Running head: BI-DIMENSIONAL ATTITUDES

Bi-dimensional attitudes, attitude accessibility and speeding behaviour

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Abstract

Positive and negative attitude dimensions (i.e., bi-dimensional attitudes) asymmetrically predict behaviour, with the positive dimension being the better predictor than the negative dimension. These findings have been demonstrated using self-reported behaviour measures. In this study, we aimed to test the bi-dimensional attitude-behaviour relationship using objectively measured speeding behaviour derived from a driving simulator and test if the asymmetrical prediction of behaviour from the positive and negative attitude dimensions could be explained by attitude accessibility (how available an attitude is in memory and therefore how readily it is able to guide behaviour). One hundred and six drivers completed online measures of the positive and negative dimensions of their attitudes towards exceeding the speed limit. Response latency measures of the accessibilities of both dimensions were also taken. A driving simulator was used to measure speeding behaviour. Both attitude dimensions independently predicted speeding, with the positive dimension being the stronger predictor. The positive attitude dimension was also more accessible than was the negative dimension. The difference in the accessibilities of the positive and negative attitude dimensions significantly mediated the difference in their predictive validities. The results demonstrate that the positive attitude dimension is the principle predictor of speeding and a reason for this is that it is more accessible in memory than is the negative attitude dimension. Road safety interventions (e.g., education) that aim to reduce speeding and associated traffic crashes might usefully decrease the valence or accessibility of the positive attitude dimension. There would also appear to be scope to reduce speeding by increasing the valence or accessibility of the negative attitude dimension.

KEY WORDS: Speeding behaviour; Bi-dimensional attitudes; Attitude Accessibility; Driving Simulator

Introduction

Road traffic crashes represent a serious problem. Globally, they account for over 1.25 million deaths per year and many more serious injuries (World Health Organisation, 2017). In the UK, they account for around 200,000 casualties per year (Department for Transport, 2015). It is widely acknowledged that exceeding the speed limit ('speeding') substantially increases the risk of road traffic crashes (RoSPA, 2017). Identifying the predictors of speeding is therefore important because it provides information about the potentially most suitable levers for reducing this aberrant behaviour through the use of educational interventions such as road safety publicity campaigns, including TV, radio and poster advertisements (e.g., Stead, Tagg, MacKintosh, & Eadie, 2004) and speed awareness courses (e.g., Stephenson, Wicks, Elliott, & Thomson, 2010).

In an attempt to identify predictors of speeding, many studies have focused on the relationship between attitudes (positive/negative evaluations) and behaviour (e.g., Conner, Lawton, Parker, Chorlton, Manstead & Stradling, 2007; Elliott, Thomson, Robertson, Stephenson & Wicks, 2013; Elliott, McCartan, Brewster, Coyle, Emerson & Gibson, 2016; Lheureux, Auzoult, Charlois, Hardy-Massard, & Minary, 2015). In these and studies of other driving behaviours (e.g., Elliott, 2012) it has been found that attitudes are statistically reliable predictors of behaviour. However, while the implication is that modifying drivers' attitudes is likely to reduce speeding, experimental studies typically show that interventions designed to alter drivers' attitudes engender very little change in behaviour (e.g., Chorlton & Conner, 2012; Elliott & Armitage, 2009).

There are several reasons why attitude-change interventions have been found to be generally ineffective at reducing driver's speeding behaviour (see Carey, McDermott & Sarma, 2013; Sniehotta, 2009). One potential reason is that they do not focus on the most relevant levers for behaviour-change. For example, research shows that while attitudes are statistically reliable predictors of speeding behaviour, the effects sizes are typically modest,

meaning that any sized change in attitudes would be expected to return smaller-sized changes in behaviour (equivalent sized changes in behaviour would only be expected if the attitude-behaviour relationship was perfect; see Armitage & Conner, 2001). In fact, research on driver behaviour has shown that only extremely large-sized changes in attitudes (in excess of d = 0.80), which are typically not achieved in practice (e.g., Hardeman, Johnston, Johnston, Bonetti, Wareham, & Kinmonth, 2010), are capable of generating changes in behaviour (see Elliott, 2012). Many researchers have therefore tested increasingly complex models that incorporate numerous behavioural predictors in an attempt to identify predictors of speeding that might, in addition to attitudes, constitute useful levers for interventions (e.g., Conner et al., 2007; Coogan, Campbell, Adler & Forward, 2014). While these models account for additional variation in speeding, over and above attitudes, they potentially undermine the importance of attitudes because they do not take into account recent developments in this construct. Of relevance to the present study is the concept of bi-dimensional attitudes.

The bi-dimensional conceptualisation of attitudes (e.g., Conner, Sparks, Povey, James, Shepherd, & Armitage, 2002) views the attitude construct as comprising two separate uni-polar, positive and negative dimensions allowing people to independently evaluate the positivity (e.g., 'speeding is not at all positive/extremely positive') and negativity (e.g., 'speeding is not at all negative/extremely negative') of a behaviour at the same time (Thompson, Zanna, & Griffin, 1995). This is in contrast to more traditional conceptualisations of attitudes (e.g., Thurstone, 1928; Osgood, Suci, & Tannenbaum, 1957), which view the construct as bi-polar and unidimensional, allowing people to evaluate a behaviour as being either positive or negative only (e.g., 'speeding is positive/negative'). Typically, unidimensional attitudes are measured directly using semantic differential scales (e.g., Osgood et al, 1957), which reflect participants ratings of the positivity or negativity of the behaviour in question (e.g., 'speeding is extremely good/extremely bad') or indirectly using belief-based composite scales (e.g., Fishbein, 1963), which reflect the summation of

participants ratings of the perceived likelihood of salient behavioural outcomes (e.g., 'speeding is very likely/very unlikely to get me to my destination quickly') weighted by their ratings of the positivity or negativity of those behavioural outcomes (e.g., 'getting to my destination quickly is extremely good/extremely bad'). Either way, these measures of attitudes are unidimensional and this unidimensionality has previously attracted criticism.

