

Psychological Influences on Traffic Law Compliance

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1. INTRODUCTION

The link between traffic offences and accident involvement has been frequently made, both at an individual and aggregate level (e.g. Evans, 1991). Indeed, it is estimated that by reducing speeding alone a casualty reduction of between 30 and 50% could be effected, while preventing close-following and driver impairment due to drugs or alcohol would enhance safety still further (see Rothengatter, 1989). Individual tendencies to commit violations are not the concern here, instead this paper will focus on the attempts which have been made to change drivers' behaviour in general, i.e. at an aggregate level. To this end the paper will review the literature relating to various attempts to increase compliance with the traffic law, it will consider various theoretical contexts in which their results might be understood, and will briefly present some very recent empirical work relating to increased compliance, which serves to clarify some of the theoretical issues raised and to specify the limits which may apply to such interventions.

2. MEASURING COMPLIANCE

While the points made below are intended to

have general application, the focus in this document is on the seven illegal activities which were originally of direct concern to the E.C. project DETER, within which the empirical research reported below was carried out. These offences were: speeding, close following, illegal overtaking, illicit use of restricted lane, red light violation, flouting of weight restrictions and driving while impaired. In fact, the focus of the paper is sharper still, i.e. on the range of behaviours which have been extensively researched and against which countermeasures have been introduced: excessive speed and inadequate headways.

Much of the research effort in attempting to increase compliance has been confined to drunken-driving, excessive speed, and red-light violation. The ways in which researchers have sought to measure the effects of efforts to increase compliance may be divided into two broad classes: those which have consequences for the perpetrator and/or the relevant authorities, and those that reflect changes in normative behaviour.

The first class of measures relates largely to the number of prosecutions for a particular offence, the numbers and types of accidents occurring as a consequence of such offences, the costs of these accidents, or the economic costs of enforcement of the laws which had been violated. The second broad class of measures can also be subdivided into a number of sub-categories. These include physical measures such as the average speed or blood-alcohol-level, or inci-

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dence of seat-belt use, the variability or range of observed speeds, reductions in the numbers in particular target groups (e.g. high speeders) and the temporal (e.g. time after intervention has ceased) or spatial (e.g. the so-called speed halo) longevity of any effect. What might be termed non-physical measures, such as attitudes towards the behaviour in question, future intentions to commit such an act (i.e. behavioural intentions), or self-reported involvement in such behaviours form the other category.

Two forms of control are used on the size of the effects observed. Taking measures before and after, as well as simply during, the intervention is the most widely adopted control. However, a number of studies also employ measurements of sites or areas or groups that are outside the intended impact of the programme, so that effects which are independent of the intervention are not misattributed to the intervention being evaluated. For example, assessing the effect of a change in the layout of a junction during an oil shortage would not be wise without also measuring the accident rates at comparable control sites.

3. ATTEMPTS TO INCREASE COMPLIANCE

Three classes of action have been undertaken with the aim of increasing compliance. These have attempted to (a) increase the likelihood of detection or apprehension, (b) increase the consequences of detection or apprehension, and (c) change the public perception of the illegal action and those involved in it (e.g. through public education programmes). Often these have been used in conjunction with one another and the effects of these interventions will now be reviewed in some detail.

3.1. *Increasing likelihood of detection*

Efforts to increase detection by manipulating policing have taken two forms: by altering traditional enforcement techniques or the introduction of new ones. Most detailed research has concerned the use of enforcement vehicles to reduce speeding, and these will be considered in some detail because of the clear link between speed violations and accident involvement, and

because of its intrinsic relationship to one major explanation of why people choose to comply.

Studies which have attempted to assess the effects of parked marked police vehicles yield the following conclusions. Hauer, Ahlin, Bowser (1980) have showed that a marked vehicle parked parallel to the roadway (facing in the same direction as the traffic in the adjacent carriageway) reduces the average speed of free-flowing vehicles to the posted speed at site of enforcement. More importantly perhaps there was a demonstrable «halo effect» on the average speed for both downstream and upstream traffic. The data reveal an exponential function halving every 900 meters from the site of enforcement. This confirms earlier research by Jocelyn et al (1971), and later work by Roop and Brackett (1981). Roop and Brackett (1981), however, who employed the additional control of assessing changes on matched sites where no enforcement was carried out during the duration of the project, show that the level of effects reported by earlier authors were somewhat attenuated if the effects on the control sites were taken into account. Nevertheless, the magnitude of effects was greater for the enforced sites. There was a 1.8% decrease in mean speed, a decrease of 9.1% in vehicles exceeding posted speed (which was 55 mph), and 10.9% in percent of vehicles exceeding 60 mph. Interestingly, Roop and Brackett also report a drop in accident rates for the enforced sites. When corrected for the effects at the control sites there was a 2.9% reduction in damage only accidents, a 11.5% reduction in personal injury accidents, and a 15.3% in fatal accidents.

