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## Traffic Psychology and Driver Behavior

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### Abstract

In this paper the authors analyze the interaction of road-safety and human factors to identify personality, attitude, ability and reliability of a driver. By psychology methods, the construction process of driver personality has been investigated by the study of processes of perception, learning and memory. Since from personality derives the driver performance, is possible to detect behaviours that tend to result in decreasing driving risk. In this way the authors provide useful indications for design of safe roads and he concludes that during the road design and management is very important the presence of a new rule, the psychologist.

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### 1. Introduction

It has been ascertained, as mentioned in previous publications, that traffic safety depends on the integrated and complex relationship between various components: the psychology of the vehicle's driver, the traffic, the vehicle, the environment and the road infrastructure [1, 2]. The component that, according to the statistics, would appear to be the most important, since it is responsible for the majority of accidents, is the behaviour and therefore the psychology of the vehicle's driver.

Since driving behavior is strongly conditioned by the perception of the road environment, it is very important to adopt a Context Sensitive Design (CSD) approach [3, 4], able to design roads that satisfy drivers' expectations, constituted by harmonious and coordinated patterns, without surprises or disturbing factors that may cause the driver to lose control of the vehicle.

The traffic, in its complexity, is undeniably conditioned by vehicles, but also by drivers who have different psychological characteristics with multiform objectives and purposes. Consequently, situations of imbalance can

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occur in which driving behaviour can become irrational. The complexity of the interactions that occur in traffic alters the specific behaviours of the various players. In order to have safe circulation that respects traffic, each driver must participate considering the behaviour of the others and is willing to observe common safety needs without attempting to impose his own behaviour.

Today vehicles are increasingly fitted with assisted driving systems that tend to relieve the driver of his responsibilities, unfortunately, some times, preventing him from paying the necessary attention. In order to improve circulation safety, these devices must be perceived, encoded, used by the driver who must rely on his behaviour, dictated by his personality, to use them appropriately.

The environment is constituted by a complexity of factors, amongst which the constitutive elements of the road, the territory, traffic and weather conditions. The road through its geometrical design, the boundary conditions; the territory through the vegetation, buildings, emergency points; the traffic through intensity, composition and speed; the meteorological conditions through atmospheric events, rain, snow, wind and fog. It is evident that in these situations personality, expressed through psychology, is decisive to the driver's behaviour.

The road infrastructure with its geometric characteristics has a fundamental importance in the driver's psychological conditioning, as extensively demonstrated in a previous publication, in which a number of precise design proposals were made [5, 6].

To conclude, all the components of the integrated and complex relationship involving circulation safety depend, albeit to different extents, on the driver's behaviour. This makes it necessary to explore the topics underlying the psychology of the individual who, once on the road, becomes a driver.

Psychology has taken on a considerable scientific importance and it has become a fundamental instrument for becoming familiar with and interpreting the behaviour of the individual in a single and social setting [7]. Consequently, the accreditation of people to be drivers on the road should also include a psychological test aimed at assessing the person's ability to adopt behaviours that form the basis of safe driving.

## **2. Driver psychology**

Psychology can be defined as the study of personality as a synthesis of maturation and learning [8]. It originated as a science and develops through various disciplines using methods and techniques to consolidate itself on an operative level. The decisive development of psychology occurred with the application to the study of the mind of the systems specific to the natural sciences.

Like all sciences, psychology relies on a variety of methods in order to investigate the personality of individuals. The methods most commonly used are the experimental, clinical and psychoanalytic methods. That which appears most suitable for treating the driver, both when studying his abilities and in the learning of traffic psychology, would appear to be the psychoanalytical method, since it considers a close relationship between analyst and subject. With psychoanalysis, founded by Freud, the positive and negative components of personality emerge from the subject's conscience.

Personality is the way of being a person. Therefore, personality is an individual manifestation represented in a form that can be processed by the environment and culture in which each one lives. As a synthesis of maturation and learning, it is a dynamic organisation of a plurality of aspects (cognitive, affective, volitive, motivational) [9].

To achieve its pre-set purposes, psychology relies on techniques. Those most frequently used are those based on experiments, talks, questionnaires and interviews. The most efficacious techniques in the relationship between analyst and driver are the talk and questionnaire techniques. These are used not merely to gather information on the driver, but also to intervene on a therapeutic level, if necessary. They make it possible to acquire useful information for personality tests and profiling, they help to pinpoint and correct behavioural difficulties and, therefore, they shape the driver to have a safe relationship with driving at all times, and in particular in emergency conditions. In this way, it is possible to test and obtain an individual that complies better with the rules of

circulation safety. From this relationship between psychology and driver we can also obtain information that is useful for road design purposes.

