

# Role and limit of safety education, and necessity of safety support systems by a car and ITS: Successful control of risky driving and over dependence on the safety support systems

**Shunji Taniguchi**

School of Culture-Information Studies, Sugiyama Jogakuen University  
 17-3, Hoshigaoka-Motomachi, Chikusa  
 464-8662 Nagoya, Japan  
 Phone: +81 52 781 6348  
 Fax: +81 52 781 6651  
 E-mail: tanshn@sugiyama-u.ac.jp

## INTRODUCTION

### Determinants of traffic accidents

The psychological mechanisms of traffic accidents can be understood by the well known basic scheme of Lewin,  $B = f(P, E)$  (B: Behaviour, f: function, P: Person, E: Environment). The equation means that human behaviour is basically decided by two factors: one is the environment around the person behaving, and the other is internal to the person. An accident happens as a result of an interaction between these two factors.

Safe driving means avoiding collision with all kinds of objects – other cars, pedestrians, and cyclists – and maintaining an adequate position on the road. Causes of traffic accidents are, firstly, driver error, and secondly, driver's delay in information processing. They can happen in the information processing stages of perception, judgment and operation. (Figure 1)

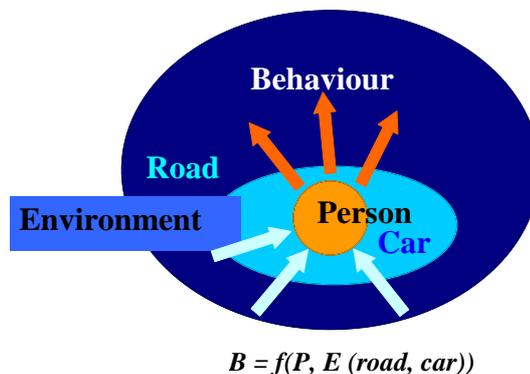


Figure 1: Illustration of general structure of the mechanism of driving behaviour based on Lewin's scheme.

Note: B: Behaviour, f: function, P: Person, E: Environment. The environment consists of two dimensions: road and car. The white arrows reveal stimulus flow from the road environment to a person through a car. Orange arrows reveal responses to the environment while driving a car on a road.

## Human factors

The relationship between individual traits (personality) and traffic accidents has been widely studied. As many surveys show, the difference between accident and non-accident groups is not large, although it shows statistically significant difference. These traits must not be understood as suggesting that 'those people who have the traits' cause accidents, but that 'these psychological conditions' could cause accidents. Therefore, even if a driver has a propensity for accidents, he will not necessarily cause an accident unless the trait occupies him at the critical moment; on the other hand, a driver who doesn't have the trait could cause an accident if his psychological condition is under control of the trait.

Errors in information processing are likely to be caused by speeding, distraction, unstable and rapid driving, and these types of driving are produced by psychological situations of anger, anti-sociality, anxiety, etc. These psychological situations can be considered to be induced by related individual traits as discussed above. Sex and age differences with regard to traffic behaviour or traffic accidents are also known to exist. They are presumed to originate from instinctive mechanisms at the biological level (Figure 2). Regarding the traits of aggression and cooperation, females are less aggressive and more cooperative than males in general. This is also consistent with traffic behaviour. Women's driving is characteristically slow, moderate and gentle, in contrast to men's quick, vigorous and aggressive style. Concerning age, younger drivers' behaviour is similar to that of the male and the elderly to that of the female. It is not yet easy to refer to the actual accident rate but it is at least known that the typology of accidents of male and female drivers is different. Accidents due to speeding and drinking are observed more in males and accidents which result from defective perception and operating skills are observed more in females.