In particular, the midpoint of a unidimensional, bi-polar attitude scale (e.g., half way between 'extremely positive' and 'extremely negative') is regarded as ambiguous (Kaplan, 1972). It could indicate attitudinal indifference (a state that occurs when a behaviour is simultaneously evaluated as neither positive nor negative) or attitudinal ambivalence (a state that occurs when a behaviour is simultaneously evaluated as both positive and negative). As a solution to this problem, Kaplan (1972) recommended splitting the unidimensional, bipolar attitude scale at its mid-point, thus producing two separate dimensions of attitude: a unipolar positive attitude dimension and a unipolar negative dimension (i.e., bi-dimensional attitudes). Operationally, Kaplan (1972) recommended the split semantic differential technique as a method for measuring the two attitude dimensions. The split semantic differential technique involves asking participants to think separately about the positive and negative outcomes of a behaviour and to separately rate the positivity of the positive outcomes and the negativity of the negative outcomes using unipolar scales. Effectively, this removes the ambiguous mid-point of a unidimensional, bipolar attitude scale and acknowledges the possibility that an individual can hold both positive and negative attitudes towards the same behaviour (e.g., speeding) at the same time (Thompson et al, 1995).

Support for bi-dimensional attitudes comes from factor analytic studies, which have demonstrated that positive and negative evaluations load onto two independent dimensions (e.g., Conner et al., 2002). However, researchers have typically continued to treat attitudes as unidimensional predictors of behaviour (e.g., McEachan, Conner, Taylor & Lawton, 2011). This violates the (positive versus negative) bi-dimensional conceptualisation of attitudes. It

also does not allow researchers to identify how well each attitude dimension can predict behaviour and thus gain greater insight into why drivers' might exceed the speed limit (i.e., is it primarily because they positively evaluate the perceived desirable outcomes of speeding or because they do not negatively evaluate the undesirable outcomes?). Furthermore, from an intervention perspective, this issue is potentially important for identifying the most effective levers for reducing speeding. Most notably, the majority of road safety interventions target the negative dimension of attitude with messages that are designed to persuade drivers that the negative outcomes of speeding (e.g., traffic crashes) are undesirable and likely (e.g., Carey et al, 2013; Fylan & Stradling, 2014; Plant, Irwin & Chekaluk, 2017). Given the above cited experimental studies showing that these interventions are typically ineffective at changing driver behaviour, a pressing question is: should practitioners continue with this approach? Alternatively, should they design educational messages that focus more exclusively on the positive dimension of attitude by persuading drivers that the perceived positive outcomes of speeding (e.g., getting to one's destination quickly) are not necessarily as desirable or likely as they might think? Or should both approaches be used in an attempt to discourage speeding? (For a recent discussion of these issues see Lewis, Watson & White, 2016). In order to help answer these questions, research testing the independent effects of the positive and negative attitude dimensions on drivers' speeding behaviour is warranted. Prior to this study, only one previously published article has addressed this issue.

Elliott, Brewster, Thomson, Malcolm and Rasmussen (2015) reported three independent studies in which they tested the effects of the positive and negative attitude dimensions on a range of health-risk behaviours, including speeding. Both the attitude dimensions independently predicted subsequent self-reported speeding. Elliott, Brewster, et al. (2015) also found an asymmetrical relationship, with the positive dimension of attitude being more predictive of subsequent behaviour than the negative dimension. On the basis of this 'positivity bias' (e.g., Boucher & Osgood, 1969), Elliott, Brewster, et al. (2015)

suggested that the positive dimension of attitude had more utility in dictating behaviour than the negative dimension and that behaviour-change interventions should therefore primarily target the positive dimension of attitude.

One potential limitation with Elliott, Brewster, et al. (2015)'s research, however, is that it focused on self-reported measures of behaviour. This is potentially problematic because self-reported behaviour measures are vulnerable to cognitive (e.g., Murdock, 1962), affective (e.g., Mayer, McCormick, & Strong, 1995) and self-presentation biases (e.g., Gur & Sackeim, 1979; Paulhus & Reid, 1991). It is therefore important to replicate findings based on self-reports using objective behaviour measures, which are less vulnerable to these criticisms. In the present context, this would enable researchers to make stronger conclusions about the predictors of speeding and possible ways to reduce it. The first aim of this study, therefore, was to test the bi-dimensional attitude-behaviour relationship using an objective measure of speeding that was derived from a driving simulator. A driving simulator was used as it allowed optimal experimental control with all drivers being exposed to the same stimuli, which is not possible in the real world. It was hypothesised that the positive and negative dimensions of attitudes will both independently predict objectively measured speeding but there will be an asymmetrical relationship with the positive dimension being more predictive than the negative dimension.

The present research further aimed to extend Elliott, Brewster, et al.'s (2015) findings by addressing the question of why the positive attitude dimension might be more predictive of behaviour than the negative dimension. We focused on attitude accessibility to address this issue. Attitude accessibility is a concept that can be found in the MODE model of attitude-to-behaviour processes (e.g., Fazio and Williams, 1986 and 1990a; Fazio & Towles-Schwen, 1999). According to this model, attitudes need to be retrieved from memory in order to guide behaviour. Attitudes can be retrieved from memory through a deliberative process that occurs when individuals are motivated and have the opportunity to reflect on their attitudes.

However, individuals often lack the motivation or opportunity to deliberate before behaving. In the case of speeding, for example, drivers may lack the motivation to reflect on their attitudes because driving is highly routinized; affording it the opportunity to become habitual, meaning that it is often controlled by automatic processes, which reduce the need for cognitive deliberation (see Ouellette & Wood, 1998). Additionally, drivers are often likely to lack the opportunity for attitudinal reflection because the driving task requires them to adjust their behaviour on moment-by-moment basis in order to cope with changes in road and traffic conditions, thus using up necessary attentional resources (Elliott, Lee, Robertson & Innes, 2015). The MODE model therefore proposes that attitudes can also be retrieved from memory automatically when an individual encounters salient cues associated with the attitude-relevant behaviour (e.g., when drivers encounter situations that they associate with speeding, their attitudes will be retrieved from memory spontaneously). Automatically retrieved attitudes are then held to exert a biasing effect in the immediate situation, effectively priming (initiating rapidly and with little conscious awareness) attitude-congruent behaviour (e.g., Fazio, 2001; Olson & Fazio, 2009).

Importantly, it is specified in the MODE model that only chronically accessible attitudes can be retrieved from memory automatically. It is proposed that all attitudes are located on a 'non-attitude' to 'attitude' continuum of associative strength. At the non-attitude end of the continuum, individuals have not yet developed an association between a behaviour (e.g., speeding) and their evaluation of it. Thus, when a behaviourally relevant situation is encountered, there is no pre-established attitude that can be retrieved to guide behaviour. At the other end of the continuum, however, attitudes are characterized by strong, well-learned, or reinforced, behaviour-evaluation associations. These attitudes have therefore been pre-formed, they have subsequently become chronically accessible and they are therefore capable of being retrieved automatically. It can be seen in the MODE model, therefore, that attitude accessibility follows attitude formation and is held to causally increase attitude-behaviour

correspondence because it dictates whether attitudes can be retrieved from memory (e.g., Fazio, 1990a; Fazio, 2001).

