Risk as feelings: implications for safe driving practice

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Driving task difficulty arises out of the degree of separation between task demand and driver capability. Drivers appear to use perceived task difficulty as the reference criterion in a closed feedback loop of homeostatic control (task difficulty homeostasis) and use speed as a principal method for controlling task difficulty. Feelings of risk may provide the input to the decision mechanism from which speed choice is determined, so that the upper boundary of a driver's target task difficulty may be described as the driver's risk threshold. This concept enables a characterization of different driver types as high risk threshold, low risk threshold, opportunistic and reactive.

Elements in a road and traffic scenario that are associated with feelings of risk may be prioritized in attention (somatic marker hypothesis). The phenomenon of 'inattentional blindness' may provide a link between high risk threshold driving, inexperience and the failure to detect emergent hazards in the roadway.

Driving task difficulty and feelings of risk

It is self-evident that if the demands of the driving task exceed the available capability of the driver, then loss of control of the task occurs and possibly a collision. The separation between task demand and capability is equivalent to the driver's safety margin and is inversely related to task difficulty. These basic concepts form the core of the Task-Capability Interface model (Fuller and Santos 2002) which provides a description of the main factors which contribute to driver capability and driving task demand. Speed is an important determinant of task demand and its modification to a large extent enables the driver to control task difficulty – in effect to pace the task. This observation gives rise to an important proposition emanating from the model, namely that drivers drive in such a way as to maintain task difficulty within a preferred range, the hypothesis of task difficulty homeostasis.

That drivers do, of course, respond to external changes in task demand (such as in road alignment or visibility) by adjusting speed is well established and hardly needs stating. Campbell and Stradling (2003) report that 98% of drivers state they drive more slowly in fog, 96% in heavy rain and 88% on unfamiliar roads. Drivers also choose to drive more slowly on a narrow version than a wider version of the same road (Uzzell and Muckle 2005, Lewis-Evans and Charlton 2006). Since drivers are making these adjustments, they must be with reference to some internalized goal state and hence the proposition that this state is that of a target level (or range) of perceived task difficulty.

If drivers use perceived task difficulty as the reference criterion in a closed feedback loop of homeostatic control, we may reasonably ask how drivers sense this. Our current line of enquiry stems from a series of experiments in which we asked drivers to rate digital videos of road segments filmed from the driver's viewpoint and traveled at different speeds. Ratings were of task difficulty, estimates of the statistical probability of loss of control and feelings of risk. We

discovered that over speeds ranging systematically from 20 to 100 mph in 5 mph steps, ratings of task difficulty correlated very highly with ratings of feelings of risk ($r = 0.97$). However over the range of lower speeds, ratings of statistical risk remained at zero and only began to rise when drivers experienced a speed at which they felt uncomfortable. Thus feelings of risk are not the same as ratings of statistical risk of loss-of-control.

The main point, however, is that the finding of a very strong association between task difficulty and feelings of risk led to the idea that feelings of risk may provide the input to the decision mechanism from which speed choice is determined (Fuller 2005), an idea proposed many years ago by Taylor (1964), on the basis of psychophysiological measures of arousal in different road segments.

The role of feelings in decision-making has been extensively reviewed and supported with a wide range of findings by Damasio (1994, 2003) and others. Damasio concludes that emotions provide a natural means for the brain to evaluate the environment and respond adaptively. Through learning, emotions become linked to stimuli and patterns of stimuli. When these arise they trigger emotional reactions that may mediate rapid adaptive responses without passing through some form of cognitive evaluation, enhancing the speed (and perhaps quality) of decision making. Because emotional signals are body-related, Damasio labeled this idea as the 'somatic marker hypothesis'. When an emotionally negative somatic marker is linked to an image or developing scenario, it automatically triggers an internal alarm. Thus the potential role of somatic markers in driver decision-making is in eliciting emotional responses to elements of the unfolding scene ahead of the driver.

One outcome from this new evidence for the role of feeling in decision-making was that it allowed us to characterize the upper boundary of the driver's target task difficulty as the driver's *risk threshold*, which may be defined as the point above which risk is felt to be too great. This turns out to be a useful concept in distinguishing between driver 'types', a notion for which there is converging evidence to which this discussion will first turn.

The second outcome is the proposal by Damasio that elements in a scenario for which there are strong somatic markers will be automatically prioritized in attention, a process in which attention is automatically directed to potential aversive stimuli in that scene (such as a rapidly looming fixed object in the direct path of the vehicle). This hypothesis has been investigated in our laboratory in a preliminary experiment which will be described later.