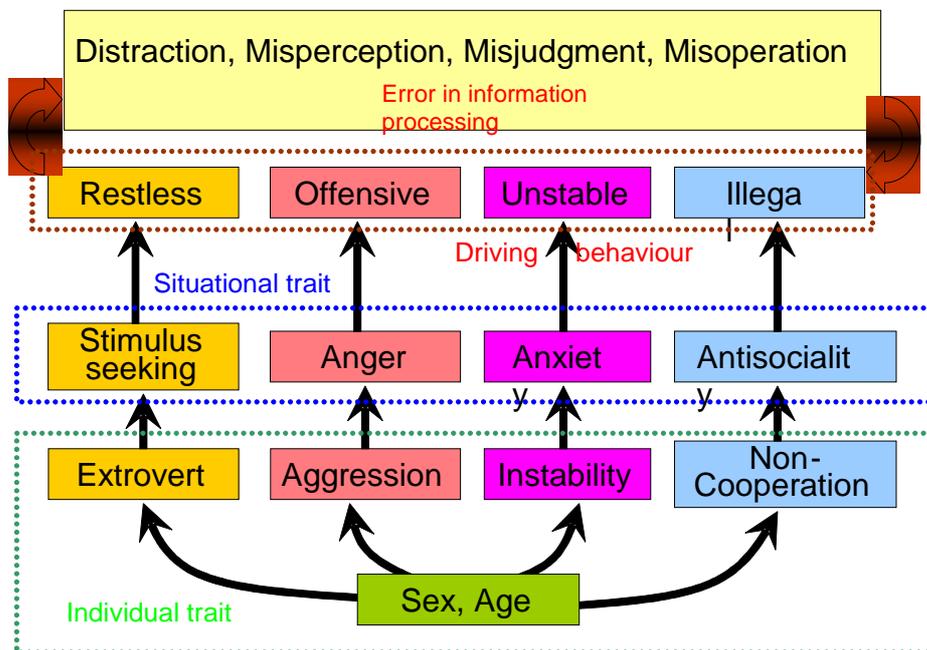


Figure 2 Individual traits, situational traits, and driving behaviours which cause errors in information processing.

Some kinds of diseases, such as dementia, should also be considered. They produce serious problems in each of the information processing stages and they cause accidents with high probability (Figure 3). With regard to dementia in particular, 2.5% of aged drivers in Japan suffer from it (based on 4000 subjects aged 65+, 2006). Sometimes they not only cannot recognize traffic signals or signs, but also cannot understand where they are or where they are going. It is anticipated that by 2030 there will be more than three million persons over

65 years old with dementia. Therefore the police recently decided to introduce a new legal system whereby all aged drivers have to be tested with regard to their cognitive functions before their licenses are renewed.

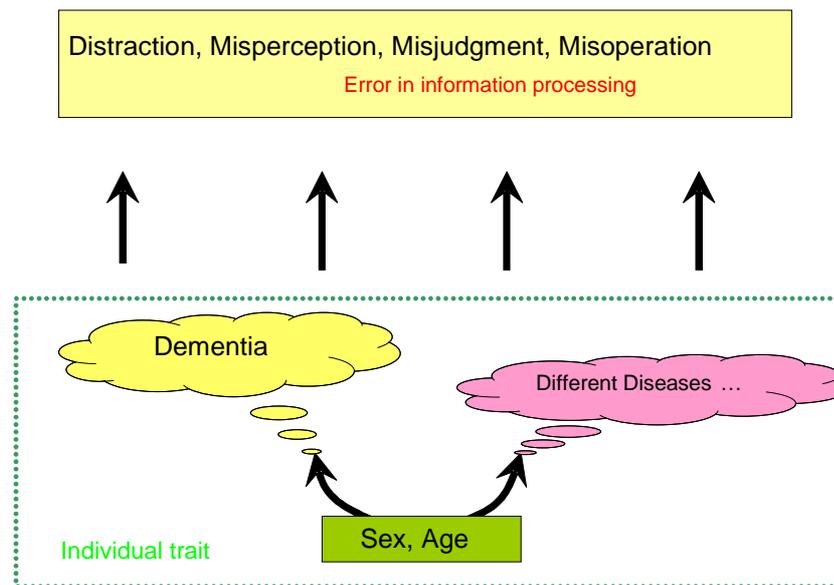


Figure 3 Dementia or different diseases directly cause errors in information processing.

Another factor determines whether an actual accident occurs or not. An accident occurs when actual hazard conditions are present as two cars come into physical proximity and a driver cannot notice it or evade the collision by adequate driving. A driver doesn't experience such critical situations frequently, as the probability of hazardous conditions is far lower than that of non-hazardous conditions. However, the number of hazards actually experienced increases directly with increased time and distance of driving. Concerning driver factors, the level of skill at risk perception and operation of the steering wheel or accelerator decides the result: safe driving or an accident. Propensities towards accidents deriving from personality may exist at a fundamental level to determine general behavioural trends; however they have only a weak correlation with traffic or driving behaviour.

