APPLIED PSYCHOLOGY: AN INTERNATIONAL REVIEW, 1997, *46* (3), 287–302

Observed Vehicle Speed and Drivers' Perceived Speed of Others

Lars Åberg

CTS, Centre for Research on Transportation and Society, Sweden

Liselotte Larsen

Danish Council of Road Safety Research, Denmark

Alf Glad

Institute of Transport Economics, Norway

Leif Beilinsson

VTT, Technical Research Centre of Finland

Les tentatives de modélisation du comportement de conducteur prennent traditionnellement en considération trois éléments fondamentaux: le conducteur, le véhicule et la circulation. Un quatrième élément n'a jamais été retenu, à savoir la dimension sociale de la circulation. Dans cet article, qui exploite des données en provenance du Danemark et de Suède, on analyse les attitudes des conducteurs envers les excès vitesse et l'impact des autres usagers de la route sur la détermination de leur propre vitesse. On a rapporté la vitesse enregistrée du véhicule (N = 483) aux réponses du conducteur à des questions concernant le choix de sa vitesse. Le questionnaire s'appuyait en partie sur la Théorie de l'Action Raisonnée avancée par Ajzen & Fishbein (1980); des items explorant l'environnement social de la circulation remplaçaient la norme subjective du modèle. Les résultats ont montré qu'un modèle intégrant les attitudes et les perceptions du comportement des autres conducteurs pouvait rendre compte d'environ 15% de la variance de la vitesse observée. Plus de 50% des conducteurs ne respectaient pas la limitation de vitesse et une

Requests for reprints should be sent to Professor Lars Åberg, CTS, Dalarna University, S-781 88 Borlänge, Sweden.

The results of the present paper concern a comparison that is part of a larger investigation of drivers in four Nordic countries. The work was supported by the Danish Council of Road Safety Research (RfT), the Technical Research Centre of Finland (VTT), the Institute of Transport Economics, Norway (TOI), the Swedish Transport and Communication Research Board (KFB), and The Nordic Committee for Traffic Safety Research (NKT).

majorité d'entre eux surestimaient la vitesse des autres usagers. Les conséquences théoriques et pratiques de ces résultats sont discutées.

Attempts to model driver behaviour have traditionally included three basic elements; the driver, the vehicle, and the traffic environment. No account has been taken of a fourth element, the social environment in traffic. In the present paper, based on data from Denmark and Sweden, drivers' attitudes towards speeding and influences from other road users on drivers' speed choice were investigated. Recorded vehicle speeds (N = 483) were compared to drivers' responses to questions concerning their speed choice. The questionnaires were based partly on the Theory of Reasoned Action suggested by Ajzen and Fishbein (1980) with questions tapping the social traffic environment substituting for the subjective norm in the model. The results indicated that a model including attitudes as well as perceptions about other drivers' behaviour could explain about 15% of the variation in observed speed. More than 50% of the drivers exceeded the speed limit and a majority of them overestimated the speed of other drivers. Theoretical and practical implications of the results are discussed.

INTRODUCTION

Speeding is a basic problem behaviour of drivers. Exceeding speed limits is probably the most widespread violation in traffic today (Østvik & Elvik, 1991). It is also well known that high levels of speed have negative effects on road-user safety, on air pollution, and on traffic noise. As speed choice has been shown to be consistent over time (Wasielewski, 1984) it should be possible to investigate reasons for driver speed adjustment. Investigations of speed behaviour have shown that enforcement has effects on behaviour (e.g. Armour 1984; Shinar & McKnight, 1985) and that speed choice can be explained by different individual motives (Vogel, 1985). Several models have been used in attempts to explain driver behaviour in general and speed choice in particular. No model has, however, been generally accepted (Michon, 1985; Ranney, 1994).

Most models trying to explain driver behaviour include three basic elements: the driver, the vehicle, and the physical traffic environment. There are seldom references to a fourth element, the social environment in traffic. According to Zaidel (1992) there is a gap between models of individual driver behaviour and the (presumably) resultant population behaviour. He proposed that each driver should be seen as an individual influenced by the social environment consisting of other road-users, general social norms, traffic-related rules of conduct, and their representations. Therefore, to understand and predict driver behaviour it is necessary to include the impact of the social traffic environment on drivers' decision making in models of behaviour.

The Fishbein and Ajzen Theory of Reasoned Action has been used as a theoretical model in many studies of driver behaviour (e.g. Forward, 1994).