What these studies also show is that the variability of speed differed as a function of the amount of exposure to enforcement, and that this reduction in variability occurs only when the enforcement persists for more than one day. Hauer, Ahlin, Bowser (1980) show that with a single day of enforcement, the residual effect on the average speed was already reduced on the following day. The effect was completely dissipated in three days. In contrast, when enforcement was maintained for five consecutive days, a residual effect was still noted six days after the intervention had ceased. Brackett and Beecher (1980) varied the enforcement schedule by parking the vehicle five days a week for the first two weeks, four days for the second two weeks,

and twice a week for the last two weeks. Comparison of the pre- and post experimental conditions indicated a significant speed reduction of 4 mph and a halo effect extending up to 11 miles.

There are therefore demonstrable, if short term, effects of using parked marked enforcement vehicles on average speed, speed variability, number of high speeders and the size of halo effects as well as on accident frequencies. Other types of intervention using enforcement vehicles have also been evaluated. Specifically, presumably in an attempt to demonstrate the readiness of the police to apprehend offenders, researchers have examined the effect of simulating a roadside arrest (i.e. unmarked vehicle stopped in front of police unit). Such manipulations have been shown to have reduced or no effect when contrasted with a single parallel parked marked car. Only Jocelyn et al. (1971) suggest that the arrest position configuration is more effective in reducing speed than the single parallel parked marked car, while many others indicate that this configuration of vehicles has no (positive) demonstrable effect. Indeed, not even Jocelyn et al show that the arrest configuration is completely effective, since there appears to be marked reduction in the size of the speed halo effect (2% within a mile versus 4% for the other configurations).

Parked marked vehicles are in general considered to have greater potential to reduce violations than moving ones (see Council (1970), Jocelyn et al. (1971)). Jocelyn et al report that the size of speed reduction was identical for stationary and moving vehicles but the location of the maximum speed reduction varied, being somewhat more extended for the moving enforcement vehicle. The halo effect was larger for the stationary vehicle, and for vehicles travelling/facing in the same direction than in the opposite direction. Shinar and Stiebel (1984) obtained similar reductions to or below the speed limit for both stationary and moving vehicles. However they report that the distance over which the halo effect operated was greater. A number of authors indicate that the use of unmarked police vehicles tends to have very little effect overall (see Shinar, & McKnight, 1986).

Taken together these findings indicate that making the threat of detection more evident, and increasing the apparent readiness of the police

vehicle to pursue and enforce the law lead to significant reductions in speed and accidents. They also indicate that the length time for which the enforcement vehicle was visible is related to the longevity of these effect, but not in a linear fashion.

The other aspect of increasing detection likelihood which has received some study, is that of increasing that actual amount of enforcement. Cirillo (1968) has demonstrated that the level of enforcement on a section of road had little or no apparent effect on speeding, with the number of hours of police patrol and the number of arrests being unrelated to mean speed or accident rate. Similarly, van Houten and Nau (1981) show that for roads with 30 or 60 minutes of overt policing per day, the speeds measured when the patrols were absent show no consistent effect of the increased enforcement.

The only extensive analysis of an automated on-site enforcement system indicates that where the uncertainty is removed from the detection and apprehension the effects of increased enforcement are very large indeed. ORBIS developed by Vought Missiles and Space Company, as described by Shinar and McKnight (1986) takes a front-end picture of the vehicle with its licence plate, the recorded speed, the violation time, date and location, followed by prosecution (Jones et al, 1980) 800 vehicles per day exceeded speed limit by 10 or more mph, was reduced by half in one week (before it was actually in operation) and continued decrease to a stable level of 15 to 25 vehicles per day.