Different types of driver

In a preliminary review of factors influencing speed choice, Fuller et al. (2006) concluded that evidence in the past decade was suggestive of four driver types identified as *high risk threshold*, *low risk threshold*, *opportunistic* and *reactive*.

Compared with other drivers, high risk threshold drivers are more likely to be involved in a collision and presumably for this reason there has been far more work published in relation to this type of driver. They are mainly, but not exclusively, young, male and inexperienced drivers. Their behaviour is associated with particular attitudes, which may be supported by a particular

life-style and culture of driving, including the use of a car simply for pleasure and self-expression as opposed to transport. They may be poorly 'calibrated' in the sense that there are important discrepancies between their perceived and actual levels of capability and driving task demand. Some of this group, especially those who are low in self-control, harm avoidance and traditionalism, who are disposed to more aggressive behaviour and sensation-seeking, will persist as they get older in driving fast just for the thrill of it and exceed speed limits by significant amounts.

A low risk threshold driver type emerged very clearly in a study by Musselwhite (2006) who carried out a questionnaire survey of 1,686 drivers approached at motorway service stations and local garages in the south of England during summer months. The questionnaire concerned the frequency with which participants engaged in various driving behaviours in 30 mph zones, previously identified through 47 semi-structured interviews. Nearly 40% of Musselwhite's sample made up the low risk threshold group who were characterized by a relatively low frequency of unsafe behaviours. For example, these drivers were the most likely to reduce their speed if they realized they were traveling faster than they thought they were in a 30 mph zone and were least likely to change their driving behaviour, even if there was a motive to raise their risk threshold, such as when in a hurry. This group had no real sex bias (47% male) but was the oldest of four different groups of drivers identified, with mean age of 41.9 years.

Opportunistic drivers consider it to be more important to adjust their speed to that of faster others or to the physical road environment than to comply with the speed limit. They are quite likely to use a different lane from other traffic going in the same direction to avoid being held up and to go faster than the 30 mph limit if it feels safe. These drivers seem to be impatient and particularly sensitive to opportunities to make more effective progress. Nevertheless, unlike high risk threshold drivers, they do not pursue high speed for its own sake. They clearly have a higher risk threshold than low risk threshold drivers, nevertheless they also appear motivated to drive up to the limit of this threshold as opportunity arises.

Reactive drivers share some characteristics with the high risk threshold group in that they readily respond to motives to drive faster, such as under time pressure or to 'escape' from a tailgating follower. Their driving behaviour also appears to be strongly influenced by emotional state: such drivers are prepared to exceed the speed limit if feeling angry or annoyed – but not if they feel this reactive driving is unsafe. Also unlike high risk threshold drivers they do not engage in dangerous overtaking; and unlike opportunistic drivers they do not appear to be so persistently concerned with making effective progress. These drivers appear have a lower risk threshold than high risk threshold drivers but seem prone to allow their feelings and other motives to push them close to it.

Confidence in this emergent typology is to an extent strengthened by the results of a study of driver behaviour in relation to the introduction of speed cameras. Corbett and Simon (1999) identified four fairly stable categories amongst urban drivers: *defiers*, who exceed speed limits, cameras or no cameras, *conformers* who always or nearly always comply with speed limits, *manipulators*, who slow down in the area of a camera site and *deterred*, who have reduced their speeds since the introduction of cameras. *Defiers* have the highest speeding and offending scores and the highest observed speeds and appear relatively unconcerned by the threat of detection by

speed cameras. They look rather like our high risk threshold group. On the other hand, *conformers* match the low risk threshold type and voluntarily comply with legal speed limits presumably because they have an internalized value of obedience to the law. They are the oldest and most experienced drivers, have the lowest offending and speeding scores and the lowest observed speeds. They are least likely to have had an accident in the previous three years and are most likely to accept the link between speed and accident risk. *Manipulators* and *deterred* exhibit compliance mainly as a response to the threat of external punishments. *Manipulators* score higher than *deterred* on offending and speeding and have higher observed speeds, looking rather like the opportunistic drivers. The link between the *deterred* group and the emergent typology is not quite so clear, but perhaps they are mostly the reactive drivers.

Limited support for the typology can also be found in a study of motorcyclists by Broughton and Stradling (2005). They asked riders to rate various road scenarios and examined the relationship between feelings of risk and feelings of enjoyment. They identified three types of rider. For *risk seekers*, enjoyment and perceived risk were positively correlated, corresponding to a high risk threshold type. The opposite was the case for *risk averse* riders, corresponding to a low risk threshold group. The third type of rider was described as *risk acceptors*. Their profile was characterized by an inverted 'U' – shaped curve relating enjoyment and perceived risk, with highest enjoyment being associated with intermediate levels of risk and falling off on either side of these levels. They appear most like the opportunistic type – motivated to sustain a particular level of experienced risk but at a target level lower than that for high risk threshold riders.