It is stipulated in the model that behaviour to a great extent is intentional and that predictions of behaviour should be based on measures of intention (Ajzen & Fishbein, 1980). Intentions are determined by attitudes and subjective norms. Attitudes are determined by beliefs and evaluations about outcomes of behaviour, and subjective norms stem from normative beliefs and motivation to comply. The subjective norms concern influences of important other persons, often family members or friends.

Several empirical attempts have been made to increase knowledge about drivers' choice of speed, for example, by investigating relations between road-user attitudes and subjective norms and speed choice (e.g. Rothengatter, 1988). The Fishbein and Ajzen model has proved to be a valuable tool in explaining road-user behaviour, but with some problematic shortcomings. For example, simply by providing information it has been possible to change behaviour without a corresponding change of attitudes and beliefs. This result is contrary to theory prediction, in that information on behaviour is supposed to be mediated through attitudes. Another example is that attitudes have normally been significantly related to behaviour, whereas subjective norms have been shown to be less relevant for explanations of behaviour, especially concerning speeding (Rothengatter, 1992). Subjective norm has also been found to be correlated with attitude in a way that sometimes makes it difficult to separate the two concepts (e.g. Åberg, 1993). As a model of driver behaviour the Fishbein and Ajzen theory is a model of individual behaviour with no references to other road users. A social environment consisting of other road users might be a better supplement to attitudes in explaining behaviour than subjective norms generated by family and friends, who are not necessarily present in the driving situation.

It was suggested by Connolly and Åberg (1993) that drivers' adjustment of speed is affected by a comparison of their own speed with that of other nearby drivers in a way that makes speeding contagious among drivers. Studies of effects of other drivers' behaviour on own behaviour within the Fishbein and Ajzen framework have not been reported, but perceived behaviour of significant others has been found to affect another contagious phenomenon, smoking intention and behaviour (Grube, Morgan, & McGree, 1986). Rothengatter (1991) argued that normative behaviour will be unattractive if it is abnormal, but attractive if drivers perceive that most others comply with it. In a series of field experiments, Van Houten et al. (1985) reported that posting the percentage of complying drivers during the preceding week on a billboard, visible to passing drivers, has an effect on driver behaviours such as speeding. If the number of complying drivers was small, it had no effect on mean speed. On the other hand when the number was high the mean speed on the road decreased significantly. Although it was not discussed by Van Houten et al., this might be an example of a way to

manipulate drivers' view of the speed of other drivers. In another study of road-user interaction, Howarth (1988) observed drivers and children in a potential conflict situation. Somewhat contra-intuitively, Howarth's investigation showed that it was the children, and not the drivers, who assumed the responsibility to avoid an accident by stopping in time. Thus, although drivers are often heard saying that they drive carefully in concern for child safety, this attitude is seldom expressed in their speed adjustment (see also Åberg, 1988). One possible explanation is that concern for other drivers' behaviour might be more important than concern for children or other vulnerable road-users. As has been suggested by Zaidel (1992) when he discussed possibilities for a change of the culture of driving, it is important to study drivers' views of how other drivers, as well as other road-users, think and behave.

The purpose of the present paper is to investigate effects of attitudes towards speeding and influences from other road-users on drivers' speed choice. To increase the generalisability of the results, the investigation was carried out in two Nordic countries. Although the countries are similar in many respects, there are differences in the infrastructure and in traffic environments (see Nordisk Ministerråd, 1996). The Theory of Reasoned Action as proposed by Ajzen and Fishbein (1980) was used as a frame of reference in the design of a questionnaire and in its analysis. In the present study the subjective norm variable in the model has been replaced with measures tapping perceived influences from other road-users.

METHOD

Interviews were carried out on six different road sections in Denmark and on five different road sections in Sweden. All roads were main roads traversing built-up areas and with a speed limit of 50km/h in residential areas and 90km/h before and after the built-up areas. Speeds of passing vehicles were recorded by a video camera installed in a parked car, invisible to passing drivers. Shortly after passing the camera car, the drivers were stopped by a police officer for a roadside interview. The interview site, within the 50km/h area, was not visible to the drivers when they passed the camera car. The interviews were performed by research personnel. The roadside questions concerned the driver's speed at the road section before stopping, local knowledge, matters related to a choice of speed on location, estimates of other drivers' speed, and perceived detection/accident risk on location.

In addition to the interview questions, the drivers were handed a questionnaire to fill out at home and mail back to the investigators. The questionnaire contained two kinds of questions. First, there were specific questions regarding the special road section such as: the speed limit on the road, own speed normally held on location, perceived accident risk, stressing

and stimulating factors during driving, perceived risk of detection and penalties, consideration for other road-users, and opinion of local urban speed limit. The second type were general questions: influence from other drivers' behaviour and matters related to adaptation of speed in urban areas.