3.2. Increasing consequences of detection

Attempts have also been made to manipulate commission of illegal behaviour by changing the consequences of being detected. Although intuitively appealing, the notion that legal threats will successfully deter behaviour to the extent that they are perceived as «swift, certain and severe» has had little confirmation in empirical studies of the criminal law, (see Zimring, & Hawkins, 1973; Ross, & Lafee, 1985). Much, but not all, of the research effort in this area of driver behaviour has concentrated on attempts to reduce drunk-driving. Shinar and McKnight conclude that any effect of increased severity of penalties lasts only as long as the increased enforcement,

and that «as enforcement declines to original levels, so does the effect, even though the more severe penalties remain in force». (Shinar, & McKnight, 1985, p. 388).

In fact, in Europe, in recent years we have seen the abandonment of the most severe drinking-driving penalties. The reduced penalties do not appear to have negatively influenced the extent of drinking and driving (Ross, 1990). Conversely, in North America, the severity of legal punishments has been increased in numerous independent jurisdictions. Currently, all states mandate jail or community service for second-offender drinking-drivers, and some mandate jail for the first offence. Evaluations of first-offender jail policies in Tennessee (Jones et al., 1987) and Arizona (Ross, et al 1990) found no measurable effect, either on the recidivism of the offenders or, through general deterrence, on the driving public. No evidence of deterrence was found for a local policy of 15 days in jail for the first offenders in an Ohio city (Ross, & Voas, 1989). In an Australian study, Homel (1988) found no impact of jail sentences of different length on subsequent recidivism. In Canada, Vingilis (1990) found that, for repeat offenders, longer jail sentences were associated with greater recidivism. Much earlier Campbell and Ross (1968) performed an analysis of a crackdown on speeding in Connecticut which involved stricter penalties. A time series analysis of the data obtained did not reveal any significant change in the number of fatalities.

From a psychological point of view the failure to produce effects through increasing the severity of apprehension is not surprising. A whole variety of theories of learning predict that likelihood of punishment rather than the severity of any punishment is the effective agent. This must be particularly true of situations where the a priori likelihood of the event is itself very small. Thus the catastrophic effect of dying in a traffic accident may give rise to a subjective feeling of risk, but deters very few motorists from actually driving. This would obviously occur if severity alone was considered to be important.

3.3. *Effects of providing drivers with information*

Another way in which reductions in illegal

driving acts have been sought is through the use of public information campaigns. While many authors (e.g. Rooijers, & De Bruin, 1990; Reinfurt, Levine, & Johnson, 1973; Shinar, & McKnight, 1985) readily support the view that media or public information campaigns can add to the effects of enforcement, it remains to be demonstrated that public information alone has any effect on violations (see Rothengatter, 1990).

Reinfurt, Levine and Johnson (1973) confined their evaluation activities to urban areas with a posted speed limit of 35 mph. Vehicle speeds were recorded for a period of 11 days divided among 3 phases: 1-2, 4-7 and 9-11 days. News releases and public service announcements «advertising» enforcement activities were published in local newspapers on the exact day when a particular experimental phase began. The results demonstrated that the addition of newspaper publicity to the visible patrol/radar configuration yielded a significant reduction in the average speed from 36.6 mph to 35.5 mph ($p < 0.001$). The percent of vehicles exceeding the speed limit by 15 mph also was significantly reduced, from 1.8 to 0.7% ($p < 0.01$). A similar pattern of results was obtained when the effect of publicity was evaluated relative to a visible police unit with a concealed radar unit. Thus, the results clearly indicated that the addition of public information to an enforcement program adds to the effect of the enforcement unit. Local media were used in this campaign, and this is generally seen to be most effective, since it more easily targets the relevant audience than national media. Similarly, dissemination of information about enforcement activities appears both more effective (and more cost effective) if «news» rather than «features» carry the items. As Wilde et al. (1971) point out, the other desirable or essential features of public education campaigns are that the message has «interest» or «appeal» (which can frequently be achieved through humour or controversy), that the message specifies the target behaviour precisely (rather than simply urges people to be «better people»). In general, the aim is to produce messages with precise content which become part of ordinary conversation, rather than some instruction divorced from everyday living. This not only boosts the coverage achieved by the campaign but may also have a collateral effect by allowing individuals to

explicitly consider their own behaviour against more clearly stated social norms (see below).

