INTRODUCTION

The term traffic psychology was first used loosely in 1990 at the International Congress of Applied Psychology in Kyoto, Japan, where the idea to create a separate division for Traffic Psychology was born. Traffic psychology has been defined as ‘the study of road user behaviour and the psychological processes that underlie that behaviour’ and it is the latter half of that definition that distinguishes it from behavioural studies in the field of road safety, which usually have no concern for psychological processes which may provide a basis for understanding that behaviour (Rothengatter, 1997).

While the term traffic psychology is relatively novel in the Anglo-Saxon domain of research, it is not in German speaking countries. The German Psychological Society has has a traffic psychology division for over 35 years. As early as 1982, a for that time quite innovative volume on the subject was published (Klebelsberg, 1982). It should be noted that in the countries where there is a traffic psychology tradition, the term usually refers to a practice of diagnosis, testing and driver rehabilitation (Blasco, 1994). Kroj, in a review of German traffic psychology, remarks subtly that where officially the main concerns are traffic safety and reduction of the impact of traffic on the environment, almost all of Germany’s 600 traffic psychologists earn their daily bread in the testing practice (Kroj, 1997). Practice rather than research seems to determine whether psychologists working in the field of traffic are identified as traffic psychologists, and whether behavioural studies are identified as psychology.

TRAFFIC PSYCHOLOGY

While the ‘human factor’ has been identified as major accident cause, the relation between behaviour and accidents still is the real enigma in traffic psychology. Police reporting is not helpful (‘cause of accident: car drove against tree’) and neither are accounts of witnesses or parties involved (a recent EU study of in-depth interviews of those involved in car-bicycle accidents, the most frequent remarks were: ‘I was suddenly hit’ and ‘when I saw the car it was too late’). Attempts to relate behaviour and accidents through conflict studies, as were in fashion a decade or two ago, also have contributed little. The initially vague definitions of conflicts such as ‘situation where at least one of the conflict partners needs to perform an abrupt and unforeseen manoeuvre to avoid an accident’ have not evolved into more sophisticated ones in which the conflict partners’ intended behaviour or expectations was specified, nor have they resulted in specific hypotheses concerning the drivers’ perceptual cognitive processes that produced the conflict situation, but instead concentrated on how conflicts could be reliably and objectively assessed. Training
methods were developed to ensure that conflict observers would reliably rate conflict severity until a few simple studies carried out by demonstrated that trained observers were no more reliable than naive observers, and either were in want of reliability (Kruysse and Wijlhuizen, 1988). With that, the initial intent to develop a measure that was based on behavioural indices and would allow the prediction of accident occurrence was irrevocably lost and conflict studies do not appear to be in fashion of late. They were not totally without impact though. An offshoot of the conflict studies rush was the development of a simple measure, called Time-to-Collision (TTC) which simply measured how long before the imminent collision one of the conflict partners initiated an evasive action, which can be calculated on objectively measurable speed and distance parameters. Similarly, a measure called Time-to-Lane crossing was developed which measures the time before the driver would leave his lane should he not make a steering correction (Godthelp et al. 1984). These measures have limited value per se, but they become extremely useful as a parameter in studying anticipatory aspects of actions such as car following, providing an indication of the quality of driver task performance dependant on for example environmental factors or driver experience (Cavallo and Laurent, 1988; Cavallo et al. 1997). An indicator of driver performance does not however indicate how drivers perform that task. There is no reason to assume that drivers actually need to continuously judge TTC as a way to maintain a safe trajectory and speed as implicitly suggested by Cavallo.

There are two ways to incorporate parameters such as TTC and TLC into driver modelling. One approach is ‘top-down’ in which ‘safety margins’ are conceptualised as derived from high-level decisions (Summala, 1996; Summala, 1997). The other is a ‘bottom-up’ approach in which low-level control models are linked to higher-level motivational aspects (Van Winsum, 1996). Both are still very much conceptualisations rather than theories with a firm empirical basis. Much more painstaking research will be required before model development is at such a stage that the validity of behavioural parameters such as TTC and TLC for accident occurrence can be assessed. Some results are promising. For example, the standard deviation of the lateral position (SDLP), which is another way of measuring heading error, appears to show a dose-effect relationship in alcohol studies which fits almost perfectly that of the ‘Borkenstein’ curve and is sensitive to a range of other factors that affect driver performance (Brookhuis, 1995). However, that, in itself, is no indication that SDLP would be a valid parameter of accident likelihood.