For an investigation of a structural model the following variables were utilised. Drivers' speed was measured in three independent ways, first, direct observations of speed at one spot along the road, second, the driver's estimate, in the interview, of his/her own speed at this point of time, and, third, the speed reported in the questionnaire to be held normally on the road section. Observed speed was used as the dependent, behaviour, variable in the model. The two variables based on self-reported behaviour are dependent on past behaviour and in the present study they were seen as substitutes for measures of intention (cf. Åberg, 1993; Fredricks & Dossett, 1983). Reported speed concerned intentions about the specific journey while normal speed concerned intentions about speed choice on the road section in general. Information about drivers' attitudes were obtained in four questions. The questions concerned attitudes towards the speed limit on the road section, attitudes towards speeding on the road section, attitudes towards speeding on 50km/h roads in general, and reasons for speed choice on the road section. Perceived behaviour of others was investigated in three questions. The drivers' estimate of other drivers' speed in km/h, estimate of the percentage of others driving more than 10km/h over limit, and an estimate of how often they had been overtaken on the road section. Furthermore, variables about drivers' concern about others were probed for the model. These questions concerned a wish to drive like others, concern about vulnerable road-users, concern about other drivers, beliefs about vulnerable road-users' impressions of the respondents' speed, and beliefs about other drivers' opinion about their speed.

Subjects

The numbers of drivers interviewed in Denmark and Sweden were 611 and 489, respectively. Speed measurements were obtained from 409 and 532 drivers, respectively. The number of questionnaires returned were 420 (69%) and 317 (65%), respectively.

In the present analysis, comparisons are made between subjective reports and objective observations of speed. Therefore it is important that the drivers' choices of speed are based on similar circumstances. Drivers who admitted being aware of the presence of a control and drivers who answered the question about the speed limit on the road section incorrectly were therefore excluded. Furthermore, because of path analyses, a listwise deletion of missing data was performed and the present analyses were based on 241 Danish drivers, of which 75 (31%) were females and 242 Swedish

drivers with 53 (22%) females. The mean age of the subjects in Denmark was 45.7 years (sd = 14.3 years) and in Sweden 50.3 years (sd = 14.6 years). In Denmark 52%, and in Sweden 53%, of the drivers drove more than 20,000km each year.

RESULTS

Observed, Reported, and Normal Speed

Three different measures were used to cover different aspects of behaviour. "Observed" speed concerned speed at a certain spot and at a certain time and was an objective measure of behaviour. The driver's own report covered a larger part of the road section and was a subjective measure of the behaviour. The subjective report about speed normally held at the road section mirrored past behaviour. Means and standard deviations of speed data are presented in Table 1 for Danish and Swedish data, respectively.

There was reasonable agreement between mean observed speed, mean reported speed at the day of measurement, and mean speed normally held on the road section. However, the variances in speed were considerably smaller for self-reported speed (reported and normal speed) than for the speed actually observed. The results of observed speed presented in Table 1 show that more than half of the driver samples drove faster than the posted speed limit. There was no significant difference between countries in observed speed but Danish drivers had a higher reported speed ($t = 5.58$; $df = 481$, $P < .001$) and a higher normal speed ($t = 4.61$; $df = 481$; $P < .001$) than Swedish drivers.

Attitudes Towards the Speed Limit

In the interviews and in the questionnaires the drivers were asked for their opinion about the speed limit; 80% of the Danish drivers and 86% of the Swedish drivers answered that it is very or quite reasonable to comply with the 50km/h speed limit. Also, 40% of the drivers in Denmark and 68% in

TABLE 1
Observed, Reported, and Normal Speeds on 50km/h Road Sections for Danish and Swedish Drivers

	Denmark		Sweden	
Speed (Km/h):	Mean	SD	Mean	SD
Observed	52.6	10.9	51.2	9.1
Reported	53.9	6.5	51.1	4.3
Normal	54.8	6.5	52.4	4.8

Means and standard deviations. (Denmark: N = 241; Sweden: N = 242).

Sweden reported that the main reason for selecting a certain speed on the road section was a wish to comply with the speed limit. A total of 47% of the Danes and 17% of the Swedes reported that the main reason was that the present speed level made them feel safe.