## ROLE AND LIMITS OF SAFETY EDUCATION

Safe driving tends to reduce over time, as there is a basic tendency of drivers to reduce energy which should be used to maintain safe driving or to fail to recognise the possibility of danger. On the other hand, they want more direct benefits from driving, such as speed or excitement. Generally speaking, an innate or acquired mechanism is necessary for behaviour to occur. The behaviour can be maintained by reinforcement, such as rewards. Reinforcement is provided by accidents (negative reinforcement) or safety (positive reinforcement). The probability of safe driving is very high compared with that of an accident. And safe driving requires a reduction in speed and frequent stops. These use considerable energy and are not pleasurable. On the other hand, the opposite type of driving produces more direct pleasure and a lower cost, at least intuitively. The result of safety itself is regarded as inevitable, and thus it is hardly recognised positively as reward. You need more ability to imagine the horrific and shocking scenes of an accident. Cutting back on safe driving which requires more energy, and releasing an uncontrollable need for speed, that is to say lazy driving, gives a direct feeling of pleasure which works as reinforcement of behaviour. It still, however, doesn't connect to accidents in the majority of cases, but safety.

An accident never happens unless all the conditions are satisfied. It is very rare that an actual accident happens. This is the reason why safe driving is apt to be reduced, and a shift to dangerous driving occurs. Thus education is needed to maintain safe driving behaviour or to reinforce it.

How can education in its broadest sense be conducted? Each section of road has a maximum speed which is authorized by traffic law. The limit works for many drivers who have basic attitude of obeying social rules so as to suppress speeding, although some drivers ignore the limit. Speed cameras and traps work as reinforcement for drivers to comply with the rule, with fines as punishment. Education for drivers to encourage autonomous control of driving with adequate, safe speed should be a basic measure to prevent speeding. Some themes of lectures would be explanation of the mechanism of speeding and accidents, and the demerits of speeding in terms of its cost both ethically (suffering inflicted) or financially (the enormous reparation the drivers responsible owe). Such lectures could contribute to basic, general and spontaneous attitudes to controlling speeding in many drivers.

Drivers' safety education is effective for the majority of people in order to improve their skills of risk prediction, operational techniques and law-abiding attitude. They are also effective in general situations of people not so inclined towards risk. On the other hand, a small number of people seem to have an innate disorder of the important abilities necessary for safe driving (Figure 4). They cause accidents frequently and it is very difficult to modify their risky behaviour to a safer one. For these drivers, and even for those safer drivers in rare situations, education could be less effective when risky drives (motives) become dominant over safe drives. Some of them could originate in instinctive mechanisms and they work strongly based on innate programs to control behaviour such as FAP.

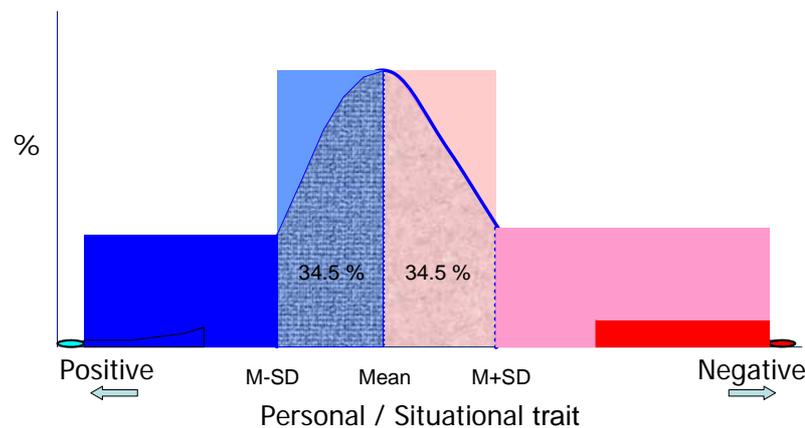


Figure 4 Extremely negative/positive individual/situational traits are rare.

## Motive, incentive and availability

The psychological mechanism which decides speeding behaviour merits discussion. This should improve understanding of the necessity and effectiveness of the physical control of speed. The mechanism consists of three parts: motive, incentive, and availability of incentive (Taniguchi, 1999; Figure 5).

Motive means the level of speed which a person chooses to drive at. The level of speed is changed by the purpose for driving, driver's education, and driver's individual traits. Some traits are biologically based. Typical examples are sex and age which may be related to an instinctive mechanism. This means the motive for speeding could be as strong as the drives of appetite and sleep, so that it strongly controls human behaviour.