In order to test the personality of a potential driver, we have to understand how it is constructed. Construction is structured through perception, learning and memory [10].

### 3. Perception

The individual cannot socialise or communicate without perceiving, learning and memorising the content of the experience. He observes reality using his senses, in particular, for the case of a driver: sight, hearing and smell.

As far as sight is concerned, the eye functions as a camera, channelling light waves through the opening of the pupils. A lens, the natural lens in our eye, focuses rays of light and transforms them through the process of accommodation. The surface on which the rays of light concentrate is the retina. The image is upside down in two dimensions on the retina, whereas the third dimension, depth, is recovered by the brain.

Hearing is possible through the ear. The dimensions of the hearing experience are the frequency and amplitude of sound waves. The ear amplifies the eardrum's vibrations and transmits them to the cochlea. The latter sends all the impulses to the brain.

Smell is a sense that operates on a chemical basis. Smell is achieved when some molecules of a substance reach the nasal cavity.

Perception can therefore be defined as a process by which the brain, obtaining information through the senses, processes them to grasp reality. In this way, the information is arranged within the system formed in this way and becomes an important part of it. Perception is based primarily on two theories: the realistic and representative theory. According to the realistic theory, the environment is grasped by the brain as it appears, whereas according to the representative theory it is the brain that produces reality. The two theories mutually integrate one another and together produce perception.

Perceptive constancies are phenomena that prove that although they change their image, objects are nevertheless perceived in a constant way in the same shape, size and colour. They are therefore phenomena that make it possible to make corrections to the errors that the sight system produces on reality. The brain therefore performs an additional process in order to correctly adapt the sensorial data and the same cerebral centres, to reality. Perceptive constancy therefore indicates that certain qualities of the phenomena remain unchanged.

The perception of movement takes place in a multiform manner. In this case, it is a construction and reprocessing of data and information that the mind interprets critically. Movement is perceived through two systems: the image-retina and eye-head systems. The image-retina system is based on the change of the image-retina; the eye-head system uses eye movements that make it possible to follow the image. The perception of movement can be proven with the autokinetic effect and the stroboscopic effect. The autokinetic effect consists in the perception in movement of a luminous and immobile point in a dark room. The stroboscopic effect occurs when certain static images are perceived in movement. The individual therefore not only has the possibility of identifying a moving object, but also has the ability to calculate its trajectory and speed.

We can thus conclude that perception is a complex process. This complexity can also be observed with optical illusions. It is this set of phenomena that interests and significantly conditions the driver. Optical illusions are visual phenomena that give the impression that one is perceiving objects that are not those that the eyes actually see. These phenomena can be explained by the psychology of shape. The latter indeed considers the shape as a whole and not the individual parts. Optical illusions are formed primarily by extension illusions and direction illusions. Extension illusions present when an object's boundary conditions induce in the observer a dimension other than the real one. Direction illusions occur when the set of information contains elements that tend to deform the emerging lines. It goes without say that these phenomena can cause the driver to interpret reality incorrectly and these interpretations will be all the more incorrect the more prone the driver is to lose his concentration and adopt a less responsible behavior [11].

#### **4. Learning**

Learning is a process by means of which the individual adopts his own behaviour. To know the dynamics underlying behaviour, we have to be familiar with the learning process. Learning manifests with the need not merely to observe and explore, but also to experiment the surrounding reality.

The acquisition of the dynamics and processes involved in learning is very complex. There are two types of learning that interact with and digest one another: the first is intended as the acquisition of notions, the second is based on the experience lived and on the motivation of learning. The second type, which is undoubtedly the more important in the case of the driver, requires joint biopsychological and mental participation. This, based on the sense of research and discovery, is self-motivating and contributes, when the subject learns, to altering behaviour. Through the learning process, the individual makes experiences his own and, with his intelligence and sensitivity, participates in many situations, referring to information from the past. He changes his behaviour, reorganising it according to what he has learned and adapts to the environment.