Perceived Speed of Other Drivers

The drivers' estimates of speed adjustment of other drivers were reflected in three different variables: the drivers' estimates of speeds of other drivers, of the percentages of other drivers driving more than 10km/h faster than the speed limit, and the drivers' perceptions of how often they had been overtaken on the section compared to how often they themselves overtook. The first two of these variables could be compared to distributions of speeds of recorded vehicles that passed the measurement sites during the data acquisition phase (see Table 2).

According to the results presented in Table 2 the drivers generally overestimated the speed of other drivers. The speed of other drivers was, on the average, estimated to be 8–10km/h higher than the speed actually observed. It was also reported that more than 50% of other drivers went faster than 60km/h while the actual figures lay in an interval between 16% and 25%. Around 60% of the drivers perceived themselves to be overtaken on the road section more often than they themselves overtook. A comparison between drivers' normal speed on the section and the speed they estimated other drivers to hold revealed that 78% of the Danish drivers and 71% of the Swedish drivers believed that they normally drove more slowly than the average driver.

Consideration for Other Road-users

The drivers were asked to estimate other road-users' perception of their speed on the road section, if it was too low, acceptable, or too high. They were also asked to state to what extent they cared about other road-users' opinions, from very much consideration to no consideration at all. The

TABLE 2
Drivers' Estimates of Other Drivers' Speed Choice Compared to Speeds of Drivers Observed on the Road Sections

	Denmark		Sweden	
	Others (N = 241)	Observed (N = 409)	Others (N = 242)	Observed (N = 532)
Mean speed (km/h)	63.2	53.8	60.5	52.2
Others 10km/h over limit	56%	25%	52%	16%
More often overtaken	61%	–	60%	–

answers to these questions for vulnerable, unprotected road-users are cross-tabulated and the result is presented in Table 3. As there were no significant differences between the answers from the two countries and in order to ensure enough number of observations in each cell of the table, the two sets of data have been combined.

According to the data presented in Table 3, a majority (about 83%) of the drivers believed that vulnerable road-users accepted their choice of speed while 17% thought it was too high. There was a tendency in the data for low concern for vulnerable road-users to be related to the impression that unprotected road-users think that the speed is too high ($\chi^2 = 7.39$; $df = 2$; $P < .05$). Of the drivers, 87% claimed that they had a great or moderate concern for vulnerable road-users. The observed speed was higher for drivers who thought that vulnerable road-users considered their speed to be too high than for drivers who thought that their speed was accepted ($t = 3.38$; $df = 483$; $P < .001$). The means of observed speed for the two groups of drivers were 55.7km/h and 51.0km/h, respectively.

In the same way as in Table 3, data about the drivers' concern about other drivers and their beliefs about the other drivers' view of their speed choice have been cross-tabulated and the result is presented in Table 4. The answers from the two countries are combined (no significant difference between the two data sets).

Table 4 shows that 30% of the drivers believed that other drivers perceived their speed as being too low. The number of drivers who believed that other drivers thought they drove too slowly, increased significantly with the drivers' decreasing concern for other drivers' opinion ($\chi^2 = 60.66$; $df = 3$; $P < .001$). Of the drivers, 35% claimed that they had little or no concern at all for other drivers in their choice of speed, and in this category 48% thought they drove too slowly in the eyes of others. Although drivers who believed that others considered them to drive too slowly, were observed to drive slower (50.7km/h) than drivers who believed that their speed was acceptable (52.3km/h), the difference was barely significant ($t = 1.70$; $df = 482$; $P < .05$).

TABLE 3
Drivers' Concern for Vulnerable Road-users and the Impression of How Their Speed is Perceived by Others

Others' perception of speed level	Concern			
	Great (N = 209)	Moderate (N = 209)	Little/None (N = 62)	Total (N = 480)
Too high	12%	20%	26%	17%
Acceptable	88%	80%	74%	83%
Too low	1%	0%	0%	0%

TABLE 4
Drivers' Concern for Other Drivers and the Impressions of How Their Speed is Perceived by Other Drivers

Others' perception of speed level	Concern				
	Great (N = 133)	Moderate (N = 174)	Little (N = 92)	None (N = 80)	Total (N = 479)
Too high	4%	8%	5%	2%	5%
Acceptable	75%	74%	60%	34%	65%
Too low	21%	18%	35%	64%	30%

Prediction of Observed Speed

To investigate to what extent observed speed could be predicted from other variables in the questionnaire, a path analysis was performed with the Ajzen and Fishbein (1980) Theory of Reasoned Action as a guide to a hierarchical structuring of variables included. The path analyses were performed as a series of regression analyses. Several variables investigated in interviews and questionnaires were initially tested for inclusion in the model, but the best solution to the explanation of drivers' speed choice was obtained with a model containing seven variables. The item content of the variables included in the path model are described in Table 5, and intercorrelations between these variables for Danish and Swedish data are presented in Table 6.