What is clear from a variety of studies is that unenforced posted roadside information has little measurable effect on behaviour. Galizio, Jackson and Steele (1979), for example, demonstrated that the presence of police cars had reduced driving speed, but that a standard «radar-enforced» speed limit sign had no effect on driving speed. Hunter and Bundy (1975) also failed to find any significant effects of such a sign. It should be noted, however, that such studies do not mean that roadside signs are ineffective, simply that their effectiveness depends on the extent to which they are valid predictors of increased enforcement for the individual motorist. For example, frequent pairings of «Speed Check Zone» signs and enforcement by Dart and Hunter (1976) show that signs can be as effective as a marked parked police car and as a marked parked car in arrest position. During the intervention the percentage of drivers exceeding speed limit reduction from 43% to 8.5%, and a speed halo effect was established for up to 1.9 miles down stream from the site. However, one would have to be sceptical about the longevity of effects of this sort, since the signs will obviously become less powerful predictors of increased enforcement activity as time elapses and enforcement resources are directed elsewhere.

The conclusion from such research is that if they do not predict an increase in the likelihood of detection, signs of such general content have very little effect. At the other extreme, i.e. signs carrying content which is specific to a single driver, the results appear equally clear and similarly disappointing. Efforts, for instance, have also been made to increase compliance with speed limits by presenting drivers with a visual indication of their current speed (Visual Speed Indication). Dart and Hunter (1976) used a loop of speed detector and a large programmable roadside sign which displayed an individual driver's speed («Your speed is XXX»). Where the speed exceeded the speed limit the speed information was preceded by the message («Slow down»). The effects of these individual messages were evaluated under a variety of conditions: three conditions where VSI and different configurations of police cars were paired, VSI only, and a control condition where no intervention

was made. The only significant speed reductions occurred where the VSI was paired with enforcement. For VSI alone, an absence of any effect on speed was noted not only at the site of the speed detection loops, but also at 500 feet, 1,000 feet and 1.9 miles downstream of the VSI. This indicates that the mere presentation of information regarding vehicle speed, even when coupled with a specific instruction to slow down, has no measurable effect on compliance. A similar conclusion is reached by (Hunter, Bundy, & Daniel, 1976) for VSI only information. Importantly, Hunter et al. additionally suggests that the effect VSI may be to increase speed variance, indicating that drivers may react to personalised information on speed in very different ways. Obviously, any intervention which serves to increase variance at a site must be treated with extreme caution.

Thus far it would appear that neither what might be termed «passive» sources of information (i.e.: general information which is presented whatever the driver does) and what might be termed «active» information (where the information is contingent upon each individual's behaviour) do not themselves reduce speeding. However, in a study to which we devote much attention below, van Houten and colleagues report a range of speed reductions which are due to a technique which combines both active and passive information, that is, so called «collective feedback». This involves the posting of the number of vehicles exceeding speed limits in, for example, the previous week.

The first two studies reported by van Houten et al. (van Houten, Nau and Marini, 1980) involved the use of a sign measuring 1.2m by 2.1m, located 2m from side of the road, 2.3m above surface of the pavement. On it were displayed «Drivers not speeding yesterday» and below a line «Best record» in letters (15.2 cm high) and percentage of figures 15.2 cm (for best record) or 20.3 (Yesterday) high. The percentages were changed, as appropriate, each day on the basis of speed recordings at the site during two daily periods of 20 minutes of observation (Monday to Friday, 10.30 and 14.30). The speed limit at the site was 50 km/h, but only vehicles travelling at 66 km/h or more were reflected in the posted speed information. During the period of the study the average number of cars contribu-

TABLE 1
*Speed distribution in a 50 km/h zone as a function of posted speed formation
 (after van Houten et al., 1980)*

Condition	No. Weeks	Percentage of drives exceeding:			
		74Km/h	66Km/h	58Km/h	51Km/h
Baseline 1 (no sign)	8	6%	24%	63%	90%
Daily posting 1	5	3%	12%	40%	78%
Baseline 2 (covered)	5	9%	26%	63%	93%
Daily posting 2	6	1%	8%	39%	93%
Daily posting 3	4	2%	12%	45%	84%
No numbers 2	2	9%	34%	72%	95%
Weekly posting 1	3	2%	11%	45%	85%
No numbers 3	2	6%	22%	61%	91%
Weekly posting 2	5	2%	11%	44%	86%
Follow up	26	2%	12%	45%	85%

ting to the speed information was 244 cars per day (range 201 to 286) and police activity in the area was kept to constant level (similar to that pertaining before the posting of speed information). The major findings are reported in Table 1, which is derived from the figures presented in the text of their paper.