Experiments on learning have produced different theories. Those that are best suited to explaining the behaviour of the driver are those on the conditioning, on learning by trial and error and on social learning. The conditioning theory has allowed us to discover, in part, human instincts. The theory on learning by trial and error focuses on the graduality with which the individual improves with experience and refines his ability progressively. Social learning, or learning by imitation, is a theory that demonstrates the importance of the environment for adopting the behaviour acquired through imitation [12].

Psychology therefore tells us that the driver learns driving behaviour, and therefore safe driving behaviour, through experience. Unfortunately, the development of the theories and experiments has shown that not all people have the ability to become safe drivers. In many cases, the individual can even learn the driving method, but not know how to put it into practice or is able to put it into practice too late, when the event requires short timeframes. This fact can be seen in an individual throughout his life on account of intellectual and/or psychophysical limitations or alternatively it may present for other reasons. Of these reasons, there are two main ones that are important for the driver. The first is constituted by a temporary lack of ability when the person is subject to a numbing of his strengths for contingent reasons, for example transient psychophysical states such as the taking of medicines or drugs. The second can be determined by old age that has created a weakening of the reaction. Clearly the potential driver must be psychologically analysed to discover and predict his psychophysical state that produces learning and therefore determine his suitability to driving.

#### **5. Memory**

Memory, or mnemonic activity, is an integrated process that refers to a dynamic vision of reality. Therefore as the memory is characterised by dynamism, it is subject to continuous changes and transformations. Memory is not therefore, an activity during which information is merely seen, encoded and stored, it also has the ability to use things acquired previously.

There can be two types of memory process. In the first, the notions that the individual thinks about and reasons on are constituted essentially by remembered elements. We are therefore able to use the concept of time referring the past to the present and making forecasts, by virtue of the flexibility, strength and availability of the realities that were perceived beforehand. In actual fact, an event is remembered through reconnection and re-integration, i.e. the reconstruction as a whole of the accessory circumstances. The stimuli to re-integration are recollections, memories of experiences that took place in a certain time in the past. In the second type of memory process, it can be seen that many signs of previous experiences do not have the property of reconstructing the past. In the case of a driver, the first type of memory process is activated when, during driving, the elements of the road, even if being travelled for the first time, and the boundary conditions, refer to experiences acquired. The second type is revealed in the operations that are performed automatically, like opening the door to get into the car. The problem lies in

the fact that the two processes must not be confused. Indeed, if driving behaviour takes place without paying the necessary attention, the second memory process will take over and clearly, this is not compatible with safe circulation conditions. The driver must, therefore, be psychologically mature in order to deal with situations according to the first memory process in all circumstances.

The formation of memories, referring to the memory processes mentioned, is not random and confused, rather it originates from the degree of information encoding. The memories that are best structured and catalogued are those that are most difficult to forget, although interferences may occur. In other words, the events learnt first can interfere with those acquired by the memory later and vice versa. On account of this set of phenomena, the characteristic of driver's psychological maturity is important and should be suitably assessed. Oblivion is also a form of interference. It can occur for various reasons: spontaneous deterioration following the disuse of certain information, the interference of certain data on those already possessed and the unconscious removal of certain information. In the first case of deterioration due to disuse, a reliable driver must be able to forget as late as possible. In the case of data interference, the driver's psychology must be rational and efficacious in order to eliminate or at least reduce this inconvenience. Lastly, the case of unconscious removal takes place when the mind no longer has its original capacity, which happens frequently with ageing.

To conclude, mnemonic activity is the ability to assume behaviour that is consistent with the experiences and learning of the past in order to activate the process through which past learning leaves traces in the mind that can be translated into behavioural changes. There is therefore a close interdependence between memory, learning and communication. Without mnemonic activity, there can be no learning and without learning we have no knowledge and we cannot communicate with others. This is what involves the driver when he is on the road and in the presence of traffic in which each vehicle is driven by drivers with different characteristics [8].

In order to explore the memory process, we can consider that, essentially, there are three types of memory: immediate, short-term and long-term. Immediate memory is a sensorial memory that lasts for just a short time. It refers to an echoic process for hearing, an iconic process for images and a photographic process that makes it possible to remember objects and images with precision. Immediate memory is therefore that which allows the driver to perceive the road and its characteristics and to store all this information unconsciously. Short-term memory has the peculiarity of allowing the storage for a limited time of what is perceived and chosen by the immediate memory and of representing in a code a piece of information that in prevalence reflects the physical characteristics of a stimulation. Through revision it can become long-term memory. Long-term memory can even last a lifetime. It is a mnemonic system that makes it possible to store and recover information for an indeterminate time through various processes. The undeniably most important and decisive phase for the driver is that of information recovery, a recovery that must take place through a rigorous encoding and orderly storing of what is perceived and that must last over time.

