TØI report 666/2003
Author(s): Truls Vaa
Oslo 2004, 74 pages Norwegian language

Summary:

Survival or deviance? A model for driver behaviour

In 1998 a Strategic Institute Program (SIP) on Driver Behaviour Models was established at the Institute of Transport Economics. The program was financed by the Norwegian Research Council and the Norwegian Public Roads Administration.

The present report is the final report from the SIP. The report presents a generic model for driver behaviour. The model attempts to integrate different aspects that influence traffic behaviour and is built on the assumption that man's deepest motive is survival, which presupposes that the organism manages to detect and handle dangers in its environments. In the model surveillance and responses takes place via a (risk) monitor which processes information and makes decisions, which in turn are influenced by personality traits, motives and interaction patterns. Emotions and feelings play a key role in the monitor's handling of dangers. The model involves the interaction with the surroundings and provides an understanding of how the organism's ability to detect dangers is disturbed by inherent and external conditions. The report also discuss examples of model applications as a possible basis for developing road safety measures.

Even if there is a considerable amount of driver behaviour models in the field of traffic safety research that have had an aim of explaining and predicting driver behaviour, an integration of different aspects under one common, overall frame of understanding has not been accomplished. The relatively considerable number of models displays first of all a lack of consensus, especially regarding theories on driver speed choice. Speeding and violation of speed limits is probably the most important risk factor in road traffic because of the high prevalence of speed violations.

A new aspect in the development of the monitor is its theoretical foundation on neurobiology, where concepts as emotions, feelings and the relationship and interplay between unconscious and conscious process are central. The act, and the consequences of the act, are best understood and explained by learning theory, i.e. *operant conditioning*.

It follows axiomatically from the assumption that man's deepest motive is survival, that the organism must have an instrument, an organ, enabling it to survey its surroundings and the situations in which it appears. This organ is the organism itself, the complete body and its inherent physiology developed by evolution through the history of man where observation and identification of dangers have been of vital importance. The organism taken as a whole is considered as a monitor, an organ for surveillance whose prime task is to monitor

The report can be ordered from:
Institute of Transport Economics, PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone: +47 22 57 38 00 Telefax: +47 22 57 02 90

the interior, i.e. the state of the body, and the exterior, i.e. the surroundings and other actors which the organism must relate to. It is remarkable that man's inherent ability to handle risks is as effective and safe as it is in road traffic, while, on the other hand, this ability fails to recognize some risks which, objectively speaking, really are dangerous. The present ***survival model,*** and the inferiority of the monitor to recognize certain dangers is, hence, also aspects that need discussion.

Antonio R. Damasio and the neurobiological perspective he elaborates in his book, *"Descartes' Error: Emotion, Reason and the Human Brain"* (1994), gives in our view a more basic understanding of man than alternative models and theories do. The basis for what we will name as the Damasio model is three simple axioms:

Axiom 1: Man's deepest and most fundamental motive is ***survival.***

Axiom 2: Man must possess a specialized ability to detect and avoid dangers that threatens his survival. Hence, man must possess an organ that takes care of the necessary monitoring of potential threats.

Axiom 3: Evolution has developed and designed the human organism to be this monitor which prime objective is detection of dangers and securing survival. ***The body is the monitor***.

The body, the human organism, is on occasions exposed to strain and emotional stress, which Damasio defines in this way:

> *"…. a set of alterations [which] defines a profile of departures from a range of average states corresponding to a functional balance, or homeostasis, within which the organism's economy probably operates at its best, with lesser expenditure and simpler and faster adjustments " (Damasio 1994).*

This functional balance will also be defined as the ***target feeling***, or ***the best feeling***. These concepts can well be applied within learning theory where the best feeling corresponds to S^R – *reinforcing stimulus* – in operant conditioning. Nevertheless it is the ***functional balance*** which is retained as one of the two central principles in the model. The drive to achieve functional balance is regarded as a central, unconscious knowledge, which the organism possesses about itself, and which the organism is actively seeking to restore or to maintain. Further, it is our assertion that this unconscious quest for functional balance becomes the steering principle in our model, and this also may constitute the basis for a deeper understanding of risk compensation.