The dependent variable in the model was Observed speed and this variable was assumed to be determined by the drivers' intention that in the present structure was represented by two variables: the drivers' Reported speed and the drivers' Normal speed on section. The variable Reported speed was placed between the dependent variable and Normal speed in the structure, as it was closer in time to Observed speed. Intentions were assumed to be determined by attitudes towards speeding (a specific and a general attitude), and by two variables that substituted the subjective norm in the Fishbein and Ajzen model, namely perceived behaviour of others, and a wish to drive like others. In the analyses only paths with significant ($P < .05$) regression weights were considered. The final result of the path analyses on Danish and Swedish data, respectively, are presented in Figs. 1a and b.

In the diagrams an assumed direct, significant influence from one variable to another is denoted by an arrow, and a numerical value, adjacent to an arrow, denotes the strength of the path. The data from the two countries yielded highly similar structural models, with only minor differences of little importance for the interpretation of the main result. The path analyses showed that the two variables concerning self-reported speed could explain 15% (adjusted R square) of the variance in *Observed speed.* There was a

TABLE 5
Items Included in the Path Analyses: Abbreviation and Item Content

Abbreviation	Content
1. Observed speed	Speed recorded on videotape
2. Reported speed	Speed at road section, the day of investigation
3. Normal speed	Speed reported normally held at road section
4. Specific attitude	"How reasonable or unreasonable do you think it is to drive with a speed 15km/h above the speed limit through [specific area]?" Very reasonable (1)–Very unreasonable (5)
5. General attitude	"It is of little importance to traffic safety if I drive 15km/h over speed limit through a residential area." Agree (1)–Disagree (5)
6. Drive like others	"For me it is more important to drive like others than to keep the speed limit, even if they drive well above the speed limit." Agree (1)–Disagree (5)
7. Percentage over limit	"Imagine the [specific area] with similar circumstances as today: what is the percentage of drivers who you believe are driving at a speed 10km/h or more over the limit?"

strong link between *Normal speed* and *Reported speed. Specific attitude* was the most important factor for *Normal speed*, while the other two variables *Percentage over limit* and *Drive like others* also made substantial contributions to the explanation of this variance. Altogether the three variables explained 38% of the variance of Normal speed. The three variables contributed indirectly, through *Normal speed* and *Reported speed*, to the explanation of *Observed speed.* Finally, the *Specific attitude* concerning the local road section was influenced by a *General attitude* towards speeding on 50km/h road sections.

TABLE 6
Intercorrelations Between Variables Included in the Path Analyses

	1	2	3	4	5	6	7
1. Observed speed	–	.36	.36	−.25	−.12	−.18	.16
2. Reported speed	.36	–	.61	−.31	−.16	−.24	.25
3. Normal speed	.37	.70	–	−.49	−.31	−.40	.32
4. Specific attitude	−.26	−.32	−.52	–	.48	.23	−.17
5. General attitude	−.27	−.26	−.39	.47	–	.42	−.03
6. Drive like others	−.23	−.24	−.42	.41	.44	–	−.04
7. Percentage over limit	.04	.24	.33	−.20	−.11	−.06	–

Danish data above diagonal and Swedish data below diagonal. A correlation of .13 and higher is significant, $P < .05$.

The interpretation of the path-analytic results was that drivers who were least negative to speeding drove faster than other drivers. Drivers who perceived others to drive fast, or wanted to drive like others, kept a higher speed than other drivers.