At this stage the validity and reliability of the driver/rider typology proposed here is tentative and the suggested links to other typologies are only speculative. Further empirical investigation is clearly warranted. However the notion of the existence of driver types, characterized in terms of risk thresholds, opens up a number of interesting research questions, not the least because of their relevance for education and training and the nature and focus of safety interventions. What, for example, are the origins of these differences between drivers? Are there drivers in the low risk threshold, opportunistic and reactive categories who actually start out that way? The observation of sex differences, even amongst the youngest drivers, implies differences that are independent of actual driver training and experience. The shift from relatively high collision involvement of a significant proportion of drivers as they move out of adolescence and through early adulthood implies that a large proportion of road users either lower their risk thresholds, become better 'calibrated' or both. And yet we seem to know very little about this process. Why, for example, do some drivers change but others persist with a high risk threshold?

The relationship between somatic marker strength and prioritisation in attention

As a preliminary investigation of the role of feelings in driver decision-making (and based on Damasio's somatic marker hypothesis), we have tested in a rudimentary way the proposition that elements in a driving scenario will receive attentional priority as a function of the strength of emotion they elicit. In driving, this emotion relates in the main to feelings of risk, given that as a driver progresses, unless avoidance responses are made more-or-less continuously, a collision or road run-off is certain. Despite this, occasional attention capture by an attractive road user or a dramatic crash scene are not unknown.

Our experimental paradigm involved giving drivers a brief (1 second) look at the static image of a road scene, photographed from the perspective of the driver looking ahead, and asked them after the brief presentation to identify the elements they noticed and indicate the order in which they noticed them. After performing this task for 24 different road scenarios, we then showed each scene again, for as long as the participant wanted, and elicited ratings of feelings of risk for each element in the scene. We could then explore the relationship between strength of risk feeling and priority of detection for the elements in the images.

The only criterion for taking part in the experiment was a minimum of three months driving experience on the road. The final sample consisted of 50 drivers, 30 female and 20 male, with mean age 30.0 years.

Results revealed that risk ratings decreased progressively from the first to the fourth detected item. This preliminary evidence, then, offers support for the proposition that elements in a traffic scene will be prioritized in attention (detection) as a function of the degree of risk feeling with which they are associated. Another way in which the same hypothesis has been tested in the laboratory is through tracking the sequence of driver eye fixations on objects when looking at road scenes and relating object fixation priority to strength of risk feeling. Similar findings to the current study have been obtained: objects fixated earlier receive higher ratings of risk feeling (Seidenstucker 2006, personal communication).

Despite this evidence, both of these studies have weak ecological validity because they used static images. This may be an important issue in studying the somatic marker hypothesis in the context of driving because the level of risk feeling associated with an object in the field of view is very likely to be related to the object's expected position relative to the driver's speed and trajectory. Hence further tests of the hypothesis are clearly needed using dynamic road scenes.

Several other aspects of the process would also merit research. For example, are there individual differences in sensitivity to somatic markers? Does the evidence that females are more emotionally reactive explain in part their lower levels of involvement in speed-related collisions? Can sensitivity be attenuated by the influence of over-riding emotional states, such as anger or the inhibitory influence of alcohol? Is this part of the process which mediates the relationship between anger and speed choice and alcohol and collision risk? How are emotional markers acquired and when in the individual's developmental, as well as driving history? Do weak markers provide a link between lack of maturity, poor socialization and preference for higher speeds?

Inattentional blindness

One final point is that there may be an intriguing relationship between the emerging evidence for driver types and attentional predictions from the somatic marker hypothesis, mediated by the phenomenon of 'inattentional blindness'. Laboratory studies show that when engaged in an attention-demanding task, some participants fail to notice obvious objects in front of their eyes (Simons and Chabris 1999). The likelihood of this failure of detection is increased with higher levels of task difficulty and is particularly strong for unexpected objects. High risk threshold drivers and young drivers in particular are prone to both these conditions – opting for a high level

of task difficulty but also having relatively poor internalized models of road and traffic contingencies and thus relatively uninformed expectations. Thus they may be particularly vulnerable to attentional errors where they are simply 'blind' to the emergence of a potentially hazardous object. Recent evidence also indicates that the phenomenon is also more likely after consuming a moderate amount of alcohol (Clisafi et al. 2006). Errors of attention, at least in motorcycle riders, are known to be associated with high speed (i.e. high task demand) (Elliott et al. 2003). Thus part of the elevated involvement of high risk threshold road users in collisions may be mediated by this process of 'inattentional blindness'.

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