The second central concept is ***account of feelings***. This is used to describe a conscious process and is defined as a cognitive 'weighting' of conscious, internal scenarios against each other. The scenarios can for example be different alternatives in a concrete choice situation which the individual faces and which requires consideration and action. A choice implies alternatives with different expectations about future events that potentially can be realized. Every scenario is coloured by a specific feeling that also may be realized if this alternative is chosen, i.e. every scenario represents a potential amount of feeling capital. In that way the scenarios can be evaluated by this feeling dimension, scenarios can be contrasted by an internal 'cost-benefit analysis'. On such a basis, a decision can

be made that realizes the best feeling in the given situation. Further, it is this feeling dimension that on the whole enables the organism to evaluate, to do the cost-benefit analysis, to make a choice. In short: No feeling, no evaluation, no choice.

Damasio discusses rationality in decision-making processes by contrasting (ideal) reasoning and proper evaluation of alternatives with what he states as the Somatic-Marker Hypothesis. In an apt and short way, he says, with reference to Plato, Descartes and Kant, that

> *"…. formal, logic will, by itself, get us the best available solution of any problem. An important aspect of the rationalist conception is that to obtain the best result, emotions must be kept out. Rational processing must be unencumbered by passion"*

The common-sense version of rational processing and decision-making is that individuals consider and evaluate each of the alternatives that are present and by means of cost-benefit analysis of each of them. To maximise the subjective utility positive and negative outcomes of each of the alternatives are considered. Rational decision-making can, however, be mentally demanding and time-consuming if one is to consider the subjective utility and costs of every alternative that can be imagined. If every aspect and labyrinths of the mind are to be examined one would in the end get lost and loose the overview. Damasio says, quite frankly, that such a strategy will not function, the span of consciousness, i.e. the working memory, just is not wide enough to maintain an overview. The initial assessments will have disappeared when new enters the internal scene.

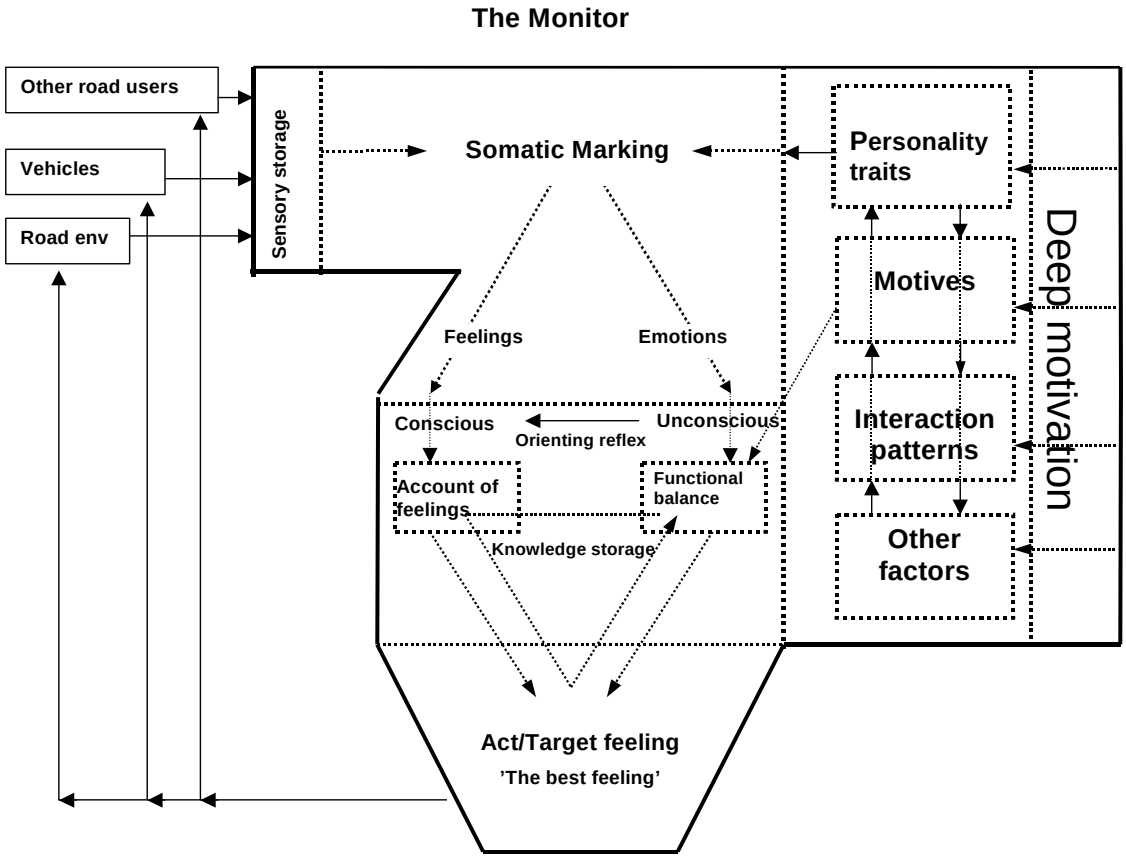
On this background, Damasio states his alternative by saying that something important happens before reasoning, before the application of a cost-benefit analysis of the inner scenarios. If, for example, a situation seems to develop into something threatening or dangerous, a feeling of unpleasantness will enter the body, an unpleasant 'gut feeling' may be under way. Because this feeling is knit to the body, Damasio labels it ***somatic*** ('soma' is Greek for 'body') and ***marker*** because the feeling marks the picture or the scenario. Damasio describes the consequence of this ***somatic-marker*** in the following way:

> *[A somatic marker.].."forces attention on the negative outcome to which a given action may lead, and functions as an automated alarm signal which says: Beware of danger ahead if you choose the option which leads to this outcome….*
>
> *…. The automated signal protects you against future losses, without further ado, and then allows you* ***to choose from among fewer alternatives*** *(Damasio 1994, page 173).*

There will still be room for a cost-benefit analysis and for proper deductions on the basis of the analysis, but now after the emotional response has reduced the number of alternatives drastically. Thus, somatic marking will increase the precision and the efficiency of the decision-making process. Without somatic marking, less precision, less expenditure and efficiency. Emotions and feelings

are now, by learning mechanisms, associated with specific scenarios in a way that makes predictions more accurate.

The introduction of a monitor is justified by the Damasio model and his assertion that emotions and feelings are fundamental mechanisms which are involved in the organism's perception and evaluation of dangers. Hence, the monitor is then both a concept and a principle, as well as a model for organising processes that influence sensing, processing of information and decision-making that will affect factors outside the organism. Figure S.1 presents the basic structure of the monitor.



Source: TØI report 666/2003

Figure S.1: The Monitor: Basic structure

The monitor is nothing less than the whole of the body, the whole organism. The boundaries of the monitor (solid line) corresponds to the boundary of the body. The internal components are all elements and processes enclosed by the solid line: Somatic marking, information processing, personality traits, motives, interaction patterns and other factors and deep motivation as base and potentially influencing other components through personality traits, motives, and interaction. Personality traits influence motives and dispose for interaction patterns that are idiosyncratic for each driver. The interaction pattern of the individual driver can in turn elicit

new, latent motives as a consequence of other road users' responses on the initial act(s) of the driver.

One superior motive is to establish or maintain (unconsciously) the functional balance of the organism. During automated behaviour, there is identity between target feeling and functional balance. Hence, there is a direct impact from motives to functional balance and to target feeling. The target feeling can also be a product of a concrete account of feelings (consciously). The motive will then influence the target feeling indirectly through the account of feelings in direction of the best feeling that can be achieved in a given situation. The functional balance, and the consciously quested best feeling, should normally be regarded as the top motives in a hierarchy of subordinate motives. In addition, personality traits, motives, interaction patterns and other factors will interact with stimuli selected from sensory storage, somatic marking takes place, before a distribution along the unconscious or conscious route and subsequent information processing and decision-making.

External components are grouped in the categories other road users, vehicles and road environment. All three categories are separated from the monitor. The report also presents the monitor on a more detailed level and conscious and unconscious routes are treated separately before merging to a complete, detailed monitor structure.