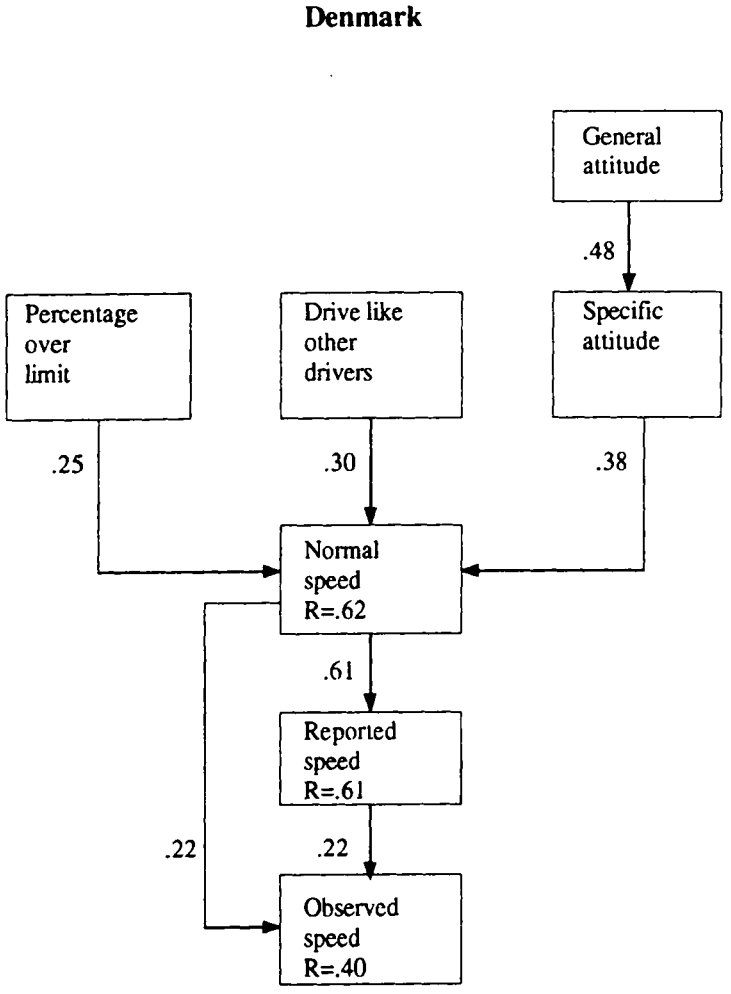

FIG. 1a. Path diagram describing significant ($P < .05$) relations between variables explaining speed choice among Danish drivers. The strength of relations are indicated by path coefficients and by multiple regression coefficients within the boxes (N = 241).

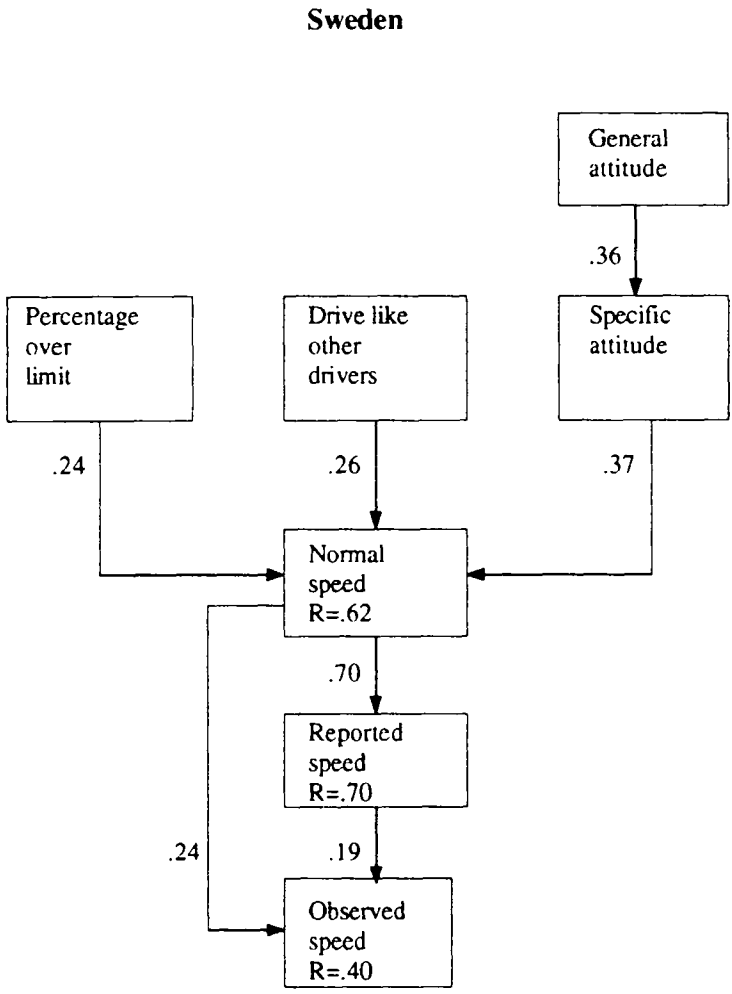

FIG. 1b. Path diagram describing significant ($P < .05$) relations between variables explaining speed choice among Swedish drivers. The strength of relations are indicated by path coefficients and by multiple regression coefficients within the boxes (N = 242).