Applying psychology to traffic

There are many aspects in traffic participation and thus almost every aspect of psychology can and has been applied to traffic participation. The question is whether this always is meaningful. Meaningful can in this context interpreted in two ways, as contributing to the body of knowledge that constitutes traffic psychology and as contributing to the development of measures that reduce accident occurrence. Traffic psychology is highly dispersed and that is in part due to the fact that few attempts are made to develop models that can act as organising principle. The question is not whether the results of an attitude survey tally with current attitude modelling, the question is whether they tally with current driver modelling. This will not only require an integration in terms of a common framework, but also in terms of methodology. Social-psychological aspects of and individual differences in driving behaviour tend to be limited to surveys; while performance aspects are limited to experimental studies, in which, moreover, individual differences, proved relevant in surveys, are flatly ignored. It is very ironical that on the one hand surveys are critised for not being sufficiently representative whereas experimental studies are based on the performance of students who are extremely unrepresentative for the general driving
population. There are very few studies that have attempted to link social-psychological characteristics of drivers to performance measures even though doing so appears to provide important cues why there are differences in accident involvement. There are, for example, important differences between sensation-seekers and sensation-avoiders in terms of their habitual time headway (Heino, 1996a; Heino et al. 1996b) which might explain why the former are more often involved in accidents than the latter.

A PSYCHOLOGICAL BASIS FOR ACCIDENT COUNTERMEASURES

The acid test for traffic psychology is not so much whether it can provide a basis for understanding traffic behaviour as it is in providing a basis of accident countermeasures. In order to do so, it should evolve from the descriptive to the prescriptive. It also should address other components of the traffic system than the driver.

Road design
The majority of road safety measures still are in the realm of road design. Much has been gained by reducing the consequences of accidents rather than preventing them. A road design that prevents accidents from occurring requires ensuring that road users pick up the cues that are relevant, which has been termed ‘self-explaining’ road and ensuring that road users on the basis of these cues display consistently the behaviour appropriate to the road design, which has been termed behavioural engineering (De Waard et al. 1995). Where in the concept of ‘sustainable safety’ the cue is standardization of road design, the issue that requires further elaboration is how such standardization in road design could be designed such that standardization of road user behaviour is induced to a degree that it fits drivers’ expectancies (Berthelon et al. 1997; Theeuwes, 1996; Theeuwes and Hagenzieker, 1993). One issue that needs addressing is the implicit road categorization drivers use, and the individual differences in their expectancies which can provide a basis for driver error (Van Elslande and Alberton, 1997). Another issue that cannot be missed is of course behavioural adaptation. Traffic Psychology here has a significant contribution to make.

Supporting and distracting the driver
While in the early stages psychologists and ergonomists in the design of telematics systems have been involved in the research and development process, this has been much decreasing as a result of progress in the design stage and as a consequence of the increasing emphasis on automated vehicle systems which would render driver, and hence psychologist, superfluous (Lasky and Ravani, 1995). It is now anticipated that the introduction of fully automated systems will be preceeded by transition stages in which the driver will continue to play an essential role in terms of safety. Early design horrors in individual applications have now largely been corrected -map-based navigation displays have become rare- the problem of integrated information remains (Hofmann et al. 1994). This is not just between different types of application but also between application modes. Though on ergonomic level there is perhaps enough known to draw up guidelines, this is not the case for all psychological aspects. The possibilities to constructively use such applications for on-line driver tutoring have been demonstrated (Groeger and Kuiken, 1995). Driver tutoring would be especially relevant to the development of sustainable safty road environments. There still is a wealth of possibilities to be explored and it is unlikely that implementation-oriented EU programmes will explore these.
Driver fatigue
While drinking-driving still is one of the most extensively studied topics with regard to driver state, and indeed drinking-driving is the target of many educational and enforcement measures, accident surveys indicate that fatigue is an accident-contributory factor of similar significance. The risks involved in driver fatigue are undervalued by the general population of drivers. Restrictive measures would therefore not be supported, and, judging from the responses of professional drivers, largely ignored (Vallet and Mercier-Guyon, 1995). Altering or warning devices on the other hand, would have a much higher chance of being accepted, provided that detection is automatic and sufficiently reliable, which requires extensive documentation of the effects of fatigue on driving parameters which are measurable in real time. It is not the task of traffic psychology to develop these devices, but it is important to come up with indices. Heading error or SDLP or TLC are sensitive to time-on-task (and sleep deprivation) but there are likely to be more (De Waard, 1996; De Waard and Brookhuis, 1997).