The effects of this intervention were impressive. The mere presence of the sign had little effect (i.e. no-sign versus sign covered by tarpaulin, that is Baseline 1 versus Baseline 2). The sign without numerical information also had no effect. However, instatement or re-instatement of the daily percentage information substantially reduces speeds greater than the cut off point of 66 km/h. There are reductions in the percentages of drivers travelling at less than these levels, but rate of reduction declines as the actual speed declines. This of course means that both the average speed at the site, and the variance in speed at the site were reduced by the posting of speed information. Two other aspects of the data tabulated above are worthy of note. Firstly, altering the sign (and the data contributing to it) from «Drivers speeding yesterday» to «Drivers speeding last week» had little effect, and secondly, the reductions achieved remained stable over a 26 week period (during which speed was still unobtrusively measured and updated information

was posted). Thus, van Houten et al appear to have demonstrated a way of reducing speeding behaviour. This interpretation is corroborated by two other types of data they report in their paper. The average number of accidents in the two years preceding the study was «a stable level of 1.56 per month» (op. cit., p. 392) reduced to 0.67 per month following the installation of the sign. Furthermore, the mean numbers of drivers charged with speeding averaged 0.75 and 0.71 per day during the baseline and no-numbers conditions, but this decreased to 0.47 per day during the daily posting and 0.25 per day during the weekly posting conditions. These reductions may of course reflect a reduction in the attention given to speeding by the local police (which van Houten et al. claim was kept constant), but even if this were true, this would probably compromise any attempt to account for these findings in terms of an increase in the objective (or actual) risk of being charged with speeding.

In a later study, van Houten and Nau (1981) replicated these effects and contrasted the effects of posting speed information with different levels of obvious/visible police enforcement. As before, speeds were unobtrusively measured, but not when police units were deployed. During periods of increased enforcement (30 minutes versus 60 minutes of «parked marked» police

presence on the two sites) the posted speed feedback sign was covered. As discussed above, the presence of police does indeed serve to reduce speeds (see also Galizio, Jackson, & Steele, 1979), but only while visible and in a position to enforce. Van Houten and Nau do not report the speed reduction in these conditions, but clearly demonstrate that the speeds on increased enforcement days (no measurements during periods of actual enforcement) was substantially higher than on the posted speed days. Thus the results are consistent with their earlier study, and strengthen the view that the basis of the reduction in speeds owes little if anything to any implied increased level of police activity.

To summarise the effects from both studies, it would appear that these signs are capable of reducing speed by as much as 15% the numbers of drivers operating well in excess of posted speed limits. Furthermore, these feedback signs did not produce «over-reaction», that is, an increase in the percent of drivers operating well under the limit, which is often a consequence of overt police enforcement (see Galizio, Jackson, & Steele, 1979). Shinar and McKnight (1985), attribute a number of other findings to van Houten and Nau, which we presume are reported in van Houten and Nau (1983), these are as follows. The higher or more lenient the speed used as a criterion on the sign, the greater the effect in reducing dangerous speeding, the sign was not as effective in producing compliance as a the presence of a marked vehicle at the enforcement site. On limited access highways the effect of the sign endured for up to 6 km downstream. This speed halo effect was greatest for drivers exceeding the speed limit by the largest amounts, but adding the insignia or name of an enforcement agency to the sign did not enhance compliance with speed limits. Finally, and rather impressively, in their 1981 paper van Houten and Nau briefly mention that the first speed sign installation was still effective some 20 months after its erection.

4. UNDERSTANDING INCREASED COMPLIANCE

In the preceding sections the factors which appear to enhance compliance with the traffic

law have been considered in some detail. Briefly, it would appear that while the presence of a police enforcement unit ready to enforce the law is undoubtedly the most effective deterrent, the duration of these effects is rather limited, both «within» an enforcement episode, and between enforcement episodes. Thus, downstream from the site of a police unit, speed gradually increases again, and on days where enforcement is absent, the ambient speed gradually reverts to the pre-intervention level even at the sites themselves. The duration of the enforcement episodes does, however, influence the rate of this reversion, an indication that drivers learn and remember the «enforcement history» of a particular site. Taken together, these results indicate that drivers adjust their behaviour to their expectations regarding the likely detection of their offence. This «subjective risk of detection», rather than the «objective» or actual risk of detection is what influences behaviour, as evidenced by the failure of researchers to demonstrate any reliable effects of the amount of enforcement.