DISCUSSION

In the present study two sets of data, one from Denmark and another from Sweden, have been analysed separately and very similar results have been obtained. The stability of the results and the theoretical framework utilised

should give a firm foundation for a discussion of influences on drivers' speed choice.

In both countries more than 50% of the drivers exceeded the speed limit, in spite of the fact that a majority of the drivers expressed attitudes in favour of compliance with the law. As there was a significant relation between drivers' reports about their speed and the objectively recorded speed it is implied that the drivers, at least to some extent, were aware of their behaviour and that speeding was a result of their conscious decision making and not entirely habitual and automatic. In accordance with the Fishbein and Ajzen model (Ajzen & Fishbein, 1980), attitudes were found to be related to speed choice and one could therefore expect that the observed positive attitudes towards compliance would lead to lower speeds, but obviously this was not the case. Therefore, in order to look for another possible explanation to speeding, the drivers' perception of others' behaviour was considered.

If the observed speed distribution in the present study could be seen as representative of the general speed distribution of traffic on the road sections under the given circumstances, it could be concluded that most of the drivers overestimated the speed of other drivers. This conclusion is supported by the fact that nearly two thirds of the drivers perceived themselves as being overtaken more often than they overtook other vehicles themselves. As a majority of the drivers also claimed that they wanted to drive with a speed similar to the speed of other drivers, it is likely that an overestimation of the speed of others is one factor that might explain speeding.

Another potentially important factor for speed choice was consideration for other road-users, and from the path analyses presented it can be concluded that drivers experienced social pressure from other road-users in their choice of speed. Two kinds of other road-users were considered, vulnerable persons and other drivers. The respondents claimed that they cared more about vulnerable road-users than about other drivers in their choice of speed. Thus, opinions of vulnerable road-users should be more influential than other drivers' opinions. However, although a majority of the subjects drove faster than the speed limit, most of the drivers believed that vulnerable persons accepted their speed choice; relatively few drivers thought that vulnerable persons considered their speed as too high. Thus, the pressure from vulnerable road-users did not appear to be very strong, although the drivers claimed that they cared much for this group of people. Even if drivers did not care about other drivers to the same extent as they did about vulnerable road-users, one third believed that other drivers thought that their speed was too low. This result might indicate that there was a force towards higher speed coming from other drivers and that more concern for other drivers might result in an increased level of speed.

The fact that consideration for unprotected road-users, at best, has only a marginal effect on drivers' speed choice is in agreement with the results of Howarth (1988) concerning children and vehicle drivers. He showed that it was the children who assumed the real responsibility to avoid accidents, not the drivers. In the present study, although drivers claimed that they cared about vulnerable road-users, it was hard to detect any sign of this consideration in their choice of speed.

Thus, the results of the present study showed that the respondents overestimated other drivers' speed, wanted to drive like others, and believed that other drivers thought they were driving too slowly. The suggested causal model also implied that perceived behaviour of other drivers will affect speed choice together with attitudes towards speeding. Contrary to implications from the Theory of Reasoned Action (Ajzen & Fishbein, 1980), earlier studies have found that information might have impact on behaviour without affecting attitudes (Rothengatter, 1992). The present results offer a possible explanation for this problem, as it was suggested that other drivers' speed was important for speed choice and that most drivers overestimated the speed of others. Information presented to the drivers about the actual behaviour of other drivers might therefore affect the behaviour without any change of attitudes. Therefore, perceived behaviour of other drivers could be substituted for the subjective norm in the explanation of drivers' speed choice when using the Fishbein and Ajzen model.

With reference to the Fishbein and Ajzen model a new variable has been introduced in addition to attitudes to explain driver behaviour. According to Rothengatter (1992), adding new variables to a theoretical model might increase the predictive power of the model while eroding its conceptual power. Although others' behaviour is a factor of social influence on behaviour it is a different variable from the subjective norm. The subjective norm concerns the perceived opinions of persons that are important to the subject while perceived behaviour of others concerns an anonymous group of people. Still, the perceived opinions of these anonymous other drivers seemed to be important for the choice of behavioural alternatives. Thus, there was little support for the Fishbein and Ajzen theory of reasoned action in the present results but they pointed to a new variable that might improve the predictive power of any model attempting to explain driver behaviour.

The results could have some practical implications. If perceived behaviour of others is important for speed choice it would be important that drivers have a correct impression of others' speed. If they wrongly perceive the majority of other drivers to drive at a speed faster than they drive themselves, they will experience a force towards higher speeds in spite of the fact that the others do not go so fast. Providing drivers with valid information about the speed of other traffic might remove this pressure towards higher speeds. In that case the attitudes, which for many drivers are against

speeding, would stand a better chance of influencing the drivers' choice of speed. Thus, the results of the present study are in agreement with the results presented by Van Houten et al. (1985). In the light of the results from the present paper, their method of informing about actual percentage of compliers to the speed limit, might be a low-budget alternative, or supplement, to the more expensive police surveillance and enforcement measures.