Older drivers
The logic of most road safety measures is that if they work they will also work for older drivers. Studies of older drivers responses to innovations in road design and intelligent transport system developments show that such changes are no means always positive. Older drivers decrements in performance, in particular in such tasks that require divided attention, are well documented (Brouwer et al. 1991). Much less clear how results in experimental settings translate to everyday driving, and what coping strategies older drivers use.

Even if the possibilities of the development of ITS applications specifically designed for older drivers may be limited, adapting their use is possible. Driver support systems, for example, appear particularly effective with elderly drivers. It is interesting but deplorable that the inclination with elderly drivers seem to be to restrict driving or revoke their licence altogether. With an increasing part of the driving population being over 60 years of age, a more realistic approach would be to design the road environment such that it is elderly driver proof.

Traffic law violations
There seems to be accumulating evidence that traffic law violations are a key to accident reduction. At the same time there is every indication that law enforcement requires fundamental rethinking. One aspect to be considered is that attitudes towards law violations seem very much interrelated. Opportunity, that is road design, no doubt makes the thief -but this consistently applies more to some than others. That implies that violations are part of a life-style, and we have as yet a very limited view of what that life-style might be, and who would live it. It also implies that traffic law enforcement would have to differentiated, not just in terms of types of violations as is presently the case, but also in terms of target groups. To put this point more generally, monitoring and control of driver behaviour is essential for achieving a homogeneity in driver behaviour and this can very well adapted to the drivers' propensities.

Driver diagnosis, testing, selection and treatment
In Germany, novice drivers, professional drivers, or drivers that have become suspicious through multiple involvement in accidents, or through severe traffic law violations, or drivers exceeding the maximum demerit points allowed, -in all about 16,000 a year- get subjected to an elaborate system of diagnosis and testing (Kroj, 1997), with as consequence for the driver, licence revocation and a form of treatment ranging from a simple course to intensive dynamic group analysis. The rationale and
empirical foundation of these activities are not well understood in the Anglo-Saxon domain which does not mean to say that they are absent. In the German system, there are specific requirements, there is quality assurance in place, and there are in fact quite a few studies demonstrating a reduction in recidive, and in general positive safety effects (Utzelmann and Jacobshagen, 1997). The problem is in part that the research methodologies used are not always in line with Anglo-Saxon tradition. That is not a good reason, however, to discard these possibilities without further thought. European traffic psychologists in the framework of EFPPA are lobbying to get these or similar systems into European directives and it may very well be that eventually that recommendations of this nature will follow the same route as the theoretical driver examination has done.

Transport behaviour
Mobility, congestion, travel mode choice, car dependency, trip substitution, these are issues that were once in the domain of travel behaviour studies only but are increasingly becoming a focus of interest in psychology and now have firmly entered the domain of traffic and transport psychology (Richter et al. 1997; Steg, 1996; Tertoolen et al. 1998; Tertoolen and Verstraten, 1995; Van Vugt, 1996; Van Vugt et al. 1995).

There are profound problems to be solved, not just in practical terms, but much more in theoretical terms. There is a heated debate whether the Theory of Planned Behaviour can be meaningfully applied in this context. This debate concentrates on the question whether mode choice is indeed a case of explicit choice or is a matter of habitual behaviour. Also, the research is still very much in a descriptive stage, there are hardly any studies that actively attempt to modify mobility or mode choice behaviour.

CONCLUSIONS
Traffic psychology still is very much dispersed and lacks an integrative framework, both in terms of theory and methodology. Moreover, the substantial gap between so-called fundamental and problem-oriented research prevents productive application of research results. An integrative approach implies that social-psychological and performance aspects of road user behaviour and accident occurrence are to be understood within a common modelling framework. While some attempts are made, much more effort will be required. In fact, the limited domain of driver behaviour provides an excellent opportunity for integration.

Traffic sciences are by definition interdisciplinary. Traffic psychology can have a much greater impact if it is more problem-oriented and develops not only descriptive but also prescriptive knowledge. This does not only apply to the issues which have been traditionally the domain of traffic psychology - e.g. driver training and performance - but in particular to domains that are dominated by other disciplines. Road design remains a key tool to accident prevention where understanding drivers’ perceptions, expectations, state and propensities can make a substantial impact. Likewise, transport psychology, as a newly evolving field of application, may offer an enormous impetus to domains which has been dominated by other disciplines.

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