noticed, antecedents operate as signals to which responding produces reinforcement; the car stopping at the red light to avoid an accident or fine is reinforcement.

2.2 The Schema Theory in Driver Behaviour at Briscol Junction

Behaviour defines observable actions of how motorists conduct themselves in traffic. The

schema theory is a concept designed to understand the spontaneous trait of motorist behaviour based on mental and psycho-physical programs called schema. The schema is concerned with how motorists think, analyse, and act on information, knowledge or data that is presented to them or acquired from the traffic environment. Each unit is a schema which is subordinate to a superordinate composite whole, the schemata.

Driving at the Briscol junction posed as a complex activity which dictated multi-level skilled behaviour. The different category of motorists studied at the Briscol junction presented varying degrees of schemata though, they were confronted with the same situation. This is established on the knowledge that motorists develop a schema for driving over time, though in a transitory manner, based on perceptions of driving situations.

Much of driving behaviour is excitatory (automatic), developed from experiences of a general or particular situation. The irregular non-resident motorists had little experience of the traffic situation they were being confronted with. Activation of the inhibitory schema was prevalent. Motorist action was hardly thought of. Their error margin of 42% formed the highest score while regular motorists resident in Kumasi who were familiar with road displayed relatively good performance with an error score of 15%. Between the two motorist categories (regular non-resident motorists and regular resident motorists) was the irregular resident motorist. This group bore characteristics of the other two categories. Though residents of Kumasi, they had not been plying the road regularly and were not as abreast of the traffic situation at the junction as much as the regular users who were also residents of Kumasi. They made the mid error score of 35%.

In emergency situations schema or automatic behaviour may not be appropriate and shifting our behaviour more consciously to control such rare events is unlikely to succeed because we do not have effective emergency behaviour or schema, at our disposal. Behaviour will reflect the psychological profile of each individual and the situations the individual is exposed to.

3. RESULTS AND DISCUSSION

3.1 Field Tests

During the study period, traffic volume on the road from Atonsu (Fig. 4) had been unusually irregular due to road diversion from a major adjoining road (the Kaase road) where the Kaase Bridge was being rehabilitated. Some motorists interviewed indicated they sometimes did not use the road because of perceived traffic density. Besides regular users of the road, a cross-section of motorists plying the road comprised Kumasi residents and non-Kumasi residents who were not regular users of the road. The total number of motorists who drove past the red light made up a total of 320 motorists within the study period. As indicated in Fig. 5, out of the total number of vehicles (n = 320), 42% (134 motorists) claimed they were obstructed by the vehicles before them; by the time the traffic light appeared in sight indicating red, they had already driven past the restriction line so they continued moving ahead. These were found to be irregular non-resident users of the road. Thirty-five per cent (112 motorists) also with sight obstructed were Kumasi resident irregular users of the road. They had been using the road alternately due to the closure of the Kaase road. These were found to be irregular non-resident motorists. Fifteen per cent (48 motorists) were regular users of the road who had flouted the traffic rule of jumping red light. They claimed they relied more on their senses of judgment. Eight per cent, representing 26 motorists did not stop to be interviewed. Of the total number (n = 320), some vehicles appeared more than once, and in some cases, driven by different motorists.

4. CONCLUSIONS AND RECOMMENDATIONS

Motorists drove past the red light because their line of vision was fully obstructed by other vehicles. Between the period of initiating a schema and its application, psychological and biological and neural processes take place in the somatic nervous system of the motorist which transmits impulses to the brain and therefore dictates outward action according to information received from the stimulus before it. These processes are concealed in the motorist and are not openly noticeable. However, if such schemata are inhibitory, the motorist may fall prey to the law. The arrest and prosecution of such motorists affect their driving composure and result in later traffic conflicts. The behaviour of motorists arrested unduly is usually, in some cases, so affected in subsequent situations. When driving, such motorists spend unnecessarily more time gazing at communication signs to be sure of what is being communicated to them; sometimes what the

mind of the motorist processes is, in reality, not what is being expected of the motorist. Motorist concentration is therefore divided and creates a tendency for secondary traffic inconveniences.