In support of the proposition that attitude accessibility increases attitude-behaviour correspondence, previous studies have shown that shorter latencies of response to attitudinal enquiries (typically used as operational measures of attitude accessibility) moderate the relationship between unidimensional measures of attitudes and a range of behaviours (e.g., Fazio & Williams, 1986; Fazio, Powell, & Williams, 1989), including speeding (Elliott, Lee, et al, 2015). In the present study, however, our concern was not with this established moderator effect. Instead, we hypothesised that attitude accessibility will mediate the asymmetry in the bi-dimensional attitude-behaviour relationship and thus help explain why the positive attitude dimension is a stronger predictor of speeding than the negative dimension. The rationale was that the positive outcomes of speeding (e.g., getting to one's destination quicker) are typically more immediate, frequent and guaranteed than most of the negative outcomes (e.g., a traffic crash or being caught by the police; cf. Cacioppo, Gardner & Berntson, 1997). This should result, on average, in the positive attitude dimension being reinforced to a greater extent than the negative dimension. In turn, the association between the behaviour of speeding and evaluations that lie on the positive dimension of attitude (i.e., not at all positive to extremely positive) should be stronger than the association between the behaviour of speeding and evaluations that lie on the negative dimension of attitude (i.e., not at all negative to extremely negative), meaning that the positive attitude dimension should be more chronically accessible in memory and therefore more predictive of behaviour.

Aims and hypotheses

To summarise, this study was conducted to test the following hypotheses:

- Hypothesis 1: The positive and negative dimensions of attitudes will both independently predict objectively measured speeding in a driving simulator.

- Hypothesis 2: The positive attitude dimension will be more predictive of behaviour than the negative dimension.
- Hypothesis 3: The positive dimension of attitude will be more accessible than the negative dimension.
- Hypothesis 4: The difference in the accessibilities of the positive and negative attitude dimensions (with the positive attitude dimension being more accessible than the negative attitude dimension) will mediate the difference in the predictive validities of the positive and negative attitude dimensions (with the positive attitude dimension being more predictive of behaviour than the negative attitude dimension).

Method

Participants. One hundred and six drivers completed the study. The participants were invited to take part using advertisements placed on notice boards around the campus of a large university in the West of Scotland and online posts (e.g., advertisements on social networking sites). Only active drivers who held a full UK driving licence and drove at least once a week were included in the study. The mean age of the sample (n = 106) was 23.63 (SD = 9.62; range = 18-69). The mean number of years that participants held a driving licence was 4.92 (SD = 8.36, range 0.08-50). The mean number of miles driven per week was 81.07 (SD = 99.77; range 3-600). Twenty eight percent of the sample (n = 30) was male.

Design and Procedure. A correlational design was used. The participants were invited to participate after being informed the study was a general-purpose investigation into driver behaviour and attitudes. All the participants were invited to the Driving Research Laboratory situated in the University's School of Psychological Sciences and Health. The participants were asked to complete an online questionnaire designed and administered using Qualtrics Survey Design and Administration Software. The same computer was used to administer the

questionnaire to each participant. The questionnaire contained four items to measure demography (age, gender, years licenced to drive and weekly mileage) and six items to measure the positive (3 items) and negative (3 items) dimensions of the participants' attitudes towards speeding. The questionnaire was programmed to measure the latencies of the participants' responses to the attitude items, which allowed measures of the accessibility of each attitude dimension to be calculated (see below). The attitude items were also presented amongst 9 'filler items' about the participants' general driving behaviour. The purpose of the filler items was to minimise any effects of consistency biases (e.g., Budd, 1987) on the responses to the attitude items. The response latencies for the filter items were also recorded using Qualtrics and these response latencies were used in the data analyses to control for the potential effects of literacy and psychomotor skills on the findings (see below).

Following completion of the questionnaire, the participants were invited to drive on a driving simulator in order to obtain objective measures of their speeding behaviour. The driving simulator was an interactive fixed-based driving simulator modelled on the layout of a British car (i.e., right-hand drive). The simulator had three high resolution screens to the front, providing 210 degree visual field of view. The simulator operated with an automatic transmission and had controls (e.g., a steering wheel, indicators, clutch, brake, and accelerator) that were situated and operate as in real life. The rear-view mirror was shown at the top of the centre screen and a speedometer and tachometer were shown at the bottom. The wing mirrors were shown on the side screens.

Before the participants drove on the trial route, they were given a five-minute practice drive to get used to the simulator controls. Following the practice drive, the participants completed the trial route, which comprised a 12.17 mile section of road through an urban environment. The drive took approximately 25 minutes to complete and speed was recorded every 5 feet of the drive. The participants were told that they would be driving on an urban road with a 30mph speed limit, and they were asked to drive as if it were a real road in the

real world. They were also told to drive straight ahead (i.e., not to turn at any junctions). The trial route comprised 50 junctions and straight sections of road linking them. In order to increase the fidelity of the drive, ten of the junctions had traffic lights that were programmed to be on the 'red' light when the participants reached them, requiring them to stop. With the exception of these instances, the route had no other factors that restricted speed. Traffic was modelled in the oncoming lane only. After completing the route, the participants were thanked and debriefed.

Bi-dimensional attitudes measures. The questionnaire comprised standard items that are commonly used to collect measures of attitudes. The participants were asked to respond to all attitude items on 9-point scales (using a mouse). All items detailed below were presented in a pseudo- random order, with the response scales reversed for half the items in order to reduce response set bias (e.g., Nederhof, 1985).