Incentive is the speed performance of a car which can satisfy a person's motive. Availability is a physical condition in which the motive can be connected with the incentive. Therefore availability decides finally the possibility of actual speeding behaviour which the motive wants to realize.

It is rather difficult to control a person's motive. Motive is unstable and always fluctuating. There could occasionally be an abrupt explosion of a strong conscious or unconscious need for high speed. On the other hand, incentive can be easily controlled. With regards to speed behaviour, both incentive and availability should be focused on for the purpose of controlling speed behaviour. At this point, prevention of dangerous speed performance by a car can be regarded as relating both to the incentive itself and its availability. However, there may be slight differences between them. The fact that a car has high-speed performance is recognised by the driver even while the opportunity to employ that performance is temporarily limited. His speeding behaviour is controlled by the limitation of availability of incentive. The driver may be satisfied by the possibility of driving much faster in other conditions. In that sense, the concept of availability should be useful as a function different from incentive.

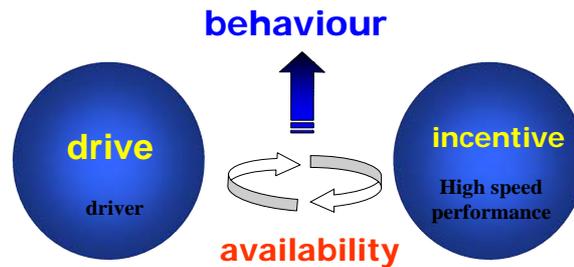


Figure 5 Drive for speeding in a driver, incentive as high speed performance in a car, and availability produces behaviour. The most effective way to control behaviour of high speed driving is to deprive or to limit the availability of high speed performance (incentive), for it is too difficult to control the drive.

## Aggressive behaviour metaphor, uncontrollable drive

The following is a discussion of aggressive behaviour as a metaphor to help in understanding the mechanism of speeding behaviour. Aggression is a kind of instinctive drive which is biologically necessary for survival. Human beings at present still preserve the drive, although in many cases they are not allowed to express it directly. Thus it must be redirected in other ways, such as the sublimation and repression which Freud identified as parts of the self-defence mechanism. In spite of the mechanism, there are still rare situations in which one is violently aggressive against someone, although it isn't a common phenomenon for most people and conditions. The uncontrollable aggressive drive corresponds to the motive for speeding, and weapons such as knives or guns to high-performance car. However, extreme aggression is of course different from the speeding motive in its abruptness, i.e., intensity and duration.

If a murderous weapon is available when a man experiences strong feelings of aggression, he will be sure to use it. The aggressive drive is also accelerated by interaction with the incentive available. Thus the availability of a weapon is one critical condition that decides whether a severe attack like murder actually occurs or not (Table 1).

With regard to measures to control a person's behaviour, there are some choices. One is to persuade a person not to take action by talking, or some educational programs about ethics or morals could be possible. However, none of these are likely to be effective at all once a similar kind of mechanism to FAP (Fixed Action Pattern), the construct of instinctive mechanism in ethology, comes into play. Another more effective and realistic course is prevention of access to weapons. Deprivation of weapons certainly makes it impossible for them to be used. The last option left after that might be the person's own fists, but that would not yield the same critical effect of killing or hurting another person seriously. There also seems to be a kind of hesitation when one wants to use a body part as a weapon, perhaps due to an aversion to what one imagines about violent physical contact. As the

metaphor above reveals, if there emerges an uncontrollably strong drive or motive, behavioural control is ineffective and the most successful measures to control it should be based on physical operation.

Table 1 Number of people killed by firearms in Japan, UK and USA.

	Japa	UK	USA
Population (thousand, 2003)	127,619	59,250	294,040
People killed by firearms	39	68	11,127
Per 10 million	3	11	378
Index (Japan base)	1	4	124

## NECESSITY OF SAFETY SUPPORT SYSTEMS

### Successful Control of Risky Driving by Engineering

As discussed above, education has its limits despite its undoubted importance, and some kinds of safety support system in a car or traffic environment in order to cope with the uncontrollable motives are necessary. They could be provided by different forms of engineering. Table 2 shows some disciplines of engineering and typical research themes which concern car traffic. It is not easy to clearly show differences between Road Engineering, Traffic Engineering, Information Systems Engineering, and Car Engineering, for they more or less relate to each other.