## **6. Behaviour**

Having analysed the elementary mechanisms of perception, learning and memory we will now consider the emotive and motivational processes that involve and determine the driver's behavior [13].

Human behaviour is always accompanied by a form of emotion. This presents through an intense emotive state that undergoes psychophysiological changes. Emotions have been defined in various ways as a consequence of the complexity that distinguishes them. Indeed, they simultaneously involve the psychophysiological, cognitive, environmental and cultural functions. The former are based on the interaction between the autonomous nervous system and the central nervous system. The central nervous system has the function of controlling and acquiring the data originating from the peripheral parts of the body. Emotive behaviour involves the whole brain, but particularly the right hemisphere, i.e. the part dedicated to the fantasy, imagination and creativity. The cognitive functions develop emotions through the processes of interpretation, evaluation and conceptualisation. The

environmental and cultural aspects of emotion make it possible to evaluate the influence of social belonging on one's emotive experiences.

Research on motivation has shown that within the individual, there is a close relationship between emotivity and physiological structure. Motivation is indeed constituted by cognitive, affective, social and physiological factors that, in an interaction process, condition behaviour. Therefore motivation can be defined a process that, by producing in the individual the psychic energy needed in relation to the environment, it allows behaviour to acquire results that are observable and variable. However, psychic energy and the action are not always activated by motivation. Repetitive and reflected actions are not motivated. In any case, psychological research on motivation must have a two-fold interest: predicting behaviour and, by directing it towards tangible objectives, modifying it.

The theory that offers the greatest guarantee concerning the interpretation of emotions is behavioural theory. Having assumed the need-impulse element as its starting point, it then demonstrated that motivation is the result of learning. The way we behave is constituted by different behavioural systems, each of which is a set of habits that is based on inborn and/or acquired factors. Some systems have a physiological phase and are determined by inborn factors. Others originate from motivations that are commonly acquired during life. Aggressiveness that, unfortunately, is a characteristic that frequently presents in drivers, and is one of the inborn factors. The individual unloads each form of aggressiveness through concealed and indirect manifestations such as when he swears, insults or make ironic comments. Aggressiveness is usually a response that frees from frustration.

The driver should be psychologically investigated in order to establish, first and foremost, his whole emotional character to establish whether the processes by which he interprets and evaluates reality are correct. Then we must encode the relationship between emotion and behaviour. In this relationship, the individual-driver must demonstrate what the impulses that drive him are, by investigating the elements that have been assimilated and that continue to act on his subconscious. This analysis will make it possible to obtain a response also on the propensity to the aggressiveness that originates in the driver often in an uncontrolled and characteristic manner only during the driving phase, which we can term "road rage".

## **7. Social behaviour**

The individual and the society he lives in undergo continuous inter-relationships [8]. He is, in his life, the inspirer and protagonist of relationships with his similars; he summarises the past as social experience, the presence as current activity and the future as collective conscience formation. The individual therefore finds himself in contradictory situations in which he is free to make decisions but is conditioned by social forms. Therefore, seeking a way to fully realise his freedom, he is always on the alert to overcome any form of limitation, so that his behaviour, in this relationship process, becomes radical. The consequence is the establishment of a situation in which actions alternate with reactions and positions are entwined with counter-positions. As a consequence, the personality of each individual becomes extrinsic in society, which therefore becomes the synthesis of the individual actions. The individual however, does not lose himself in society but remains an active element always and in any case. Society is therefore the result of each individual action, but not the arithmetical sum of these actions.

In this situation the individual fashions and expresses his personality. Personality manifests through the attitudes that are the way to notify the various aspects of each element that presents in everyday reality. Therefore attitudes depend not merely on direct experience but also on the social context. Although the individual is often consistent with his actions, he frequently also adopts irrational attitudes. Attitudes are generally speaking conditioned by various components. One component is the fruit of beliefs, convictions and assumptions that induce the individual, through judgements and estimates, to catalogue people, things and situations. A second component has an affective characteristic and draws its origin from the set of sentiments and emotions that constitute the acquired and inborn baggage of each individual. There is a strong interrelationship between these

two components. Indeed, the first component fixes the objectives that the individual sets to be reached and the ways in which to do so. The second is related to the motivational and dynamic parts of attitudes and is connected to the relationship with people, objects and situations that each individual perceives in certain circumstances. Lastly, another component is constituted by the psychological characteristic of the individual conditioned also by the environment that, as we have seen, can lead to the assumption of behavioural irrationality.