The split semantic differential technique (Kaplan, 1972) was used to measure the positive and negative dimensions of attitude.[1] This is the standard procedure used to measure the separate positive and negative dimensions of attitudes (e.g., Elliott, Brewster, et al, 2015; Kaplan, 1972; Conner et al, 2002). Three items were used to measure the positive dimension of attitude: "Think only about the enjoyable outcomes that you associate with driving faster than the speed limit. How enjoyable are they?" (Not at all enjoyable [scored 1] to extremely enjoyable [scored 9]); "Think only about the rewarding outcomes that you associate with driving faster than the speed limit. How rewarding are they?" (Not at all rewarding [scored 1] to extremely rewarding [scored 9]); and "Think only about the pleasant outcomes that you

[1] Kaplan (1972) recommended that the split semantic differential technique be used to ask participants to consider only the positive qualities (i.e., attributes) of a concept and to evaluate how positive its positive qualities are. However, given that the attributes of behaviours such as speeding are behavioural outcomes (e.g., Fishbein & Ajzen, 1975; Ajzen, 1985), we operationally defined the positive and negative attitude dimensions in terms of evaluations of the *outcomes* of speeding. This is in keeping with many previous studies on (unidimensional) attitudes towards behaviours in which evaluations of behavioural outcomes have been used to measure attitudes and in which evaluations of behavioural outcomes have been shown to correlate highly with direct attitude measures (e.g., Armitage & Conner, 2001; Elliott, Armitage & Baughan, 2005).

associate with driving faster than the speed limit. How pleasant are they?" (Not at all pleasant [scored 1] to extremely pleasant [scored 9]). The mean of the three items was calculated to produce a composite measure that served as the positive dimension of attitude in the data analysis (Cronbach's $\alpha = 0.85$). Higher scores on this composite measure indicated more positive attitudes.

Three items were also used to measure the negative dimension of attitude: "Think only about the unenjoyable outcomes that you associate with driving faster than the speed limit. How unenjoyable are they?" (Not at all unenjoyable [scored 1] to extremely unenjoyable [scored 9]); "Think only about the unrewarding outcomes that you associate with driving faster than the speed limit. How unrewarding are they?" (Not at all unrewarding [scored 1] to extremely unrewarding [scored 9]); and "Think only about the unpleasant outcomes that you associate with driving faster than the speed limit. How unpleasant are they?" (Not at all unpleasant [scored 1] to extremely unpleasant [scored 9]). The mean of the three items provided a composite measure of the negative attitude dimension for use in the data analysis (Cronbach's $\alpha = 0.71$). Higher scores on this composite measure indicated more negative attitudes.[2]

Attitude accessibility measures. The accessibility of the positive and negative dimensions of attitude was also measured using standard procedures commonly used in the literature (e.g., Fazio, 2001; Fazio & Williams, 1986). Specifically, the participants were

[2] A confirmatory factor analysis was used to test the discriminant validity of the positive and negative attitude dimensions. A two-factor model was tested (factor 1 – the positive attitude dimension; factor 2 – the negative attitude dimension). The factors were allowed to co-vary. Each factor had three indicators (the three items from the questionnaire measuring the positive attitude dimension and the three items measuring the negative attitude dimension) with associated error terms. The model provided an excellent fit to the data and supported the separation of the positive and negative attitude dimensions (see appendix). An exploratory (principal components) factor analysis (oblique rotation) with parallel analysis to ensure no spurious factors emerged from the data (Horn, 1965; Cota, Longman, Holden, Fekken & Xinaris, 1993) was also conducted given that exploratory factor analyses can sometimes reveal divergent findings from confirmatory factor analyses. Consistent with the confirmatory factor analysis, the principal components analysis revealed a two component model that supported the separation of the positive and negative attitude dimensions (also see appendix). Regardless of the analysis technique used, the results supported the independence of the positive and negative attitude dimension measures.

presented with an instruction screen before each of the items that were used to measure the positive and negative dimensions of attitude, described above. Before each item, the participants were instructed to "answer the next question as quickly and as accurately as possible while making sure that your response accurately reflects your opinion". The participants were then asked to click a "NEXT" button when they were ready to complete each item. The items were then presented along with the response scales. Response latencies were measured for each item (i.e., response time from item onset to final response). The mean of the response latencies to the three positive attitude dimension items was used as the measure of positive attitude dimension accessibility (Cronbach's $\alpha = 0.69$). The mean of the responses latencies to the three negative attitude dimension items was used as the measure of negative attitude dimension accessibility (Cronbach's $\alpha = 0.69$). The mean response latency measures were subjected to a reciprocal transformation (1/response latency) and multiplied by 1000, in order to increase the normality of their distribution and avoid problems associated with small numbers (see Fazio, 1990b). This meant that higher scores on these measures indicate faster response times, and thus greater attitude accessibility.

In a previous programme of research on unidimensional attitudes, attitude accessibility and speeding behaviour (Elliott, Lee, et al., 2015), response latency measures of attitude accessibility were obtained from a single attitude item. However, multi-item measures are regarded as preferable to single items because single items can lack reliability (e.g., Nunnaly, 1978). For this reason, and also to permit tests of discriminant validity of the bi-dimensional attitude measures (see appendix), multi-item measures of bi-dimensional attitudes and their accessibilities were used in this study. To avoid confounding the attitude accessibility measures (i.e., to avoid responses to previously presented attitude items from priming responses to subsequently presented attitude items and thus engendering faster response latencies), a standard cognitive distractor task (Brown, 1958, Peterson & Peterson, 1959) was used to empty participants' working memory prior to the completion of each

attitude item. Prior to the items measuring the positive and negative dimensions of attitude, the participants were shown a number on the screen and asked to count backwards in units of either 3 or 4 until the next question appeared. This task has been shown to be an effective strategy for emptying working memory by reducing the opportunity for information to be rehearsed and remembered (e.g., Mertens, Gagnon, Coulombe & Messier, 2004; Peterson & Peterson, 1959; Rai & Harris, 2013).

Filler items. As mentioned in the design and procedure section, the attitude items were also presented amongst filler items about general driver behaviour. The filler items were: "How often do you drive to and from work/university?"; "How often do you drive during rush hour traffic?"; "How often do you drive in built-up areas?"; "How often do you drive as part of your work?"; "How often do you drive in residential areas?"; "How often do you drive when it is dark?"; "How often do you drive in busy town centres?"; and "How often do you drive to the shops?" and "How often do you drive with passengers in your vehicle?". The participants responded to all filler items using 9-point scales (never to very often). The response latencies to the filler items were recorded and transformed in the same way as described above for the attitude response latencies. The mean of the response latencies to the filler items was then used as a control variable in the subsequently presented mediation analysis. The rationale was that any difference between the measures of positive and negative attitude accessibility could be due to genuine differences in attitude accessibility (i.e., how quickly participants could recall their attitudes from memory), or differences in literacy or psychomotor abilities (i.e., how quickly participants could read the items or provide their responses on the scales). However, controlling for the latencies of responses to the filler items meant that any differences in the latencies for the positive and negative attitude items could be attributed to differences in attitude accessibility rather than literacy or psychomotor skills.