The present driver behaviour model integrates recent research regarding personality traits and how these may influence driver behaviour. This is a new dimension compared to previous models. Personality traits kan be defined as dimensions of individual differences in the tendency to display consistent patterns in ways of thinking, feeling, and in behaviour. A central goal regarding research on personality traits has been to identify basic building blocks which constitutes personality. Today, it seems to be a consensus in the perception of personality as composed of five main components known as the "Big Five": *Extraversion, Neuroticism, Conscientiousness, Agreeableness* og *Openness*. Each of these main components are represented by six more specific components – *facets* – or *lower-order personality traits.* Empirical studies give clear indications that these traits are relatively stable over time and also across different cultures and countries.

One basic hypothesis in the present model is that personality traits express deeper motivation that influence motives and, in turn, driver behaviour.

The integration of personality traits in the present driver behaviour model is based on Ulleberg's doctoral thesis (2002). Ulleberg found, by application of hierarchic cluster-analysis on young drivers, aged 18-22, that a six-cluster solution seemed to be the most valid and the most interpretable. The six-cluster solution could also be recreated after a randomized, split-half procedure. Ullebergs clusters, which are briefly described, is included in ***the expanded monitor model***. It is argued that one can deduce: 1) Superior motives, and 2) Interaction patterns of an individual, from personality traits that are predominant in individual drivers.

The present driver behaviour model also includes 'other factors' which encompasses factors that contribute to increased accident risk, i.e. age (young and elderly drivers), use of intoxicants, diseases and other medicinal and psychological conditions that influence accident risk, interaction conflicts regarding differences in driving styles and driving cultures, and suicides by car collisions. The monitor also exhibit certain limitations and inferiorities that are categorized as 'other factors'.

According to the most recent estimations of accident risks in Norway (2003), the risk of a personal injury accident among drivers is 0,18 person injury accidents per mill km. I.e. one driver must drive 5.5 mill km before s/he, on the average, would be injured in an accident. If we suppose that a driver drives in 65 years, i.e. from 18 – 83 yoa. With an average of 14.000 km per year, one driver will drive a total of approx 910.000 km. Hence, it takes 5,5 : 0,910 ≈ a group of 6 drivers of which one will experience one injury accident during a lifelong carrier as a car driver.

Hence, what is normal in one, individual driver's life, is ***not*** to experience a personal injury accident. Taking the perspective of an individual, road accidents must be characterized as very infrequent events. Thus, it may be argued that man has a high competence regarding the avoidance of road traffic accidents. Individually speaking, the risk monitor is quite successful.

Complementary speaking, the survival model also is a model of deviance: Drivers are under influence of motives competing with the survival motive, driver are under influence of intoxicant stimulants as alcohol, drugs and narcotics, there is a certain prevalence of conflict-seeking and aggressive driver behaviour considered to raise accident risk, certain diseases and medical conditions increase accident risk, young and elderly drivers have higher accident risks than the average driver.

The monitor is not an infallible machine, it has weaknesses regarding monitoring of dangers, even if some of its functions can be modified and improved by driver training and driving experience. Underestimation of the dangers of speeding in curves is a habit that is quite rapidly improved by training while drivers seem quite poor in the ability to identify speed changes in the vehicle which a driver follows, a situation that is supposed to be a more stable weakness and less modifiable property of the monitor. Drivers accept distractions and their ability to stay awake while driving is overestimated, again examples of monitoring weaknesses that may call for ITS-solutions as Intelligent Speed Adaptation, electronic monitoring of falling asleep, etc.

Road traffic accidents no doubt exhibit one of the most serious society problems of the day, but, as mentioned, in the perspective of the individual driver it should be regarded as the normal state of affairs to experience a lifelong drive on the roads without a single accident. The individual drivers' ability to detect and handle dangers in traffic, is, after all, remarkably good. With this observation as base, one should probably put more focus on what is previously denoted as deviances. High relative risks because of speeding also belongs to the deviance perspective. It is supposed that speeding would possess the largest potential for effective accident reduction.