That drivers are insensitive to levels of objective risk has previously been demonstrated for the risk of accident by Groeger and Chapman (1991). Earlier work in the accident-risk area, which demonstrates that driver's estimates of risk can be biased by available (but irrelevant) information (Groeger, & Chapman, 1990), offers a possible framework within which these and other results reported above can be understood. Specifically, drivers rely on easily available information about themselves and their environment to guide their behaviour, rather than any exhaustive interrogation of themselves or of the current driving task. Thus, when a highly visible police unit is detected, or remembered, behaviour is adjusted, otherwise it plays no role. In other words, objective risk is only important and influential in behaviour in so far as it is correlated with the aspects of the scene which give rise to the driver's feeling of subjective risk. This may also help to account for the consistent absence of any effect of the severity of detection.

Another set of results bears upon this issue. Groeger and Grande (in press) show that in the absence of information to the contrary, drivers assess their ability very positively in comparison to a novice driver. Where feedback on their abi-

lity is provided, by for example a driving instructor, their view of their own ability in relation to that of others is altered by this previously unavailable view of their own ability. Thus, we suggest drivers rely on the information that is available to them from the scene, and their own and other driver's ability. When, as in the case of the collective feedback regime reported by van Houten and Nau, more veridical information about others is provided, the driver's own performance or self assessment can be adjusted to conform with it. This may not necessarily be a pressure to conform, but a recalibration of some assessment of what others do. Thus, we would suggest that where the other traffic travelling in the scene conflicts with the posted «normative speed information», the prevailing speed choice rather than the posted norm will exert the primary influence. It should also be borne in mind that any pressure to conform may be less powerful than the goal which exceeding the speed limit may satisfy, and this too would mitigate against complete adjustment towards legal speeds. Both of these suggestions would imply that speed changes will be greater the more excessive the speed is, which is borne out by available evidence.

Shinar and McKnight (1986) give a rather different account of the enforcement and feedback effects presented above. In essence, they suggest that the threat of enforcement implied by the scene is what governs speeding, stressing as we do that subjective rather than objective risks are what influence behaviour. This implied threat account is not, intuitively at least, consistent with the collective feedback results given above. For example, the objective risk of being apprehended was obviously substantially reduced in the van Houten studies. A lack of correlation between subjective and objective risk does not, of course, disprove the «implied threat» account. However, the fact that «collective feedback» but not «individual feedback» are associated with speed reductions, would appear to be more awkward for the Shinar and McKnight position to account for, since one must surely presume that the «threat» implied by feedback on your own behaviour must surely be more influential than the knowledge that statistics have been collected on others' behaviour.

In discussing their own results, van Houten

and Nau discuss a number of possible causal mechanisms. They claim, quite reasonably, that since the number of drivers charged with speeding declined, the compliance effect is unlikely to have been the result of increased ticketing on the part of the police. Another possibility that they raise is that the change in the behaviour of drivers is reinforced by the improvement in percentage of drivers not speeding. This does not account for the erratic increases and decreases over time evident in their papers. A strict reinforcement would suggest a linear decline until, perhaps, some plateau is reached. Another possible explanation they discuss is that of implied surveillance, raised later by Shinar and McKnight. However, van Houten and colleagues conclude, perhaps hastily, that an implied surveillance account is in conflict with that fact that changes made to the sign were not significantly correlated with increased ticketing or additional surveillance. It is also worth considering the possibility that the daily changes in the information should suggest a greater increase in surveillance than do weekly postings. In neither of the van Houten et al studies is there any difference between daily and weekly postings. They also raise two other possible explanations, that a «chain reaction» is caused by the brake lights of compliant motorists, which itself becomes reinforcing. However, their methods of data collection are insufficiently precise to distinguish between cases where vehicles were travelling alone or in convoy.

The final possibility they raise is that the collective feedback sign comes to acquire discriminative control over driver behaviour, because of «social comparison», but they fail to indicate why such a comparison should influence behaviour. Social comparison is, of course, a fundamental aspect of Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), which has much contributed to our understanding of volitional behaviour. Briefly, TRA states that behaviour is immediately preceded by a behavioural intention, and that such intentions are formed by the joint action of the attitude to the behaviour and the individual's subjective norms. The attitude to the behaviour is itself formed by the product of individual's behavioural beliefs (about consequences) and the evaluation of the outcome (i.e. its seriousness of consequences). Subjective norms