The speeding behaviour measure. Following previous research (e.g., Brewster, Elliott, McCartan, McGregor & Kelly, 2016; Elliott, Armitage & Baughan, 2007), the speeding behaviour measure was the percentage of the simulator drive that the participants spent driving over the speed limit. This was operationalised as 30.50mph or above (i.e., 0.5 mph over the posted speed limit in order to prevent micro-fluctuations in speed around 30mph from unduly influencing the results).

Previous research has shown that the demographic and socio-cognitive variables that are typically associated with real-world speeding behaviour and traffic-crash rates have been also been found to be associated with the present measure of speeding behaviour as measured on the driving simulator that was used in this study. More specifically, age and driving experience are the key demographic predictors of both real-world speeding and traffic-crash risk, with younger and less experienced drivers being found to speed more often and have higher traffic-crash rates than older and more experienced drivers (e.g., Stradling, Campbell, Allan, Gorell, Hill, Winter, & Hope, 2003; McCartt, Mayhew, Braitman, Ferguson, & Simpson. 2009; Department for Transport, 2016). A re-analysis of the data from an independent study by Brewster et al. (2016) showed that both these demographic variables were reliable predictors of the percent of time that participants spend driving over the speed limit on the present driving simulator (for age: $\beta = -.26$, $p < .01$; for driving experience: $\beta = -.23$, $p < .01$). Additionally, Conner et al. (2007 [study 2]) showed that the socio-cognitive variables that predict on-road vehicle speeds in the real world were behavioural intention ($\beta = -.35$, $p < .01$), perceived behavioural control ($\beta = -.03$, $p < .05$) and moral norm ($\beta = -.21$, $p < .05$). Re-analysis of the data collected by Brewster et al. (2016) showed that behavioural intention ($\beta = -.35$, $p < .01$), perceived behavioural control ($\beta = -.14$, $p < .05$) and moral norm ($\beta = -.16$, $p < .05$) also predicted vehicle speed in this driving simulator. We return to the issue of simulator validity in the discussion.

Results

Descriptive statistics and correlations. The sample means, standard deviations and correlations for the two dimensions of attitude and the measure of speeding behaviour are shown in table 1. The sample mean for the positive attitude dimension was around the scale mid-point (i.e., 5), which indicated that the participants, on average, evaluated the positive outcomes of exceeding the speed limit as moderately positive. The sample mean for the negative dimension was between the middle and top end of the scale (i.e., 9), which indicated that the participants, on average, evaluated the negative outcomes of exceeding the speed limit as moderately to very negative. The participants, on average, exceeded the speed limit for 31.63% of the simulator drive. In addition to the data in table 1, 92.5% of participants exceeded the speed limit at least once; 50% exceeded the speed limit for a quarter of the drive or more; 28.3% exceeded the speed limit for half of the drive or more; and 10.4% exceeded the speed limit for three quarters of the drive or more.

The correlations in table 1 show that the two attitude dimensions were negatively correlated. Thus, the more that the participants evaluated the positive outcomes of exceeding the speed limit as being positive, the less they evaluated the negative outcomes as being negative. This correlation (r = -.31) was substantially below Tabachnick and Fidell's (1996) criterion for demonstrating independence among constructs (r < .70), even when disattenuated for measurement error (disattenuated correlation = -0.51). The correlations in table 1 also show that the positive dimension of attitude was positively correlated with behaviour (i.e., the more the participants evaluated the positive outcomes of exceeding the speed limit as positive, the more they exceeded the speed limit) and the negative dimension was negatively correlated with behaviour (i.e., the more the participants evaluated the negative outcomes of exceeding the speed limit as negative, the less exceeded the speed limit).

Table 1. *Descriptive statistics and correlations for exceeding the speed limit.*

Variable	1.	2.	3.	Mean	SD	Min	Max
1. Behaviour	-	.52**	-.35**	31.63	28.01	0	94
2. Positive Dimension		-	-.31*	4.70	1.93	1	8.67
3. Negative Dimension			-	6.78	1.60	3	9

*$p < .05$ ** $p < .001$

In addition to the descriptive data shown in table 1, the participants, on average, had higher scores on the accessibility measure of the positive attitude dimension than they did on the accessibility measure of the negative attitude dimension. The mean on the accessibility measure of the positive attitude dimension was $M = 145.62$ ($SD = 42.64$). The mean on the accessibility measure of the negative attitude dimension was $M = 127.48$ ($SD = 40.95$). This meant that the average response latency to the positive and negative attitude dimension items was 7.48 seconds ($SD = 2.29$) and 8.73 seconds ($SD = 3.06$), respectively.

Predicting behaviour from bi-dimensional attitudes. To test whether the positive and negative attitude dimensions independently predicted objective speeding behaviour, a multiple linear regression was conducted (see table 2). The dependent variable was speeding behaviour and the predictor variables were the positive and negative dimensions of attitude.

Table 2. *Multiple linear regression predicting speeding behaviour from the positive and negative dimensions of attitude.*

Variables	R^2	F	β	*t* test for difference
Positive dimension	.31	23.39	.46**	6.34**
Negative Dimension			-.21*	

*$p < .05$ ** $p < .001$

In support of hypothesis 1, the regression revealed that both the positive and negative attitude dimensions independently predicted objectively measured behaviour, accounting for 31% of the variance. In addition, and in support of hypothesis 2, the positive dimension was more predictive than was the negative dimension because it had a significantly larger beta-weight (see *t* test for difference in table 2).

Testing the difference between the accessibilities of the positive and negative attitude dimensions. In order to test whether the positive attitude dimension was significantly more accessible in memory than was the negative attitude dimension, a paired samples *t*-test was conducted on the response latency measures of these constructs. In support of hypothesis 3, the *t*-test revealed that the positive attitude dimension was more accessible in memory than was the negative attitude dimension, $t\ (102) = 4.58$, $p < .001$, $d = 0.45$.

Attitude accessibility mediation analysis. Mediation analyses are used to define a causal path from a predictor (e.g., the differences in predictive validities of the positive and negative dimensions of attitude, with the positive dimension of attitudes being a better predictor of behaviour than the negative dimension) to an outcome (e.g., speeding behaviour) through a proposed mediator (e.g., the difference between the accessibilities of the positive and negative attitude dimensions). Temporal sequencing is regarded as critical in such analyses (i.e., the predictor must come before the mediator and both the predictor and the

mediator must come before the outcome in the temporal sequencing of events). As noted in the introduction, the MODE model specifies that attitude accessibility is a property of attitude which follows attitude formation and subsequently dictates (i.e., causally influences) the extent to which attitudes can guide behaviour. Therefore, in the present context, mediation (i.e., causal) analyses are appropriate for testing whether differences in accessibility between the positive and negative dimensions of attitudes mediate the differences in their predictive validities (i.e., whether the asymmetrical relationship between bi-dimensional attitudes and behaviour, with the positive dimension of attitudes being a better predictor of behaviour than the negative dimension, can be explained by the positive attitude dimension being more accessible in memory).