It therefore follows that the driver, whilst driving, does not manifest wholly simply his personality, but also expresses a series of social conditionings. These conditionings can be positive or negative. Indeed, we need to explore whether the driver is able to control his attitude in the sense that he adopts positive and consistent attitudes alone or whether he can be subject to irrational behaviours that are certainly to the detriment of circulation safety. Ultimately, we need to ascertain in what way the driver behaves when faced with abnormal situations defined and carried out by the social environment. Social or group psychology explores these behaviours and decides on the driver's ability.

## **8. Investigation methodology**

Given the above considerations, it appears obvious that to approve an individual as being fit to drive in conditions of circulation safety, it is not sufficient to consider merely the theoretical and experimental content currently required to obtain a driver's licence. We also need to perform a behavioural or attitudinal evaluation, using psychological methods [5, 6]. In this case, psychology can use two main techniques: interview and questionnaire. The interview consists in a meeting and a talk between the psychologist and the applicant driver. The interview must be structured, i.e. it must consist in a series of pre-prepared questions focussing on his eligibility to drive. The questionnaire consists in the completion of a grid characterised by a methodological sequence. Both techniques can have certain common characteristics. The questions must be comprehensible, i.e. they must use known terms and be formulated using simple, linear sentences, they must be clear and univocal, i.e. vague and ambiguous expressions should be avoided and no debates should be developed, they must be formulated in a concise manner so that understanding is immediate, they must be concrete to avoid issues referring to reality and, last but not least, they must be pertinent.

The professional figure who must be involved in this research is the psychologist, who is currently usually involved under a clinical-medical profile in therapeutic operations [10]. In the case of a potential driver, we need to thoroughly investigate his personality to understand its various aspects. The first is that of perception; we must investigate the process by which the brain, obtaining information through the senses, processes it to grasp the reality that must be true and not manipulated and artificial. Then we need to investigate the learning process that conditions behaviour; through this process the individual makes the experiences his and, with his intelligence and sensitivity, he adapts his behaviour to the environmental situations, highlighting and intellectual and/or psychophysical limitations. Lastly, we need to explore the memory mechanisms, i.e. the complex processes that are not merely activities during which information is seen, encoded and stored, but also have the ability to use things acquired previously. With these investigations, we can identify the individual's personality and therefore his behaviour considering his actions and/or reactions in emotive and motivational processes. In this context we must consider that there is a social behaviour issue in that the future driver will operate in a context in which he is not alone, but will be conditioned by the presence of other players who will be plasmers first and direct interlocutors later [12].

## **9. Conclusions**

In recent years, psychology has made great progress and it continues to find increasingly broad applications. Unfortunately, these applications are primarily connected to knowing and evaluating the behaviour of an

individual aimed at resolving contingent situations of a personal or relational nature. Until now, road psychology, i.e. the psychology of the driver in traffic, has not been extensively explored or adequately applied.

However, it goes without say that, in the road field, a psychological relationship exists between the driver and the infrastructure. This relationship is complex and integrated. It is complex as it depends on all those factors referring simultaneously to the driver and the infrastructure surrounded by the environment. It is integrated because the various factors influence and interact with one another [8].

In previous publications we studied the influence, on circulation safety, of traffic, the vehicle, road infrastructures, the environment and the driver's psychology [8]. As a consequence we have challenged the method usually adopted when planning roads by proposing polynomial lines to be used in designing the axis. Considerations have been made on the importance of the boundary conditions in relation to driving conduct [5, 6].

The aim of this paper was to investigate the issues upstream, i.e. the driver's aptitude when interpreting the driving operation to guarantee circulation safety. These considerations show that the driver's psychology must be verified a priori in order to study his aptitude to safe driving. In these circumstances it is clearly necessary to intervene in the road field through a new professional figure: the psychologist. This professional would not merely approve individuals as roadworthy but, consequently, also offer planning advice. Therefore, in the complex issue of road infrastructure planning and management, we need to change the approach used to date by including a psychologist in the set of engineers, town planners and economists.

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