FIGURE 1
Theory of Reasoned Action (after Fishbein & Ajzen, 1975)

$$\begin{aligned} \text{Behavioural Intention} &= \text{Attitude to behaviour} * \text{Subjective Norms} \\ &= (\text{behavioural beliefs} * \text{outcome evaluation}) \\ &\quad * (\text{normative beliefs} * \text{motivation to comply}) \end{aligned}$$

FIGURE 2
Theory of Planned Behaviour (after Ajzen, 1985)

$$\begin{aligned} \text{Behavioural Intention} &= \text{Attitude to behaviour} * \text{Subjective Norms} \\ &= (\text{behavioural beliefs} * \text{outcome evaluation}) \\ &\quad * (\text{normative beliefs} * \text{motivation to comply}) \\ &\quad * \text{perceived behavioural control} \end{aligned}$$

are themselves the product of the individual's normative beliefs (regarding the social expectations about that behaviour) and his or her motivation to comply (see Figure 1).

This theory was later extended to incorporate the Theory of Planned Behaviour (TPB) by Ajzen (1985, 1988), in an effort to provide an extension to the non volitional domain. TPB simply added a single term perceived behavioural control, i.e. the ease of performing the activity or of avoiding it. It is worth noting that for Ajzen, perceived behavioural control is altogether different from more global notions of controllability and locus of control popular in the early seventies, since for him perceived behavioural control, is tied to a specific behaviour in terms of time, action, target and context (see Figure 2).

The increased explanatory power of TPB over TRA for behavioural intentions to drink and drive, speed, close follow, and to overtake dangerously has recently been tested by Parker, Manstead, Stradling, Reason, and Baxter (1992). Parker et al show that the inclusion of «control» as a term, allowed significantly more of variance to be accounted for in a large (N= 881) sample of British drivers ratings their future intentions to commit the actions described in four simple verbal descriptions of the offences referred to

above. This demonstrates the applicability of the TPB to freely expressed «behavioural intentions» if not to actual behaviour, and indicates that drivers feel that such activities are not necessarily fully under their own control. Obviously, until such theories actually predict how people perform in real or simulated situations, TPB is an interesting description of, rather than an explanation of, people's commission of illegal acts. In terms of the van Houten and Nau research, one would presume that the behavioural control over reducing speed is high and that the normative beliefs are enhanced by the provision of collective feedback. Given the findings, if we adopt the TPB, we have to assume that the motivation to comply is high, but given the formulation of the theory (i.e. the fact that behavioural intentions are the product of the sub-components), we are also forced to assume that the drivers consider their detection likely, and that they consider the seriousness of such detection great. As we have seen from the earlier discussion of this area, there is little evidence to support such assumptions. Thus, while useful descriptively, one must conclude that TPB requires substantially more confirmatory evidence before we can accept it as an accurate explanation of behaviour in traffic.

5. ADVISORY STRATEGIES FOR INCREASING COMPLIANCE

As part of our research effort within the DETER project, Peter Chapman and I have had the opportunity to explore the types of effects reported by van Houten and Nau. We chose to do so in a controlled laboratory setting, using an Animated Interactive Driving Environment (AIDE, see Groeger, & Chapman, submitted). AIDE is a driving task, based on Macintosh Computer, which was specifically developed so that we could investigate what types and combinations of messages were most effective in encouraging drivers to make compliant decisions. These studies revealed that where posted information on normative behaviour with respect to speeding was presented, drivers in this laboratory based task were less likely to break the speed limit. However, there were two important caveats to this general finding which was revealed in a further series of AIDE experiments. Specifically, drivers did not become more compliant in general, law-abidingness increased only for the posted offence. Thus, drivers did not commit fewer tailgating violations, red light violations, overtaking violations, etc. The second important finding from these studies was that posting normative information about speeding was effective only when the incidence of actual speeding encountered during the trial was low. Where the behaviour of other drivers appeared to be at variance with the posted information, it did not reduce speeding. These findings, if true, suggest that posting of normative information is not effective because of the increased surveillance such signs imply. They also suggest, that there may be different sources of normative information available, and that available from the posted information may well not be the most influential.