The following procedure was used to test whether the difference in attitude accessibility (with the positive attitude dimension being more accessible than the negative dimension) mediated the difference between the predictive validities of the positive and negative attitude dimensions, on the one hand, and behaviour, on the other (with the positive attitude dimension being more predictive of behaviour than the negative attitude dimension; see previous subsection). First, we calculated, for each participant, both the difference between the scores on the positive and negative attitude dimensions (Difference $_{\text{Positive/Negative}}$) and the sum of the scores on the positive and negative attitude dimensions (Sum $_{\text{Positive/Negative}}$). Second, we calculated, for each participant, the difference between the scores on the positive and negative attitude accessibility measures (Difference $_{\text{Accessibility}}$). Third, we calculated an average of the response latencies to the filler questions (Control $_{\text{Response latencies}}$).

Next, we ran a mediation analysis using the Hayes (2009) technique (also see Hayes, 2018). The measure of speeding behaviour was the dependent variable. The Difference $_{\text{Positive/Negative}}$ was the independent variable. Difference $_{\text{Accessibility}}$ was the mediator. Sum $_{\text{Positive/Negative}}$ and Control $_{\text{Response latencies}}$ were the covariates. Including Sum $_{\text{Positive/Negative}}$ as a covariate meant that the beta weight for the independent variable (Difference $_{\text{Positive/Negative}}$)

was an estimate of the difference between the predictive validities of the positive and negative attitude dimensions (i.e., β for the positive attitude dimension versus β for the negative attitude dimension in the prediction of behaviour; see table 2). Including Control $_{\text{Response latencies}}$ as a covariate meant that between participant differences in literacy and psychomotor abilities were statistically controlled (see method section).

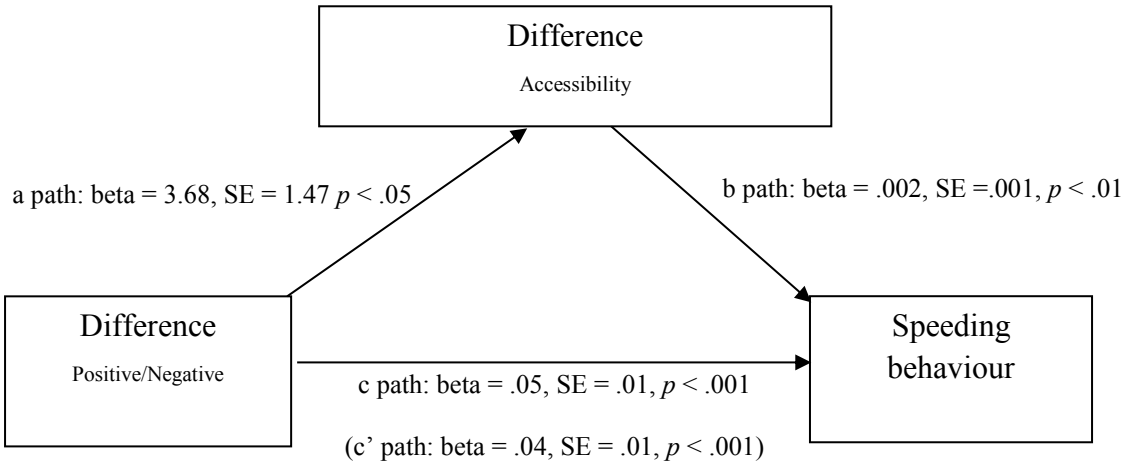


Figure 1. Mediation of the difference in predictive validity of the positive and negative attitude dimensions (β Positive versus β Negative) on speeding behaviour by the difference in the accessibilities of the positive and negative attitude dimensions (Accessibility Positive versus Accessibility Negative).

As can been seen in Figure 1, the effect of Difference $_{\text{Positive/Negative}}$ on Difference $_{\text{Accessibility}}$ was statistically significant (a path) as was the effect of Difference $_{\text{Accessibility}}$ on speeding behaviour (b path). In addition, both the direct (c path) and indirect (c' path) effects of Difference $_{\text{Positive/Negative}}$ on speeding behaviour were statistically significant. The indirect (mediation) effect of Difference $_{\text{Positive/Negative}}$ on speeding behaviour through Difference $_{\text{Accessibility}}$ (c' path) was tested using Hayes (2009) bootstrapping procedure with 5000 random bootstrap samples. This showed that the 95% confidence interval around the indirect effect

was 95% CI = .0005 to .0125. Since this 95% CI did not span zero, it meant that the indirect effect was statistically significant at $p < .05$. Thus, in support of hypothesis 4, the observed difference between the accessibilities of the positive and negative attitude dimensions significantly mediated the observed difference between the predictive validities of the positive and negative attitude dimensions on speeding behaviour.

Discussion

The first aim of this research was to test the bi-dimensional effects of attitudes on objectively measured speeding in a driving simulator. Hypothesis 1 was that the positive and negative dimensions of attitudes will both independently predict objectively measured speeding in a driving simulator. Hypothesis 2 was that the positive dimension will be a stronger predictor than the negative dimension. The second aim of this research was to test whether attitude accessibility mediates the asymmetrical relationship between bi-dimensional attitudes and behaviour. Hypothesis 3 was that the positive dimension of attitude will be more accessible than the negative dimension. Hypothesis 4 was that this difference in attitude accessibility will mediate the difference in the predictive validities of the positive and negative attitude dimensions (i.e., explain why the positive attitude dimension is more predictive of behaviour than the negative attitude dimension).