REFERENCES

Åberg, L. (1988). Driver behaviour and probability of detection on roads with temporary 30km/h speed limit. In J.A. Rothengatter & R.A. de Bruin (Eds.), *Road user behaviour: Theory and research*. Assen/Maastricht, The Netherlands: Van Gorcum.

Åberg, L. (1993). Drinking and driving: Intentions, attitudes, and social norms of Swedish male drivers. *Accident Analysis and Prevention, 25*, 289–296.

Ajzen, F., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Englewood Cliffs, NJ: Prentice Hall.

Armour, M. (1984). A review of the literature on police traffic law enforcement. *Australian Research Board, 14*, 17–25.

Connolly, T., & Åberg, L. (1993). Some contagion models of speeding. *Accident Analysis and Prevention, 25*, 57–66.

Forward, S. (1994). *Theoretical models of attitudes and the prediction of drivers' behaviour* (Uppsala Psychological Reports. No. 434). Uppsala, Sweden: Department of Psychology, Uppsala University.

Fredricks, A.J., & Dossett, D.L. (1983). Attitude–behavior relations: A comparison of the Fishbein–Ajzen and the Bentler–Speckart models. *Journal of Personality and Social Psychology, 45*, 501–512.

Grube, J.W., Morgan, M., & McGree, S.T. (1986). Attitudes and normative beliefs as predictors of smoking intentions and behaviours: A test of three models. *British Journal of Social Psychology, 25*, 81–93.

Howarth, C.I. (1988). The relationship between objective risk, subjective risk and behaviour. *Ergonomics, 31*, 527–535.

Michon, J.A. (1985). A critical view of driver behaviour models. What do we know, what should we do? In L. Evans, & R. Schwing (Eds.), *Human behaviour and traffic safety*. New York: Plenum Press.

Nordisk Ministerråd (1996). Forhold som påvirker føreres fartsvalg – en undersøkelse blandt førere i de nordiske landene. [Conditions influencing drivers' speed choice – a study of drivers in the Nordic countries]. *Tema Nord*, 1996, 598. Copenhagen: Nordisk Ministerråd.

Østvik, E., & Elvik, R. (1991). The effects of speed enforcement on individual road user behaviour and accidents. In M.J. Koornstra, & J. Christensen (Eds.), *Enforcement and rewarding: Strategies and effects*. Leidschendam, The Netherlands: Institute for Road Safety Research.

Ranney, T.A. (1994). Models of driving behaviour: A review of their evolution. *Accident Analysis and Prevention, 26*, 733–750.

Rothengatter, J.A. (1988). Risk and the absence of pleasure: A motivational approach to modelling road user behaviour. *Ergonomics, 31*, 599–607.

Rothengatter, J.A. (1991). Normative behaviour is unattractive if it is abnormal: Relationships between norms, attitudes and traffic law. In M.J. Koornstra, & J. Christensen, (Eds.), *Enforcement and rewarding: Strategies and effects*. Leidschendam, The Netherlands: Institute for Road Safety Research.

Rothengatter, J.A. (1992). Road users attitudes and behaviour. In G.B. Grayson, (Ed.), *Behavioural research in road safety III*. Crowthorne, UK: Transport & Road Research Laboratory.

Shinar, D., & McKnight, A.J. (1985). The effects of enforcement and public information on compliance. In L. Evans & R. Schwing (Eds.), *Human behavior and traffic safety*. New York: Plenum Press.

Van Houten, R., Rolider, A., Nau, P.A., Friedman, R., Becker, M., Chalodovsky, I., & Scherer, M. (1985). Large-scale reductions in speeding and accidents in Canada and Israel: A behavioral ecological perspective. *Journal of Applied Behaviour Analysis, 18*, 87–93.

Wasielewski, P. (1984). Speed as a measure of driver risk: Observed speeds versus driver and vehicle characteristics, *Accident Analysis and Prevention, 16*, 89–103.

Vogel, R. (1985). Motives for speed choice on Dutch motorways. *Traffic research centre annual report 1984*. Groningen, The Netherlands: University of Groningen.

Zaidel, D.M. (1992). A modelling perspective on the culture of driving. *Accident Analysis and Prevention, 24*, 585–597.