One puzzling aspect of these results was that we failed to alter drivers tendency to close follow with posted roadside information. Because of this we undertook another study (see Groeger & Chapman 1994) in which drivers were given auditory warnings whenever they followed another vehicle at less than 1 second. The results were striking, drivers invariably complied with the warnings, although their tendency to commit speeding violations was not affected. This meant that it was indeed possible to alter tailgating be-

haviour within AIDE, although not, apparently, using posted roadside information. Closer examination revealed, however, that all of our traffic conditions had relatively high incidence of tailgating. Thus, if the argument may above with regard to the greater influence of the actual behaviour of the other drivers encountered is correct, we might not have expected to see any effect of the posted information. Accordingly, we ran another series of studies in which the tailgating behaviour of other drivers was carefully controlled. The results showed that where other drivers seemed to be adhering to the posted (tailgating) information, subjects were more likely to conform, but were not more likely to conform where other appeared not to be doing so. Posted tailgating information did not affect speeding. It should be noted that none of the traffic conditions investigated actually constrained subjects to respond in particular ways, but they nevertheless chose to behave like the others they encountered.

More recently, we have had the opportunity to replicate the AIDE study which employed auditory in-car warnings under real driving conditions (see Groeger, Chapman & Stove, 1994). The results were as impressive as were obtained under laboratory conditions, i.e. drivers tendencies to follow others with a temporal gap of less than 1 second was significantly reduced where a simple auditory warning was produced whenever they did so. In spite of the effectiveness of this warning with respect to tailgating, drivers in the trial frequently drove in excess of the speed limit. This study both serves to validate some of the earlier laboratory based work, but also extends it substantially, showing that some, but not all, ways of giving drivers advice about violations are relatively impervious to how other drivers are behaving.

6. CONCLUSIONS

The research findings summarised above has considered a number of different explanations of, and strategies towards reducing, traffic violations. There is little evidence that the severity of the penalty is itself a deterrent, especially in the

situations where detection or apprehension is unlikely. Where the likelihood, real or apparent, of being caught is high, so is compliance. Where many other are also likely to be apprehended, this deterrent effect appears to be reduced. Arguably, where very many people break the law simultaneously that law becomes unenforceable, thus reducing the likelihood of any individual being apprehended. The results of our own empirical studies suggest that the effects of public posting of violation information may be somewhat unpredictable and, perhaps, artefactual. Compliance will depend on the aggregate level of compliance in the situation. Thus the information presented on the sign is, per se, relatively uninformative. Nevertheless, given strategic placement of signs, such as in locations where most drivers will be constrained to comply, e.g. on bends or near schools in the case speeding, since the aggregate level of compliance is likely to be high, public posting of speed information may well prove very effective (see Fuller, 1994). Unfortunately, such an approach is unlikely to work in the case of tailgating, since it is intrinsically difficult to envisage situations in which inter-vehicle spacing is increased. Our studies make very clear that because an effort is made to comply with one traffic law does not mean that compliance will increase across all offences, even those as intuitively related as speed and distance keeping. This would seem to mitigate an explanation of earlier results, or indeed our own, in terms of «implied surveillance». Finally, the fact that personalised, rather than aggregate feedback has been found to be influential irrespective of traffic conditions would appear to undermine the view that normative influences on traffic behaviour are particularly strong, unless we revise the basis on which normative behaviour has its effect. It may be that in-car systems, such as that studied here, because they make clear that one's own violations have been detected, may only serve to reinforce the idea that other drivers will not be the ones who will be apprehended. Arguably, under such circumstances, knowing that others will not be punished may itself exert a very strong normative pressure towards compliance.

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SUMMARY

This paper reviews a range of studies which have sought to increase drivers' compliance with the traffic law. These range from: studies which have manipulated levels of enforcement to studies which have investigated the effects of providing drivers with information about current levels of compliance, to studies which have sought to assess the impact of different levels of penalty. It is concluded that the effects of normative information are weak and inherently dependent on the actual behaviour of other drivers. The results presented further suggest that the risk of apprehension, which may be augmented by provision of in-car warnings, is most likely to be effective in increasing compliance.

RESUMO

Neste artigo procede-se a uma revisão de estudos sobre o aumento da submissão dos condutores à legislação de tráfego. Estes vão desde os que manipularam diferentes níveis de controlo policial até aos que se debruçaram sobre o fornecimento aos condutores de informações sobre os níveis existentes de submissão às normas, ou ainda até aos estudos sobre o impacto de diferentes graus de penalização. Conclui-se que os efeitos da informação normativa são muito reduzidos e são intrinsecamente dependentes da observação do comportamento dos outros condutores. Os resultados a seguir apresentados sugerem que a percepção imediata de risco e transgressão, que pode ser aumentada através de sistemas de aviso colocados nos automóveis, tende a ser mais eficaz no aumento da submissão às normas.