Bi-dimensional effects of attitudes on objectively measured behaviour

In support of hypothesis 1, the results showed that both the positive and negative dimensions of attitude independently predicted objectively measured speeding in the driving simulator. In support of hypothesis 2, the positive attitude dimension was a significantly stronger predictor of speeding behaviour than was the negative attitude dimension. These findings are consistent with Elliott, Brewster, et al. (2015) who also found that both the positive and negative attitude dimensions were significant independent predictors of behaviour with the positive attitude dimension being the stronger predictor. These findings therefore provide further support for attitudes being bi-dimensional predictors of behaviour

and that bi-dimensional attitudes have an asymmetrical relationship with risky behaviours such as speeding. However, because this study used an objective measure of behaviour, the findings extend Elliott, Brewster, et al. (2015) in which only self-reported outcomes (intentions or behaviour) were used. Given that objective behaviour measures are less vulnerable to potential cognitive (e.g., Murdock, 1962), affective (e.g., Mayer, et al, 1995) and self-presentation biases (e.g., Gur & Sackeim, 1979; Paulhus & Reid, 1991) than are self-reported measures, it means that the findings can be held with greater confidence. Additionally, the consistency between the findings of Elliott, Brewster, et al. (2015) and this study implies that either self-reported or objective (simulator) measures of behaviour can be employed in future research when testing the relationship between bi-dimensional attitudes and behaviour. More generally, the present findings extend most previous research on the attitude-behaviour relationship in which attitudes are treated as unidimensional rather than bi-dimensional predictors of behaviour (e.g., McEachan et al., 2011).

Mediation of the asymmetrical relationship between bi-dimensional attitudes and behaviour

In support of hypothesis 3, it was found that the participants had shorter latencies of response to the items measuring the positive dimension of attitude than the items measuring the negative dimension, indicating that the positive dimension was more accessible in memory (e.g., Fazio, 1990a). This finding is consistent with the rationale presented in the introduction that the higher prevalence, on average, of positive outcomes compared with negative outcomes results in the positive dimension of attitude being reinforced to a greater extent than the negative dimension, resulting in stronger (i.e., more accessible) attitudes.

Importantly, the difference between the accessibilities of the positive and negative attitude dimensions was found to significantly mediate the greater predictive validity of the positive attitude dimension compared with the negative attitude dimension. This finding therefore supports hypothesis 4 and extends research on bi-dimensional attitudes, which has not yet identified mediators of the asymmetrical relationship between positive and negative

attitude dimensions, on the one hand, and behaviour, on the other (Elliott, Brewster, et al, 2015). This finding suggests that the positive dimension of attitude dictates behaviour to a greater extent than does the negative attitude dimension because it is, on average, more available in memory and therefore better able to guide behaviour when a behaviourally-relevant situation (e.g.., a situation in which a driver has the opportunity to speed) arises. The negative dimension of attitude, on the other hand, is less mentally available to guide behaviour when a behaviourally-relevant situation arises (e.g., Fazio, 1990a).

Implications for behaviour-change interventions

The results from this research have potential practical implications for reducing speeding and associated traffic crashes. Given that both the positive and negative dimensions of attitude predicted speeding behaviour, the implication is that interventions should target *both* attitude dimensions. This approach is not typically used in road safety because interventions tend to focus exclusively on the negative dimension of attitudes. For example, it is common for researchers and practitioners to develop interventions that emphasise the negative outcomes of risky driving such as increased risk of traffic crashes or being caught by the police (e.g., Carey et al, 2013). It is less common for interventions to challenge the perceived positive outcomes of risky behaviour such as 'speeding will get me to my destination quicker'. However, this is a viable intervention strategy that is recommended by several researchers, in line with the findings of this study (e.g., Lewis et al., 2016). Therefore, future research could usefully identify the salient beliefs (perceived positive and negative outcomes) that underpin the separate positive and negative dimensions of attitudes so that educational messages can be designed to challenge the appropriate perceived advantages of speeding and reinforce the appropriate perceived disadvantages. While researchers have previously identified salient beliefs that underpin unidimensional attitudes towards speeding (e.g., Elliott, Armitage & Baughan, 2005; Parker, Manstead, Stradling & Reason, 1992;

Warner & Åberg, 2008), they have not, to date, identified the salient beliefs that underpin the separate positive and negative dimensions of bi-dimensional attitudes.

Given that the results from this research also show that attitude accessibility mediated the asymmetry in the bi-dimensional attitude-behaviour relationship, they imply that it is possible to change behaviour by manipulating attitude accessibility. More specifically, interventions that decrease the accessibility of the positive attitude dimension might prevent risky behaviours such as speeding by disabling its ability to dictate behaviour. Similarly, interventions that increase the accessibility of the negative attitude dimension might prevent risky behaviour by enabling its ability to dictate behaviour. Future research might usefully identify effective interventions that can manipulate the accessibilities of the positive and negative attitude dimensions. In particular, interventions that incorporate cognitive restructuring can potentially decrease attitude accessibility (see Foa et al, 2005) and interventions that require people to repeatedly express their attitudes can potentially increase it (e.g., Elliott, Lee, et al., 2015; Powell & Fazio, 1984). Testing the effectiveness of these techniques for decreasing the accessibility of the positive attitude dimension and increasing the accessibility of the negative attitude dimension, and reducing risky behaviours such as speeding, is a potentially worthwhile endeavour.

Methodological Considerations

While the results of this study have important implications for both theory and practice, they need to be interpreted in light of several methodological considerations. First, the objective measures of speeding behaviour were from a driving simulator rather than the real world. Real-world driving can be influenced by numerous motivational (e.g., time pressure) and external (e.g., traffic density) factors that may not have been captured in the driving simulator in this study. However, the findings can be held with confidence on the basis that simulator tasks, when driven under similar instructions to those used in this study, have been shown to produce measures of behaviour, including speed behaviour, which

replicate results that are obtained from real world measures in instrumented vehicles (e.g., Helman & Reed, 2015). In addition, as discussed in the method section, the same constructs that typically predict speeding in the real world (e.g., age, driving experience, behavioural intentions, perceived behavioural control and moral norm) have been shown to predict speeding on the driving simulator that was used in this study. It is also important to note that external factors (e.g., experience of difficult traffic conditions) differ across drivers in the real world and therefore introduce confounds, which are fully controlled in driving simulators because all participants are exposed to the same environmental conditions. That said, given the ecological validity of real-world behaviour measures, future research could usefully measure real-world driving when testing bi-dimensional attitude-behaviour relations.

A second issue to consider is that all participants drove using an automatic transmission in this study whereas most drivers use manual transmissions in the UK. However, there is little evidence to suggest that speeding behaviour is unduly influenced by whether drivers use manual or automatic transmissions (e.g., Selander, Bolin & Falkmer, 2012). This is consistent with hierarchical models of the driving task (e.g., Parker & Stradling, 2001; Summala, 1997) which specify that operational driving skills (e.g., gear shifting) become automated during a 'technical mastery phase' (usually 2-12 months of driving), after which they are performed with little cognitive effort and therefore have little bearing on higher-order decision-making such as speed selection. Given that the sample in this study had held a full driving license for 4.92 years, on average (see 'participants' section), the findings are held with confidence.