ISA, Intelligent Speed Adaptation, is a leading safety support system which controls the availability of speed performance of a car (Hjälmdahl, 2004; Hydén, 2002; Risser, 2002; Várhelyi, 1996). Social experiments which have been conducted in Sweden and other countries suggest that this system controls drivers speed behaviour almost completely.

The physical functions or traits of a car and a road environment have a strong effect in determining driving behaviour and are able to control risky driving successfully. Therefore effectively implementing a traffic system, which involves both environment and cars, should be considered another core element of deterrent measures against traffic accidents in parallel with the other core element of education.

Table 2 Some Research Themes of Road, Traffic, Information Systems, and Car Engineering

Road Engineering	Traffic Engineering	Information Systems Engineering
Geometric design Bridge, Tunnel Intersection Traffic sign, indication Road lighting Traffic lights Pavement Crash barrier	Traffic planning Traffic demand management Traffic lights management Traffic congestion measure Traffic safety management Traffic control	VICS: Vehicle Information and Control System ITS: Intelligent Transport System UTMS: Universal Traffic Management System
		Car Engineering
		ABS: Antilock Braking System ISA: Intelligent Speed Adaptation ASV: Advance Safety Vehicle

DSSS, the Driving Safety Support System, is an ITCS (Integrated Traffic Control Systems) project by UTMS, the Universal Traffic Management Society of Japan (UTMS, 2007). DSSS uses technologies such as infrared beacons and computers to provide real-time traffic information to drivers. The system is now being tested in Toyota City, Aichi prefecture, Japan. One of the functions of the system is to alert drivers approaching an intersection, giving information about the traffic signs or lights via an in-vehicle device. The benefits of the system are expected to increase drivers' awareness of risk or safety, and to reduce drivers' decision-making burden. The system is intended to make drivers reduce speed at intersections. Furthermore, as the next step, it could intervene in the operation of the vehicle if a driver doesn't respond to a risky situation.

## Over-Dependence

On the other hand, the effects of some types of safety support systems may be covered by a corresponding amount of risk-taking behaviour, i.e., risk compensation (Wilde, 1994). But it is not easy to show statistical evidence that reveals the phenomenon regarding different safety technologies. That kind of phenomenon may apply to specific people or limited conditions. The more important, common and serious problem could be drivers' over-dependence on the safety support systems. The system could reduce or sometimes deprive driver of general information processing resources. Safety support systems are not perfect enough to respond to every type of risky situation successfully without any problem. Reduction of drivers' own abilities at paying attention, making judgments and vehicle operation seems to be very risky when drivers face hazardous situations out of the control of safety support systems. The ideal safety support system is expected to work adequately both dealing with risky situations and maintaining drivers' safety ability (Figure 6). Some social experiments on ITCS are being executed in different areas with some car manufacturers in Japan and the field data collected is expected to be made public.

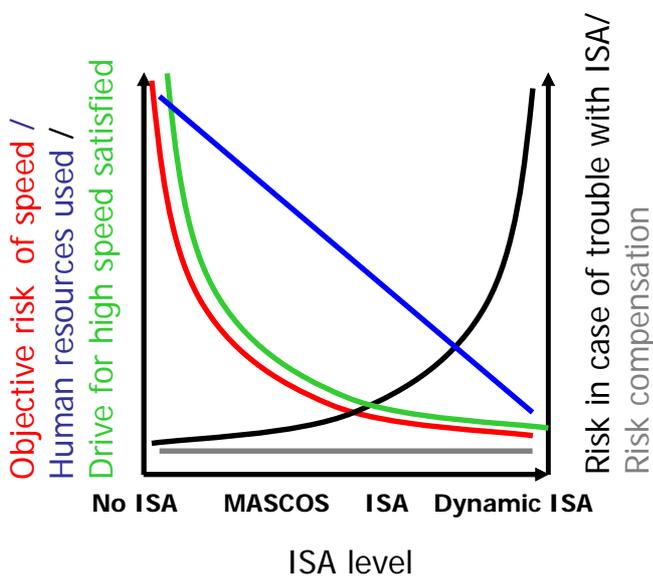


Figure 6 Relationship between ISA level and objective risk of speed, human resources used, drive for high speed satisfied, risk in case of trouble with ISA and risk compensation.

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