Ideally, traffic audit and management should first ensure that all traffic communication features are properly situated and oriented. This would justify TLEAs arrest of motorists whose actions are an infringement on traffic regulations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nsiah-Achampong NK. The impact of traffic education in Ghana. The case of selected geographical areas of Ashanti Region, Ghana. Unpublished MA thesis submitted to the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; 2004.
2. Ministry of roads and highways. Manual of road signs and markings. Unpublished Manual. MRH/SM 3 – 6; 1991.
3. Nsiah-Achampong NK. The impact of traffic education in Ghana. The case of selected geographical areas of Ashanti Region, Ghana. Unpublished MA thesis submitted to the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. 2004;197 – 220.
4. Ross A, Baguley C, Hills B, McDonald M, Silcock D. Towards safer roads in developing countries. A guide for planners and engineers. Transport and road research laboratory. Overseas development administration. Ross Silcock Partnership, Newcastle upon Tyne, England. 1991;50,7,50,152.
5. Nsiah-Achampong NK. The impact of traffic education in Ghana. The case of selected geographical areas of Ashanti Region, Ghana. Unpublished MA thesis submitted to the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; 2004.
6. Ross A, Baguley C, Hills B, McDonald M, Silcock D. Towards safer roads in developing countries. A guide for planners and engineers. transport and road research laboratory. Overseas development administration. Ross Silcock Partnership, Newcastle upon Tyne, England. 1991;50,7,50,152.
7. Organisation for economic co-operation and development. Research into road safety at junctions in urban areas. Paris. 1971;17.
8. Organisation for economic co-operation and development. Research into road safety at junctions in urban areas. Paris. 1971;24
9. Cherry K, Gans S. The somatic nervous system. How it works and what role it plays; 2017.
   Available:https://www.verywell.com/what-is-the-somatic-nervous-system-2795866. (Accessed 18/01/2018)
10. Davidoff LL. Introduction to psychology. McGraw-Hill Book Company, New York; 1987.
11. Transportation Research Institute. Stopping sight distance and decision sight distance. Oregon State University, Corvallis, Oregon; 1997.
12. Cassiabue PC. (Ed) Modelling driver behaviour in automative environment. Critical issues in driver interactions with intelligent transport systems. Springer-Verlag London Ltd. 2007;257.
13. Jin J, Wang W, Wets G, Wang X, Mao Y, Jiang X. Effect of restricted sight on right-turn driver behaviour with pedestrians at signalized intersection. Advances in mechanical engineering. Hindawi Publishing Corporation. 2014;4.
14. Ross A, Baguley C, Hills B, McDonald M, Silcock D. Towards safer roads in developing countries. A guide for planners and engineers. Transport and road research laboratory. Overseas development administration. Ross Silcock Partnership, Newcastle upon Tyne, England. 1991;50,7,50,152.
15. Ross A, Baguley C, Hills B, McDonald M, Silcock D. Towards safer roads in developing countries. A guide for planners and engineers. Transport and road research laboratory. Overseas development administration. Ross Silcock Partnership, Newcastle upon Tyne, England. 1991;50,7,50,152.
16. The constructor. Sight distance considerations for highways; 2017.

Available:https://theconstructor.org/transportation/sight-distance-highway-engineering/10977/.
(Accessed 04/08/2017).

17. Maze T, Plazak D. Access management handbook: Balancing the demands on our roadways. Ames, Iowa: Centre for transportation Research and Education, Iowa State University; 2000.
18. Santos-Berbel C, Castro M, Medina SL-C, Paréns-González M. Sight distance studies on roads: Influence of digital elevation models and roadside elements. Science Direct, Elsevier Ltd. 2014;449.
19. Ministerio de Fomento. In Santos-Berbel C, Castro M, Medina SL-C, Paréns-González M. Sight distance studies on roads: influence of digital elevation models and roadside elements. Science Direct, Elsevier Ltd. 2014;450.
20. Transportation Research Institute. Stopping sight distance and decision sight distance. Oregon State University, Corvallis, Oregon; 1997.
21. Davidoff LL. Introduction to psychology. McGraw-Hill Book Company, New York; 1987.
22. Cherry K, Gans S. The somatic nervous system. How it works and what role it plays; 2017.
(Accessed 18 January 2018).
Available:https://www.verywell.com/what-is-the-somatic-nervous-system-2795866. Accessed 18/01/2018
23. Purves D. Excitatory and inhibitory postsynaptic potentials. Neuroscience. 2nd edition. U.S. National Library of Medicine, 1970.
(Accessed 20 Jan 2018).
Available:http://www.differencebetween.com/difference-between-excitatory-and-vs-inhibitory-neurotransmitters/
24. Davidoff LL. Introduction to psychology. McGraw-Hill Book Company, New York; 1987.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/25557