Third, it is worth considering the mediation results reported in the article. Notwithstanding their importance for understanding the asymmetry in the bi-dimensional attitude behaviour relationship, it should be borne in mind that in a correlational study, such as this one, it is not possible to distinguish between a mediation model and a confounding model (Hayes & Rockwood, 2017). In other words, other variables associated with attitude

accessibility may explain why attitude accessibility was found to mediate the asymmetry in the bi-dimensional attitude-behaviour relationship. In particular, attitude accessibility is known to be correlated with other facets of attitude strength (e.g., Glasman & Albarracín, 2006; Kokkinaki & Lunt, 1997; Kraus, 1995). It is possible that these other facets of attitude strength might explain the asymmetry in the bi-dimensional attitude behaviour relationship. Experimental research is therefore required to manipulate the accessibilities of the positive and negative attitude dimensions (e.g., through cognitive restructuring or repeated attitude expression) and test the extent to which any changes in attitude accessibility causally increase or decrease the relationship between the positive and negative attitude dimensions, on the one hand, and behaviour, on the other. More generally, it would also be worth testing the extent to which facets of attitude strength, other than attitude accessibility (e.g., attitude certainty or stability), mediate the asymmetry in the bi-dimensional attitude-behaviour relationship that has been observed in this study. Nonetheless, this study has provided correlational evidence, for the first time, that differences between the accessibilities of the positive and negative attitude dimensions mediate the asymmetry in the relationship between bi-dimensional attitudes and behaviour, which goes some way to explaining why the positive attitude dimension is a better predictor of behaviour than the negative attitude dimension. Future research might also usefully test this mediation effect in the context of other behaviours (e.g., traffic light violations or the use of mobile phones while driving).

Conclusions

This research supports the bi-dimensional conceptualisation of attitudes and shows that attitudes are bi-dimensional predictors of objectively measured speeding behaviour in a driving simulator. It provides support for the asymmetrical relationship between bi-dimensional attitudes and behaviour, showing that the positive attitude dimension is more predictive of objectively measured speeding than the negative attitude dimension. Attitude accessibility was found to be a significant mediator of this asymmetrical relationship. Future

research might usefully employ experimental designs to test whether attitude accessibility and other facets of attitude strength can mediate the asymmetrical relationship. Further research is also needed to test interventions that are designed to manipulate bi-dimensional attitudes and their accessibilities in order to change reduce speeding. Finally, further research could usefully test the relationships between bi-dimensional attitudes and other safety-related behaviours.

Appendix

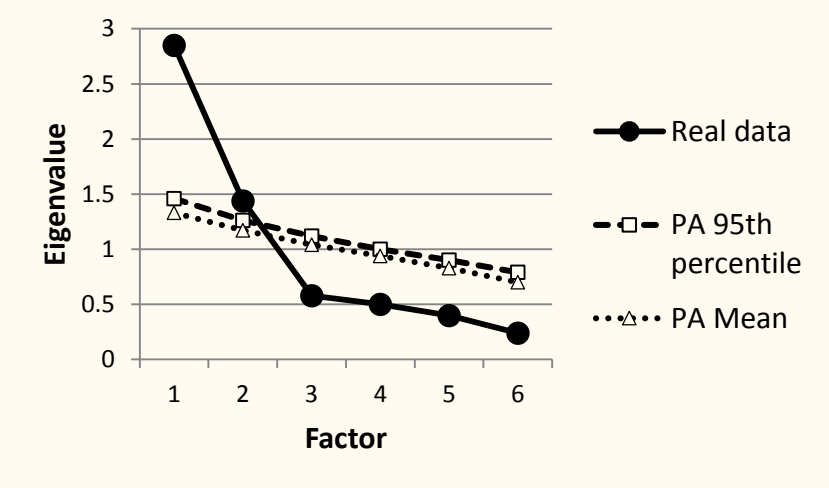
Confirmatory Factor Analysis (two-factor model) of the items used to measure the positive (3 items) and negative (3 items) dimensions of attitude: Standardised regression weights and model fit indices

Items	Factor	
	I Positive Attitude Dimension	II Negative Attitude Dimension
Think only about the enjoyable outcomes associated with driving faster than the speed limit; how pleasant are they?	.741	-
Think only about the rewarding outcomes associated with driving faster than the speed limit; how rewarding are they?	.795	-
Think only about the pleasant outcomes associated with driving faster than the speed limit; how enjoyable are they?	.902	-
Think only about the unenjoyable outcomes associated with driving faster than the speed limit; how unenjoyable are they?	-	.582
Think only about the unrewarding outcomes associated with driving faster than the speed limit; how unpleasant are they?	-	.755
Think only about the unpleasant outcomes associated with driving faster than the speed limit; how unrewarding are they?	-	.721

Model fit indices: $\chi^2(8) = 8.60$, $p = .377$. CMIN/DF = 1.075. CFI = .997. RMSEA = .027. 90% CI = .000 to .120

Appendix (continued…)

Exploratory (Principal Components) Factor Analysis of the items used to measure the positive (3 items) and negative (3 items) dimensions of attitude: Scree plot of Eigenvalues (real data) compared with mean and 95th percentile Eigenvalue estimates from Parallel Analysis (PA) run using 636 random datasets (i.e., sample N = 106 x item N = 6 = 636)



Exploratory (Principal Components) Factor Analysis of the items used to measure the positive and negative dimensions of attitude: Item loadings following direct oblimin rotation

Items	Component	
	I Positive Attitude Dimension	II Negative Attitude Dimension
Think only about the enjoyable outcomes associated with driving faster than the speed limit; how enjoyable are they?	.82	-.08
Think only about the rewarding outcomes associated with driving faster than the speed limit; how rewarding are they?	.90	-.05
Think only about the pleasant outcomes associated with driving faster than the speed limit; how pleasant are they?	.91	.00
Think only about the unenjoyable outcomes associated with driving faster than the speed limit; how unenjoyable are they?	.14	.83
Think only about the unrewarding outcomes associated with driving faster than the speed limit; how unrewarding are they?	-.11	.78
Think only about the unpleasant outcomes associated with driving faster than the speed limit; how unpleasant are they?	-.08	.78
% variance explained	47.41	23.97

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